July 18, 1939. R. POPP ET AL 2,166,607

MULTIPLE CIRCUIT SWITCH

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Fig. 1

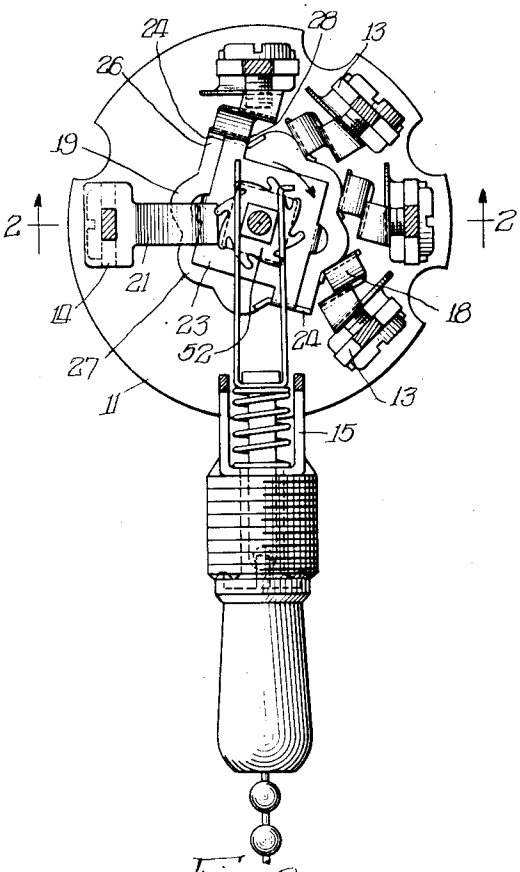


Fig. 4

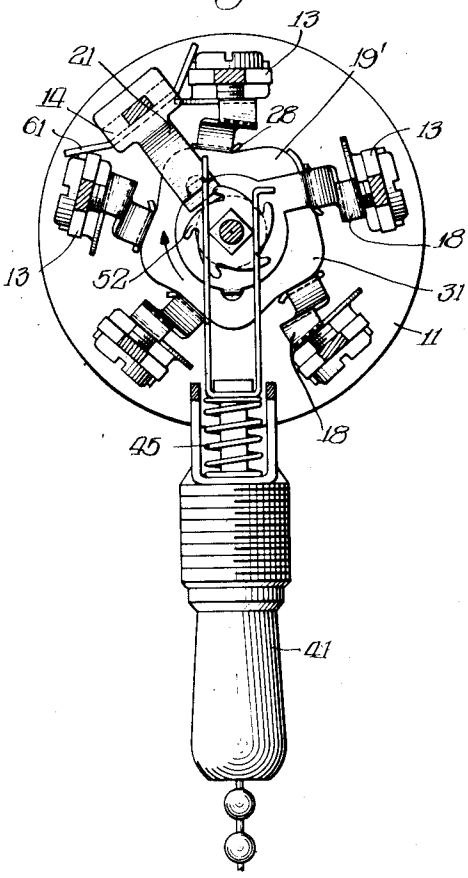


Fig. 2

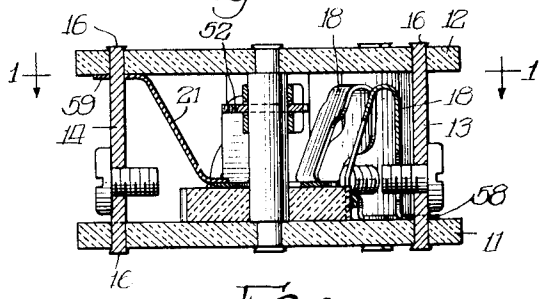


Fig. 5

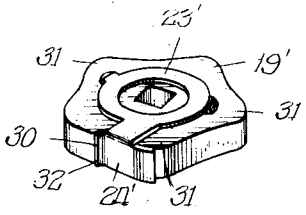
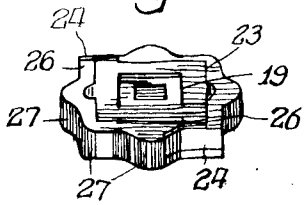


