SELECTOR SWITCH CONTACT CONSTRUCTION WITH DEFORMABLE CONTACT SUPPORT PLATE MEANS

Fig. 1

Fig. 2

Fig. 3

Fig. 4

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This invention relates to electrical switches and more particularly to a multiple position switch and the method of manufacturing such switch. Although not so limited, the switch is particularly useful for controlling the operation of an electrically reversible, multi-speed, shaded pole fan motor. Likewise, the method of manufacturing the switch may be employed in making many types of switches having a wide variety of applications.

In the manufacture of electric fans or similar applica-
tions, the large volume of production frequently involves the highly competitive nature of the business dictates that each component be as inexpensive as possible while yet providing the necessary reliability. As a means for reducing costs, it is extremely desirable that automation be employed in the manufacture of the various compo-
ents. In addition to the foregoing criteria, certain compo-
ents such as switches must meet various rigid safety requirements including provision to preclude shorting in the event of overheating.

Accordingly, it is the primary object of this invention to provide an improved electrical switch assembly and method of manufacturing such assembly.

It is a further object of this invention to provide a multiple position switch which may be inexpensively mass produced.

Another object of this invention is to provide an im-
proved multiple position switch for a multi-speed shaded pole fan motor. It is a further object of this invention to provide an energy storing switch knob which provides quick and posi-
tively acting switch operation.

Briefly stated, this invention relates to an electrical switch comprising a punched metal contact plate forming a plurality of contact elements interconnected by metal-
lic bridges and a molded support which has projections adapted to fit within the space between the contact ele-
ments. The support is made of thermoplastic or similar material so that the projections extending through the spaces between the contact elements may be deformed un-
der heat and pressure after the support is assembled with the contact plate. The contact elements may then be severed or separated by removal of the metallic bridges, thus leaving the contact elements in space, insulated re-

The contact plate and support assembly may be sand-
wiched between a case comprising a thermosetting plastic base and clamping member which are adapted to inde-
pendently position the contact elements. A rotor carrying one or more contact connector units cooperates with the clamping member, and the entire assembly is securely clamped together by means of a suitable cover. To rotate the rotor, a plastic knob is provided having an integral tongue which is adapted to engage the rotor. The tongue serves as an energy storing member so that rotation of the knob provides a positive snap action. To secure the knob to the rotor, the knob may be provided with integral resilient members adapted to cooperate.

Further features, objects and advantages will become apparent with reference to the following drawings, in

FIG. 1 is a perspective view of a punched metal con-
tact plate of the invention;

FIG. 2 is a perspective view of a molded thermoplastic support adapted to be assembled to the contact plate of FIG. 1;

FIG. 3 is a perspective view of the contact plate of FIG. 1 and the support of FIG. 2 after the components have been assembled and secured together by deformation of the thermoplastic support;

FIG. 4 is a perspective view of the assembly of FIG. 3 after a punching operation has been performed by which metallic bridges have been removed from the contact plate to form a plurality of contact elements secured to the support;

FIG. 5 is a plan, partially sectional view of the entire switch assembly of the invention;

FIG. 6 is a side elevation sectional view of the switch assembly;

FIG. 7 is an exploded perspective view showing the switch knob, cover, rotor, shading coil selector unit and selector arm unit;

FIG. 8 is an exploded perspective view of the switch clamping member, contact plate and support assembly, and base member; and

FIG. 9 is a schematic version of the switch of the in-
vention shown connected to an electrically reversible three-speed fan motor.

The particular switch assembly shown and described herein is a rotary seven position switch, useful for example with reversible, multi-speed, electric fans to pro-
vide three speeds in each direction and an "off" position. Referring first to FIG. 5, the entire switch assembly may be seen as comprising a base 10, a support plate, and con-
act assembly 12, a clamping and indexing member 14, a rotor 16 carrying a selector arm unit 18 and a shading coil arm unit 20, a cover 22 and a knob 24. These various components will be individually described in detail in the following paragraphs.