Fig. 3



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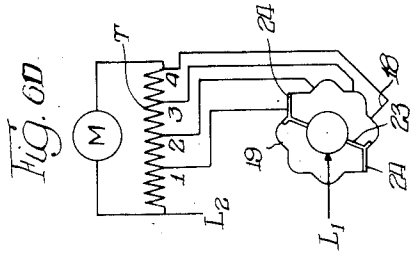
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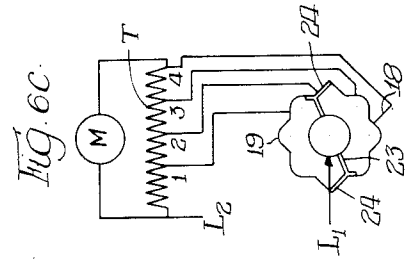
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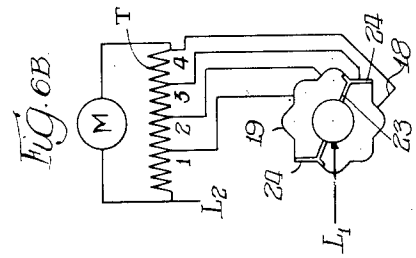
MULTIPLE CIRCUIT SWITCH

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Fig. 6







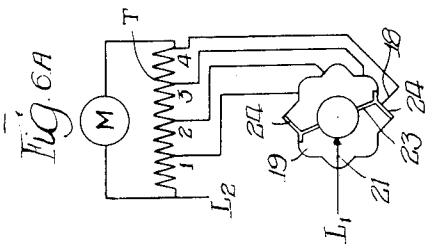
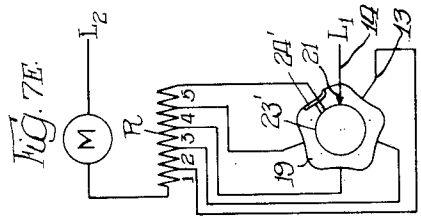
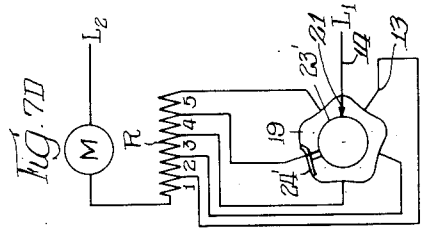
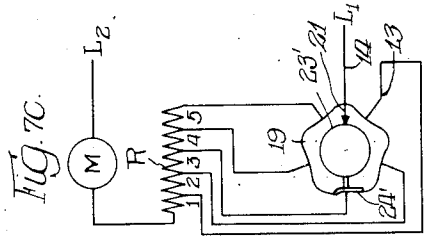
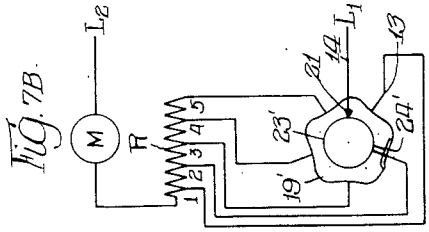


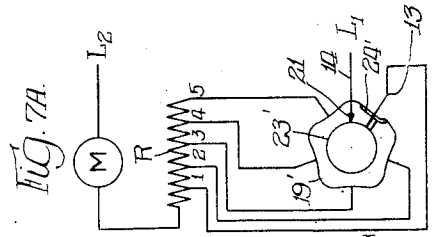
Fig. 7











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MULTIPLE CIRCUIT SWITCH

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Fig. 8

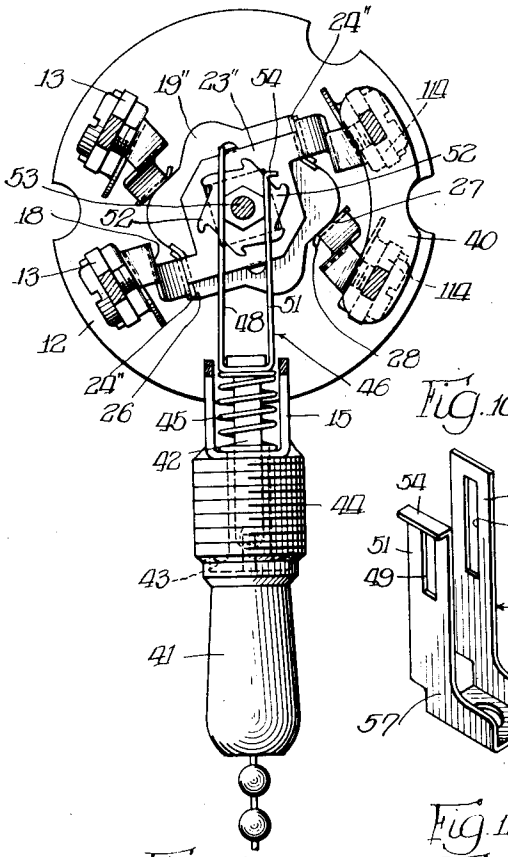


Fig. 9

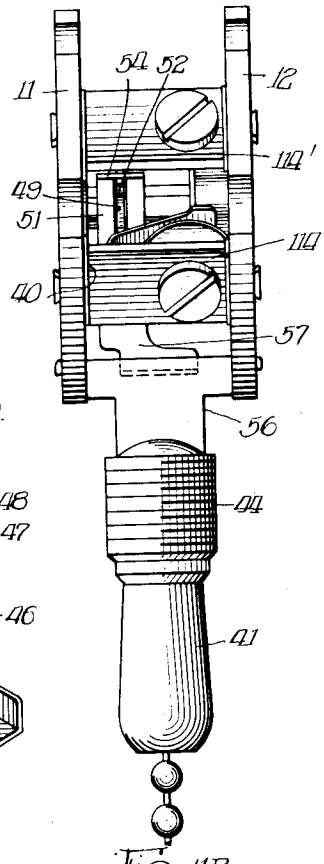


Fig. 10.

Fig. 11

Fig. 11A

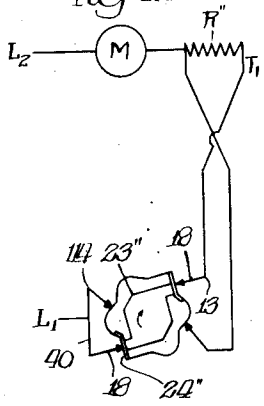


Fig. 11C

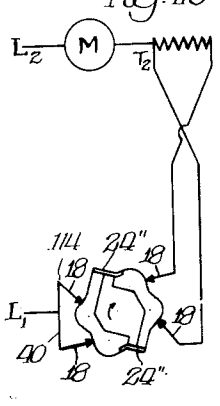
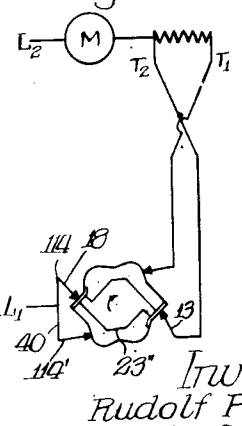


Fig. 11B



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UNITED STATES PATENT OFFICE

2,166,607

MULTIPLE CIRCUIT SWITCH

Rudolf Popp and Marvin C. Carlson, Valparaiso, Ind., assignors to McGill Manufacturing Company, Valparaiso, Ind., a corporation of Indiana

Application April 12, 1937, Serial No. 136,242

3 Claims. (Cl. 200—6)

This invention relates in general to electric switches and more in particular to a switch which is especially adapted for connecting a line to any one of a plurality of circuits, or any one of a plurality of branches of one circuit, as in the case of controlling a tapped resistance or connected to a transformer having a plurality of outlet connections thereon.

The embodiment of the present invention is more particularly an improvement over Patent No. 1,858,597, to the applicant Popp, wherein was disclosed a switch for controlling three circuits, which switch utilized a universal lever and rotatable bridging contact member mounted between two frame plates and rotated by movement of the universal lever. The embodiment of the present invention provides a more simple switch and one which makes possible in an improved manner the control of a greater number of circuits or branches of a single circuit. Among the features of the improved switch of the present invention is a rotor with teeth rounded to a greater extent than the teeth of the switch of the above patent, as well as other switches of the prior art to improve the operation of the switch as well as increase the life of the stationary contacts through which the rotor moves and which are in engagement therewith, as will be more fully discussed hereinafter. The control of the greater number of circuits has been accomplished by means including a radial faced contact for the rotor or switching disc, so that a line may be connected through this radial faced contact and all of the peripheral contacts may be devoted to the control circuit. The result is that the line may be connected to the bridging contact of the rotor or switching disc at all times by means of the radial faced contact, and the peripheral portion of the bridging contact will connect with successive circuits as it is successively rotated to different positions.