Describing first the support and contact assembly 12, there is shown in FIG. 1 a contact plate 26 having a pattern of apertures and forming a plurality of contact ele-
ments 28, 30, 32, 34, 36, 38 and 40 each having a respective terminal 28a, 30a, 32a, 34a, 36a, 38a and 40a. Contact element 36 is also provided with an additional terminal 36b. In FIG. 1, the contacts are interconnected by ten metallic bridges 42-51, which are to be removed in a subsequent operation. The contact plate with the bridges removed may be seen in FIG. 4 wherein the spaces formerly occupied by the bridges have been numbered identical with the bridges. Since the bridges 42-51 are to be removed, it is neces-
sary to provide means by which the respective contact elements will be permanently positioned in the desired spaced, insulated relationship. For this purpose, a sup-
port 60 is provided having, as may be seen from FIG. 2, a pattern of projections adapted to be received within a portion of the pattern of apertures formed in contact plate 26. The support 60 is also formed with a pattern of apertos which coincide with the remaining open aperture portions of plate 26 for positioning the support and plate within the switch base 10. In accordance with the inven-
tion, the support 60 is preferably made of thermoplastic or similar material having the properties of being deform-
able by heat and pressure and at the same time being a good electrical insulator. As the next step of the fabrica-
tion, the contact plate 26 is assembled with the support plate 60 so that the extensions or projections on the sup-
port extend through the apertures within the contact plate. It may be noted that both contact plate 26 and the plastic support 60 are asymmetrical, so that they may be assembled only in the proper manner. Next, certain projec-
tions are deformed by heat and pressure to thereby se-
cure the contact plate to the support, as shown in FIG. 3. It should be noted that projections 62, 64, and four semi-
cylindrical projections, all indicated by the numeral 65, are not deformed during the heat and pressure operation in that they serve as bearing surfaces in the operation of the switch. Also, a centrally located recess or socket 66 in the support 60 is not deformed in that it is a bearing surface adapted to receive a portion of the rotor 16, as will be hereinafter described.

After the deforming operation, the bridges 42–51 are removed in a punching operation or some other suitable method, leaving the spaces 42–51 as shown in FIG. 4. By this operation, the contact plate 26 is separated into seven different contact sections 28, 30, 32, 34, 36, 38 and 40, which are supported in spaced relationship by the support plate 60. It should be noted that portions of the thermoplastic support 60 are also removed during the bridge removing operation as exemplified at spaces 43 and 51 in FIG. 4.

Although the contact and support assembly 12 may be produced by means of the manufacturing methods desired, one of the features of the assembly is that it easily lends itself to automation mechanism. For example, the operation may begin by passing a metal strip beneath punching equipment to punch the pattern of apertures to form the contact plate 26; and by successively repeating this operation, a strip of contact plates connected means of their terminals may be produced. While still in strip form, a support 60 may be assembled to each contact plate, the deformation operation may be performed, and the bridges may be removed by a suitable punching operation. At this point, the contact plates are still connected by their terminals; and it should be noted that although there may be a small amount of play between the support and the contact, contact element 36 provides the necessary rigidity to the strip for further automatic procedures if desired in that both terminals 36a and 36b are connected to the adjacent contact plates. This continuous metal strip also prevents shear stresses from developing between the metal and the thermoplastic. The remainder of the switches may then be assembled on the strip before the contact plates are severed from one another. Of course, the contact plate 26 may be removed from the strip prior to the subsequent forming or punching operations if a lesser degree of automation is preferred.

The support and contact assembly 12 is also shown in FIG. 8 where it is in position to be assembled to the base 10, which is provided with a plurality of upstanding projections adapted to fit within the spaces in the assembly 12. Additionally, the base 10 is provided with a central aperture 68 adapted to receive the base of socket 66 of the support 60. The base 10 also forms a major portion of the switch exterior as may be seen from the assembly drawing of FIG. 6. Again it may be noted that base 10 has its series of projections arranged asymmetrically, so that contact assembly 12 mates with the base only when assembled in a properly oriented position.

After the contact and support assembly 12 has been placed in the base 10, the clamping member 14 is also received within the base over the assembly 12 to thereby sandwich the contact and support assembly between the two members. The clamping member 14 is provided with recesses and projections, some of which are shown at 72 and 74, adapted to mate with upstanding projections and recesses respectively of the base 10 to position the contact and support assembly. In its preferred form the base 10 and clamping member 14 are made of a heat resistant, non-conducting, thermosetting plastic, such as phenolic. With this arrangement, safety standards may be easily met. In the event the switch is overheated and the thermoplastic support 60 should melt or be deformed, the contact elements will still be independently clamped in insulated relationship by the base and clamping member so that the switch will continue to function properly.

An asymmetrical design of clamping member 14 is again useful in connecting with automatic assembly techniques.

It should be noted that the clamping member 14 is provided with openings 76 and 78 through which the depending wiper arms of the selector arm unit 18 and the shading coil arm unit 20 will extend, as shown in FIG. 7. The clamping member 14 is also provided with a central opening 79 surrounded by an upstanding annular ridge having radially extending grooves 80. The grooves 80 cooperate with the rotor 16 to provide the necessary indexing action required of a snap action switch as well as the phasing, as will hereinafter be described.