Switches which have a relatively large number of stationary contacts bearing on the rotor have heretofore presented considerable trouble in making the switches operate with sufficient ease. In order to insure a quick make and break in the circuit it is customary to provide the rotor with a toothed periphery so that with each movement of the rotor the stationary contacts are sprung away from the axis of rotation by the teeth and spring back as the tooth passes out from under the contact. In other words, as the stationary contact leaves one tooth it springs against another one. If the tooth which it leaves had a contact portion of the bridging contact thereon, the stationary contact would spring away from said bridging contact with sufficient rapidity to substantially prevent arcing. If the tooth against which the stationary contact should spring has a contact portion thereon, it would close the circuit with equal rapidity. Such an arrangement is very satisfactory with a small number of stationary contacts, but with a large number of stationary contacts it takes a very appreciable force to compress all of the stationary contacts at the same time. Since the stroke of the actuating member is limited by the size of the switch including, in this case, the universal lever wherein the diameter of the seated end of the lever determines the length of the stroke, and since it is desirable to keep the switch size small from the standpoint of cost and for the most satisfactory mounting, it is obvious that the mechanical advantages of the actuating member cannot be increased to make up for the greater force required in compressing the stationary contacts and still maintain the same size switch. According to the present invention this difficulty is overcome by so shaping the teeth on the rotor (at least those which do not have thereon contact portions of the bridging contact) that these teeth are made only about half the normal height, considering the distance from valley to peak thereof, and compress the stationary contact springs only during the first half of each movement, these springs urging the rotor forward in the second half of the movement.

Although this feature of specially shaped teeth on the rotor is most necessary in switches having a large number of contacts, it may also be applied to other switches and particularly to rotors with idle teeth therein, by which is meant teeth not carrying contact members. Of course, it can also be applied to the busy or contact teeth of the rotors as well, though usually only to a modified extent, and provision must be made for a quick, clean break of the circuit.

Wherever the teeth are made of reduced size, another advantage is obtained, namely that the stationary contacts have longer life due to the fact that the amplitude of movement is less, and the compression itself upon the member is less. In the switches of the present invention, for example, it is believed that the life of the stationary contacts and hence of the switch is about three times as long as if the teeth were of the conventional size and shape.

From the foregoing discussion, the objects of the invention will be obvious for the most part. In summary, it may be stated that the main objects of the invention are to provide a form of

multiple circuit controlling switch which may be simple in construction, with resulting lower costs, and small in size in spite of controlling even as many as four or five circuits, as by connecting a line to each of them in sequence; and further to make any switches of the toothed rotor type more easily operated.

Other objects and advantages will be apparent from the description and from the drawings, in which:

Fig. 1 is a sectional view of one form of the switch, the section being taken approximately on the line 1—1 of Fig. 2. As illustrated, this switch is provided with an eight-tooth rotor.

Fig. 2 is a sectional view taken approximately on the line 2—2 of Fig. 1.

Fig. 3 is a perspective view of the rotor seen in Figs. 1 and 2.

Fig. 4 is a view corresponding to Fig. 1, but showing a modified form of switch. This embodiment is illustrated with a five-tooth rotor. The switch in this figure, as well as that of Figs. 1 and 2, is illustrated in double the size of an actual commercial embodiment.

Fig. 5 is a perspective view of the rotor therein.

Figs. 6A to 6D are diagrammatic views showing the successive positions of the switch of Figs. 1 to 3 and the resulting connections for a typical load.

Figs. 7A to 7E are similar illustrations showing the successive positions of the switch of Figs. 4 and 5.

Fig. 8 is a sectional view corresponding to Fig. 1, showing a further modification of the invention, with the switch in twice actual size. A six-tooth rotor accomplishes the switching, as this embodiment is illustrated herein.

Fig. 9 is a side elevation of the complete switch of Fig. 8 in a position turned counter-clockwise 90° from the position of Fig. 8.

Fig. 10 is a perspective view of the actuating pawl for the switches of Figs. 1, 4 and 8.

Figs. 11A to 11C are diagrammatic views showing the successive positions of the switch of Figs. 8 and 9.

Although this invention may take numerous forms, only three have been chosen for illustration. In these forms the switch includes a pair of frame plates 11 and 12 spaced apart by a plurality of terminal posts 13 and 14 and a U-shaped stem extension 15, all of which have lugs 16 extending through the frame plates 11 and 12 and upset on the outside thereof to hold the frame plates 11 and 12 firmly on the spacing members to form a rigid structure. Each of the terminal posts 13 has a stationary spring contact 18 secured thereto with its free end bearing against the periphery of a rotor 19 (or rotor 19' in the form of Fig. 4, and rotor 19'' in Fig. 8). The terminal post 14 of Figs. 1 and 4 has a contact 21 secured thereto which bears against the face of rotor 19 or 19'.