The remainder of the internal construction may be seen in the exploded perspective view of FIG. 7. The rotor or core 16, selector arm unit 18 and shading coil arm unit 20 are adapted to be assembled as a unit and cooperate with the clamping member 14 and the contact and support assembly 12 to provide the contact connecting operation of the switch. The rotor 16, which is made of a thermosetting plastic or other electrically insulating material, which will remain rigid when overheated, is provided with a shaft 82 having a rounded end which, as previously mentioned, is adapted to fit through the opening 79 in clamping member 14 and be received in socket bearing plates connected means of their terminals may be produced. While still in strip form, a support 60 may be assembled to each contact plate, the deformation operation may be performed, and the bridges may be removed by a suitable punching operation. At this point, the contact plates are still connected by their terminals; and it should be noted that although there may be a small amount of play between the support and the contact, contact element 36 provides the necessary rigidity to the strip for further automatic procedures if desired in that both terminals 36a and 36b are connected to the adjacent contact plates. This continuous metal strip also prevents shear stresses from developing between the metal and the thermoplastic. The remainder of the switches may then be assembled on the strip before the contact plates are severed from one another. Of course, the contact plate 26 may be removed from the strip prior to the subsequent forming or punching operations if a lesser degree of automation is preferred.

The two arm units 18 and 20 are made of suitable resilient electrical conducting material such as Phosphor bronze. The arm units are each provided with a central opening and are adapted to be press fitted over the rounded shaft end 82, or the units may be secured to the rotor by other suitable means. As shown, the attached end of the rotor shaft is provided with a pair of diametrically spaced flutes one of which is shown at 84. The flutes are adapted to receive the inwardly extending tongues 86 of shading coil arm unit 20. By properly selecting the dimensions of the flutes and tongues the arm unit may be self-locking on the shaft of rotor 16. The arm unit 20 is further provided with a pair of spring-like extremities 87 which are designed to snap over the arrow-like extremity 88 on the rotor periphery to thereby lock the arm unit in position, and proper orientation is assured. As may be seen from the drawing in FIG. 7, arm unit 20 is provided with a pair of flexible, depending wiper arms 90 and 92 which are adapted to extend through opening 76 in clamping member 14 to cooperate with the contact elements of the switch, as will be hereinafter described. When assembled, the pressure of the contact arms 90 and 92 against the switch contact elements assists in maintaining the arm unit 20 in engagement with the rotor 16.

After the arm unit 20 has been secured to the rotor 16, the selector arm unit 18 may be pressed onto the shaft 82 of the rotor and secured thereto, in a manner similar to arm unit 20, by a pair of inwardly extending tongues 94 (fric tional engaging a second pair of flutes one of which is shown at 96 on the shaft 82. A pair of wiper arms 98 and 100 diametrically aligned with wiper arms 90 and 92, depend from the arm unit 18 and are adapted to extend through the openings 76 and 78, respectively, in the clamping member 14 to engage the switch contact elements, as will be hereinafter described. When the switch is assembled, the wiper arms 98 and 100 are pressed into engagement with the contact and support assembly 12. This assists in maintaining the arm unit 18 on the shaft 82. The arm unit 18 is also provided with a pair of radially extending corrugated sections 102 and 104 which are adapted to engage the grooves 80 in the clamping member 14. The corrugated sections 102 and 104 and grooves 80 serve as detent means to resist rotation of the rotor. They assist also in maintaining the arm unit 18 on the shaft 82. Four wing-like extremities on the unit 18, two of which are shown at 106 and 108 cooperate with four, peripheral features 110, 112, 114 and 116 located on the periphery of rotor 16. The flanges of the four wing-like extremi-
ties in contact with the step-like features of the rotor transmit torque between the selector arm unit and the rotor. The step-like features 110 and 112 also result in a cut-away clearance area necessary for the flexing of the corrugated section 102 with respect to the areas 106, 108 and that area of arm unit 18 which bears against the shaft 82 of the rotor 16. This applies also to step-like features 114 and 116.