The rotor 19 in Figs. 1 and 3 carries a bridging contact 23 which has two contact portions 24 on oppositely disposed teeth 26 of the rotor. The six-tooth rotor 19'' of Fig. 8 carries a bridging contact 23'' which likewise has two oppositely disposed and integral contact portions 24'' on corresponding teeth 26. The bridging contact portions 24 are both integral extensions of the main portion of the bridging contact 23 which lies on the radial face of the rotor 19 and which member 23 is so shaped that it constantly engages the contact 21 which presses against the face thereof. The idle teeth 27, i. e. those which do not have contact portions thereon, are all rounded so that they flex the stationary contact springs 18 less than do the teeth 26 with the contact portions 24 thereon. This greatly prolongs the life of the contacts 18.

It will be observed that each of the contacts 18 is provided with a flange 28 on the edge last engaging the teeth 27 as they pass therefrom. These flanges 28 are so shaped as to provide a smooth inclined surface portion engaging the departing teeth with the result that the pressure of the spring contacts 18 against the teeth urges the rotor in a rotative direction as soon as the high point of the teeth has passed from under the contacts 18. It may be noted that this is also true to some extent as to the teeth 26 bearing the contact portions 24. Of course all contacts 18, except the one or more in engagement with contact portions 24, are bearing against rounded teeth to give the added drive to the rotor, so that the contact portions 24 need not be rounded to so great an extent if sharper breaking of the circuit is accomplished with substantially a straight surface for such contact portion as shown in Fig. 3.

A typical circuit arrangement for which the switch of Figs. 1 to 3 is particularly adapted is shown in Figs. 6A to 6D, with the successive positions of the switch shown in the successive figures.

The switch has been shown connected to a transformer T for operating a motor or similar load across the output requiring a variable voltage. The transformer has four taps, 1, 2, 3 and 4 thereon. One line L_1 is connected by contact 21 through a radial engagement to the bridging contact 23 having a peripheral contact portion 24 which in Fig. 6A is connected through a stationary contact 18 to tap 4 of the transformer, which latter is directly connected to the other line L_2. It is understood, of course, that any load may be connected across the output of the transformer, such load requiring a variable voltage in the same manner as the variable speed motor. The voltage variation could be accomplished in the motor itself as well as by a separate transformer. Fig. 6A shows diagrammatically the minimum output voltage position of the switch for operating the motor at the lowest of its variable speeds, for in this circuit line L_2 is connected at one end of the transformer and line L_1 at the other, and so that there actually is no transformer action.

Fig. 6B shows the switch in the medium low position for the next higher output or speed, connecting the line L_1 to tap 3 of the transformer, thus providing a high primary turn—low secondary turn ratio for transformer output.

In Fig. 6C, the switch is shown at its medium high position, with line L_1 connected to tap 2 to increase the voltage output from the transformer and consequently the speed of the motor. The maximum output from the transformer is obtained with the switch as connected in Fig. 6D, wherein line L_1 is connected to tap 1, and the coil of the transformer from L_2 to tap 1 acting as a primary, and the entire coil as the secondary. The ratio of primary turns to secondary turns is greatest at this position.

It may readily be seen from the illustrations of Fig. 6, that the two peripheral contact portions on the rotor 19 are each operating as active contacts during approximately one half of the complete cycle. One of the two contact portions 24 is always in engagement through the radial face 23 with the stationary contact 21 for the line L_1. A second switch may be employed to completely turn off the circuit, or the terminal and rotor

layout may be changed to provide a vacant terminal and consequently an off position.

Figs. 7A to 7E are very similar to Figs. 6A to 6D, but show the various positions of a five-position switch as shown in Fig. 4 controlling the motor M through resistance coil R having five taps numbered 1 to 5. In Fig. 7A the first position of the switch has been shown as the high speed position, with the line L_1 connected as through post 14 and contact 21, through bridging contact 23' and contact portion 24' to a post 13 and tap 1, thus connecting L_1 with the motor through the minimum amount of resistance R (or entirely shunting the resistance if preferred). Line L_2 is connected directly to the motor or load. Fig. 7B shows line L_1 connected to tap 2 for medium high speed operation. Fig. 7C shows the line L_1 connected to tap 3 for medium speed operation. Fig. 7D shows the line L_1 connected to tap 4 for medium low speed operation. The final position, for low speed operation, is shown in Fig. 7E with line L_1 connected to tap 5, putting the entire resistance R in series with the motor M. It should be understood, of course, that in all of the figures from 7A to 7E, the motor M might be replaced by any other type of load and, furthermore, the resistance R could be replaced by any other type of control. A second switch or a vacant terminal as previously described may likewise be employed with this circuit embodiment to completely break the circuit.