Once the rotor with its accompanying wiper arm units have been assembled with the clamping member 14, contact and support assembly 12 and base 10, the entire assembly should be secured together to maintain the proper relation between the respective components. For this purpose, cover 22 having an upstanding tubular neck 132 fits over the core or rotor 16 and abuts the combined upper peripheral flange of clamping member 14 and base 10. Although it may not be completely clear from the drawings, the upper tubular neck 134 of core 16 is formed with a slight taper from a larger diameter adjacent flange 134a to a smaller diameter at the upper edge 134b, as viewed in FIGS. 6 and 7. This facilitates the molding operation. The inner surface of the neck 132 of cover 22 is formed with a cylindrical zone 132a at the base of the neck followed by a major tapered section 132b of greater ascending tang 156 of the mounting cover 22, as shown in FIG. 7. If only a portion of the switch contacts are to be employed, the rotation of the knob 24 may be further limited by providing an additional upstanding tang of the cover 22 spaced at the desired location. By so modifying the cover 22, the switch may be employed in different electrical units thus providing versatility to keep manufacturing costs to a minimum.

As mentioned before, the switch described herein may be employed in different types of electrical equipment, but the particular embodiment described is adapted to control the operation of a three-speed electrically reversible shaded pole fan motor. To complete the understanding of the operation of the switch, a brief description of its function when used with such a motor will be given. Referring to FIG. 9, there is shown a schematic drawing of the contact support assembly 12 and the selector arm units 18 and 20 connected to a shunted pole motor shown schematically as including a pair of serially connected shading coils 162 and 164 and three serially connected primary motor coils 166, 168 and 170 to provide high, medium and low speed operation.

As may be seen from FIG. 9, one end of shading coil 162 is connected to contact 30 of the contact assembly, while one end of shading coil 164 is connected to contact 28. The shading coil circuit is completed by connecting a center tap between the two shading coils to contact 34. The wiper arms 90 and 92 of the shading coil arm unit 20, as shown in FIGS. 6 and 9 are positioned to cooperate with contacts 28, 30 and 34 as the arm unit 20 is rotated. With the wiper arms 90 and 92 positioned as shown in FIG. 6, the switch is in the off position where-in wiper arm 92 is engaged with contact 34 while wiper arm 90 engages the plastic projection 62 so that the shading coil circuit is open. Wiper arm 92 engages contact 34 at all times; and by rotating the knob and rotary assembly in one direction wiper arm 90 will engage contact 28 to close the shading coil circuit to shade motor rotation in one direction. By rotating the arm unit 20 in the opposite direction, wiper arm 90 will engage contact 30, as shown in FIG. 9, to again close the shading coil circuit, but to shade motor rotation in the opposite direction.

As may be seen from FIG. 9, one lead 174 to be connected to a line power supply is connected to one end of primary coil 166, and the other lead 176 is to be connected to contact 32 of the terminal assembly 12. The various motor speeds may be obtained by selectively connecting the primary motor coils, by means of the switch of the invention, to the pair of line terminals 174 and 176. More specifically, the end of the primary motor coil 166, remote from the line terminal, is connected to contact 36; the end of coil 168 adjoining coil 170 is connected to contact 38; and the opposite end of coil 170 is connected
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Having thus described the invention, what is claimed is:

1. In a multiple position electrical switch,
   (a) a thermoplastic support plate having a plurality of projections extending from one surface of the plate;
   (b) a plurality of switch contact elements arranged in spaced relation in a single plane between said projections and held in such position by the plate;
   (c) an enclosing case made of thermosetting plastic material surrounding said contact elements and said support plate and including a plurality of projections to position said contact elements in spaced insulated relation independently of said support plate; and
   (d) movable contact means supported by said case for varying the electrical circuits through said switch contact elements.

2. The switch of claim 1 in which some of the projections of said support plate are positioned to engage and separate said contact means from said contact elements as the contact means are moved to their various positions.

3. In a multiple position electric switch,
   (a) a plurality of switch contact elements arranged in spaced relation in a single plane;
   (b) a thermoplastic support plate having a plurality of projections extending from one surface of the plate, said plate being positioned in parallel relation to said contact elements with said projections extending between said contact elements to hold said contact elements in insulated spaced relation to each other.
   (c) means formed integral with the ends of said projections to secure said contacts to the plate;
   (d) an enclosing case made of thermosetting plastic material supporting said contact elements and said support plate; and
   (e) movable contact means supported by said case for cooperating with said contacts to vary the electrical circuits through said switch.