The switch of Figs. 7A to 7E is preferably that shown in Figs. 4 and 5. This switch, though adapted to control five circuits, is otherwise quite similar to that of Figs. 1 to 3 except for the shape of the rotor and a more uniform distribution of the fixed contacts. The rotor 19' has five teeth 31, as previously noted, all of which are rounded in a manner somewhat similar to the rounding of the teeth 27 of Figs. 1 and 3. A bridging member 23' is mounted on one radial face of the rotor 19', with a contact portion 24' formed as an extension of the bridging member 23' positioned on one side of one of the rounded tooth portions 31. The leading end or flange 30 of the contact portion 24' is preferably countersunk behind a shoulder portion 32 of the rotor so that the fixed contacts 18 will spring off of the shoulder 32 onto the contact 24', thus removing all danger of a stationary contact catching on the contact portion 24'. Contact between member 18 and contact portion 24' is improved by this construction, inasmuch as flange 30 conforms substantially in shape with flange 28 on the member 18.

The modification of the invention illustrated in Figs. 8 and 9 includes, as previously noted, frame plates 11 and 12 and terminal posts 13 upon which are mounted stationary contacts 18, successively engaging peripheral faces of the toothed rotor 19'' upon which a bridging contact member 23'' is fixedly secured. Peripheral contact portions 24'' lie on opposite teeth 26 of the rotor 19'' as previously described in connection with the illustration of Fig. 3. In this embodiment, however, a six-toothed rotor is employed rather than the eight-toothed rotor of Fig. 3. This switch may be very satisfactorily employed to control a multiple circuit including a two-speed motor as the load, wherein the speeds are varied in accordance with the amount of resistance R'' cut into the circuit. This is illustrated in the diagrammatic representation of Fig. 11, wherein line L_1 of a circuit is connected either to terminal post 114 or 114' (Fig. 8). By means of a metal jumper 40 on top of each of the two posts and intermediate the shoulders of the post and the frame plate 12, the two terminal posts become common to this line L_1. The other side of the circuit, that is, line L_2, is connected directly to one side of the motor, while the other side of the motor is connected to the resistance as heretofore stated.

In Fig. 11A, or the circuit diagram of the low speed position of the motor, the circuit is completed through a terminal 114 or 114' made common by jumper 40 through a corresponding stationary contact 18 and a peripheral contact 24'', across the bridging contact 23'', through a stationary contact 18 and a terminal post 13 to the outer end of the resistance R'' at the terminal T_1. The circuit then continues through the full resistance to the motor M and line L_2. The circuit for the high speed position of the motor is illustrated in Fig. 11B, where on the next successive rotative step of the rotor the bridging contact 23'' carries the current from a terminal 114 or 114' to a stationary contact 18 and a terminal post 13 where it passes through terminal T_2, completely shunting out the resistance, to motor M and line L_2. On the next successive step of the rotor, both peripheral contact portions 24'' are out of engagement with stationary contacts 18, thus completely breaking the circuit for the off position of the motor (Fig. 11C).

It will be understood, of course, that the frame plates 11 and 12 of each of the three embodiments of the invention are formed of insulation material, as are the rotor discs 19, 19' and 19''. The rotor may be actuated by a universal lever 41 which is pivoted to a connecting link 42 and seats at 43 on the end of the threaded portion 44 of the mounting member, including the U-shaped stem extension 15. A recoil spring 45 is carried on the link 42. A U-shaped actuating pawl 46, illustrated in detail in Fig. 10, is secured at the end of the connecting link 42, and by means of a slot 47 in the guide leg 48 of the pawl, and a shorter slot 49 in the actuating leg 51 rides on a toothed ratchet 52 non-rotatably mounted on the spindle 53, which in turn is mounted between the frame plates 11 and 12. The number of teeth in the ratchet 52 corresponds with the number of teeth on the rotor, and as may be seen from the drawings, the ratchet 52 of Fig. 1 has eight teeth, of Fig. 4 has five teeth, and of Fig. 8 has six teeth. A ratchet tooth is pulled by the end of the slot 49 in the actuating leg 51 of the member, with a substantially right angled flange 54 on the end of the leg and at the termination of the slot engaging the tapered end of a ratchet tooth to throw the actuating leg into the depression or crotch of the tooth, and also taking some of the rotating pull of the actuator so as to obtain a firm pulling engagement on the ratchet wheel.

As may be noted from Fig. 10 particularly, the legs 48 and 51 of the actuating pawl are offset from the body portion 56 by means of an irregularly shaped neck 57 intermediate the body portion and legs. With this construction, it is possible to space the ratchet wheel 52 at some distance from the rotor 19, 19' or 19'' on the spindle 53 and thus, without the use of insulating washers or the like intermediate the ratchet wheel and bridging contact member on the rotor discs, prevent any possibility of short circuiting between the same. The bridging contacts 23, 23' and 23'' are of course all rigidly secured on the insulating rotor discs and spaced away from the spindle 53 at the center thereof

so that there is no possibility of short circuiting between these two members. The ratchet wheel 52 and rotor discs as noted, are retained in the proper spaced position on the spindle 53 by merely upsetting an edge of the square or polygonally-shaped spindle above and below a ratchet wheel and above a rotor disc.

The various fixed contact members 18 and 21 may be secured to the terminal posts 13, 14, 114 and 114' in any desired manner. According to the illustrated construction, each contact member 18 is provided with a securing extension 58 (Fig. 2) having an aperture therethrough, through which a lug 16 of the associated terminal post passes, the upsetting of the lug on a frame plate holding the contact firmly against the terminal post. As may be noted also from Fig. 2, the contact 18 extends upwardly from the securing extension 58 and bends to a downwardly extending contact portion. Each contact member 21 for radial contact with the bridging member on a disc, has a similar securing extension 59 apertured to fit over a terminal post 14 and is then held thereon by the lug 16 as previously described. It will be noted from Fig. 2, that the contact 18 is secured intermediate a post and one frame plate, while the contact 21 is secured intermediate a post at the opposite end and between that post and the other frame plate of the switch. Similarly, where the jumper 40 is employed (Fig. 8), the jumper is secured intermediate a frame plate and the posts 114 and 114' at that end, while the stationary contacts 18 have their securing extension held between the remaining terminal posts at the opposite end and against the other insulating plate of the frame.

With the arrangement of the fixed contacts in Fig. 1 and also in Fig. 8, the terminal posts for line connection, as terminal posts 14, 114 and 114' are grouped away from the terminal posts 13 for connection to various circuits or branches of a circuit. In Fig. 4, this spacing is not practical, however, and the terminal post 14 is positioned between two terminal posts 13 and close to each of them. To prevent short circuiting between the adjacent terminal posts, an insulating plate or shield 61 is positioned over the inside face of the terminal post 14 with wing extensions extending beyond that post and the adjacent terminal post 13. The contact 21 on the terminal post 14 is of course positioned and spaced so as to be safely spaced from the adjacent contacts 18.

Among the important factors in the commercial success of the switch of the Popp patent noted above, were the small size of the switch, and the flexibility for mounting accomplished because of the universal lever actuation of the mechanism. In providing the present invention, wherein a greater number of circuits or branches of a circuit may be controlled by a single switch, it was desirable to retain the same small size for the switch which in the present instance is a diameter of one and one-half inches for each of the frame plates, and retain the advantages afforded by the universal lever action. However, inasmuch as the diameter of the universal lever at the seat governs the length of the planetary pull thereof, and this in turn governs the length of the circular pulling movement of the rotor of the switch, there were certain definite limitations on the structure without increasing the size of the switch or frame plates. With a three-eighths inch (⅜") diameter at the seat of the universal lever, it had not been possible to satisfactorily accomplish a greater movement of the rotor than one-eighth of a revolution thereof, with each successive movement of the universal lever. This result also took into consideration the pressure of the stationary contacts against the peripheral face of the bridging contact rotor, and with a large number of terminal positions and corresponding stationary contacts, it required a more strenuous pull on the lever to move the rotor through the large number of stationary contacts, if in fact it could be moved at all, with the same diameter size for the seat of the lever.