4. A multiple position, snap-action, electrical switch comprising:
   (a) a plurality of contact elements;
   (b) a thermoplastic support positioning said contact elements in spaced insulated relationship;
   (c) a thermosetting plastic base and clamping member holding said support and said assembled contact elements therewith, said base and clamping member being made of material capable of withstanding temperatures substantially higher than said thermoplastic support and said assembled contact elements will remain in insulated relation even though the support is deformed by excessive heat;
   (d) a rotary member extending through an opening in said clamping member to selectively connect said contact elements; and
   (e) a plastic knob for rotating said rotary member and including an integral tongue engageable with the rotor and formed to provide energy storage means whereby the rotor is moved with a snap action.

5. The switch of claim 4 wherein said knob is formed with a pair of legs positioned on opposite sides of said tongue and extending in the direction of said tongue, each of said legs having an outwardly extending nib, means defining a pair of arcuate recesses within said rotary member, said legs being positioned within said rotary member with each of said nubs being positioned within a respective one of said recesses to limit the rotational movement of said knob with respect to the rotary member and hence the energy which may be stored by the knob.

6. A multiple position, snap-action, electrical switch comprising:
   (a) a plurality of contact elements;
   (b) a thermoplastic support positioning said contact elements in spaced insulated relationship;
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(c) a thermosetting plastic case enclosing said support and said assembled contact elements;
(d) a rotary member extending through an opening in said clamping member to selectively connect said contact elements; and
(e) a plastic knob for rotating said rotary member and including an integral tongue engageable with the rotor and formed to provide energy storage means whereby the rotor is moved with a snap action.

7. A multiple position, snap-action, electrical switch comprising:
(a) a plurality of contact elements;
(b) a thermoplastic support positioning said contact elements in spaced insulated relationship;
(c) a plastic base and clamping member holding said support and said assembled contact elements therebetween, said base and clamping member being made of material capable of withstanding temperatures substantially higher than said thermoplastic support so that the contact elements will remain in insulated relation even though the support is deformed by excessive heat;
(d) a rotary member extending through an opening in said clamping member to selectively connect said contact elements, said rotary member and said clamping member having mating detent means to restrain rotation of the rotor; and
(e) a plastic knob for selectively rotating said rotary member and including an integral tongue engageable with the rotor and formed to provide energy storage means whereby said rotor is moved with a snap action.

8. A multiple position, snap-action, electrical switch comprising:
(a) a plurality of contacts;
(b) means supporting said contacts in spaced insulated relation;
(c) a rotor supported by said supporting means and carrying contact means cooperating with said contacts for completing the various switch circuits;
(d) a plastic knob selectively rotating said rotor including an integral plastic tongue engageable with the rotor to provide energy storage means whereby said rotor is moved with a snap action when said knob is rotated;
(e) a pair of diametrically spaced legs formed integral with said knob and extending on opposite sides of said tongue;
(f) means defining a pair of arcuate recesses within said rotor; and
(g) stop means formed integral with said legs extending into said recesses to limit the rotational movement of the knob relative to the rotor and to thereby limit the rotational energy which may be stored by said knob to obtain the switch snap action.

9. A multiple position action switch comprising,
(a) a plurality of contact elements,
(b) a thermoplastic support having integral deformed projections securing said contact elements in spaced insulated relationship,
(c) a thermosetting plastic base receiving said support, 
(d) a thermosetting plastic clamping member mating with said base to secure said contact elements therebetween independently of said thermoplastic support, 
(e) a rotor received within an opening in said clamping member and having wiper arms extending through openings within the clamping member to selectively connect said contact elements, 
(f) said rotor and said clamping member having mating detent means to restrain rotation of the rotor, and
(g) a cover member for securing the rotor to said base and securing said clamping member and said support therebetween.

10. A multiple position snap action electrical switch comprising,
(a) a plurality of contact elements,
(b) a thermoplastic support plate having a centrally located socket and including a plurality of deformed projections securing said contact elements in spaced insulated relationship surrounding said socket,
(c) an insulated base receiving said support carrying the contact elements,
(d) a clamping member to mate with said base to position the support and contact elements therebetween,
(e) a rotor positioned within said insulated base and having a central shaft extending through an opening within said clamping member to fit within the socket in said plastic support,
(f) selector means mounted on said shaft and having wiper arms extending through openings within said clamping member to selectively connect said contact elements,
(g) said rotor and said clamping member having mating detent means to restrain rotation of the rotor, and
(h) a plastic knob including an integral tongue engageable with the rotor to provide energy storage means whereby said rotor is caused to move with a snap action as the knob is rotated.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,214,536

October 26, 1965

Henry W. Wallace

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 9, line 56, for "action" read -- snap action --.

Signed and sealed this 27th day of September 1966.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

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Commissioner of Patents