Increasing the size of the seat of the lever necessitated increasing dimensions in the actuating mechanism, which of course increased the size and cost of the cooperating elements of the switch, to in turn increase the entire cost of the switch. Furthermore, an increased size of the switch complicated, at least, the installation of the same in many places. The same sizes for the universal lever, and in fact the remainder of the switch, as those for the commercial switch of the above noted Popp patent, were retained in the commercial embodiment of the present invention. By means of the action of the stationary spring contacts on the rounded teeth of the rotor cooperating with the normal lever pull to urge the rotary movement of the rotor, the same size universal lever is used with the six-toothed and five-toothed rotors of the switches of Figs. 8 and 4 respectively, as has been used with the eight-toothed rotor of the patent, and it has been found that the eight-toothed rotor of the embodiment of Fig. 1, moves with materially greater ease in the new combination. Furthermore, a greater number of circuits may be controlled, and advantageous results as to contact pressure are obtained with combinations including the radial contact herein.

In addition, the switching mechanism has been simplified both in structure and operation by the use of the offset actuating pawl and the spaced-apart ratchet wheel and rotor disc eliminating intermediate insulation as above described. The flexing of the spring contacts has been minimized by the rotor construction, and the life of the contacts therefore greatly increased over anything heretofore possible.

The disclosures of this application are illustrative, and the invention is not to be limited by them. In fact, if modifications or improvements are not at once obvious, they may be devised in the course of time to make additional use of the broad ideas taught and covered by this application. The claims are intended to point out novel features and not to limit the invention except as may be required by the prior art.

We claim:

1. An electric switch including in combination, a frame, a mounting seat supported on said frame, a spindle rotatably supported in said frame for step-by-step movement, a plurality of spring contacts fixedly mounted on said frame radially disposed from said spindle, an actuator for said spindle including a tiltable portion on the mounting seat and a linearly movable portion intermediate the tiltable portion and the spindle, with the rotary travel of the spindle for each step of movement being in direct ratio to the linear travel of the linearly movable portion of the actuator and said linear travel being limited by the width of the tiltable portion at the

mounting seat, a plurality of interchangeable contact rotors for mounting one at a time on the spindle, with each contact rotor having a different number of peripheral teeth thereon for engagement by the spring contacts and each tooth width normally corresponding to a step of rotary travel for the spindle, but with the limited linear travel of the linearly movable portion of the actuator being too short for at least some of the interchangeable rotors to complete a step of movement thereof, and with the outermost portions of at least some of the teeth on each of the contact rotors being rounded to minimize the resistance by the spring contacts on a selected contact rotor and being acted upon by the spring contacts when past the center of a rounded portion to push the rotor on the spindle through the remainder of one step of its rotation after rotation has been initiated by movement of the tiltable portion of the actuator even though the corresponding linear travel of the linearly movable portion is shorter than a step travel of the rotor.

2. An electric switch including in combination a frame having a pair of spaced apart plates, a switch mounting stem supported by said frame at a position midway between the frameplates, a rotatable spindle extending between said frame plates and journalled therein, a rotor on said spindle at one end thereof having a peripheral contact and a face contact thereon and with the latter positioned on the face of the rotor toward the inside of the frame, a plurality of substantially U-shaped stationary spring contacts for engaging the peripheral contact mounted at one frame plate and extending within the frame substantially to the other frame plate, a spring face contact mounted at the other frame plate and extending within the frame toward the one frame plate for engagement with the face contact on the rotor, with all of said spring contacts occupying a relatively great portion of the space within the frame, a metal ratchet wheel fixedly secured on said spindle at a position substantially at the other end thereof, with said ratchet wheel being insulated from said peripheral and face rotor contacts and said spring contacts solely by the spacing therefrom, actuating means for said spindle seated on said stem, and a metal pawl operatively connected with said actuating means having a mounting portion in alignment with said stem and a ratchet engaging leg extending from said mounting portion in a position offset in a direction away from said rotor and insulated from said rotor and spring contacts by spacing therefrom, for engagement with the ratchet wheel to rotate the same.

3. An electric switch including in combination, a pair of frame plates, a plurality of combination spacing and terminal posts spacing said plates apart and mounting them in a rigid structure with said posts being spaced relatively close together, a contact rotor rotatably supported between the frame plates adjacent one frame plate having a peripheral contact portion and a contact portion on the face thereof toward the other frame plate, a face spring contact mounted on one post and extending substantially from one frame plate to the other, and substantially U-shaped peripheral spring contacts mounted on adjacent posts and extending substantially from one frame plate to the other, the posts being spaced sufficiently close together to normally position identical spring contacts on all posts unsatisfactorily close together for adequate insulation spacing over the bodies of said contacts, but said face spring contact comprising a substantially straight member and being mounted on its one post at one end thereof and said peripheral spring contacts being mounted at the other ends of their posts whereby said spring contacts may be adequately separated and insulated from one another over the bodies thereof.

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