June 17, 1947. S. L. CHRISTIE 2,422,339

TAP-CHANGING SWITCH

Filed April 18, 1944

Fig. 1

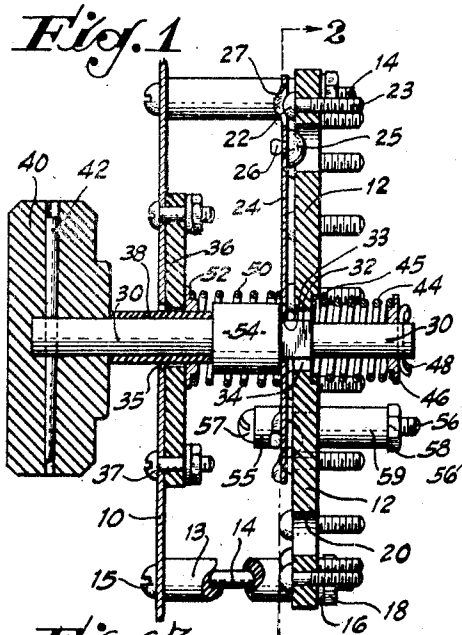


Fig. 2

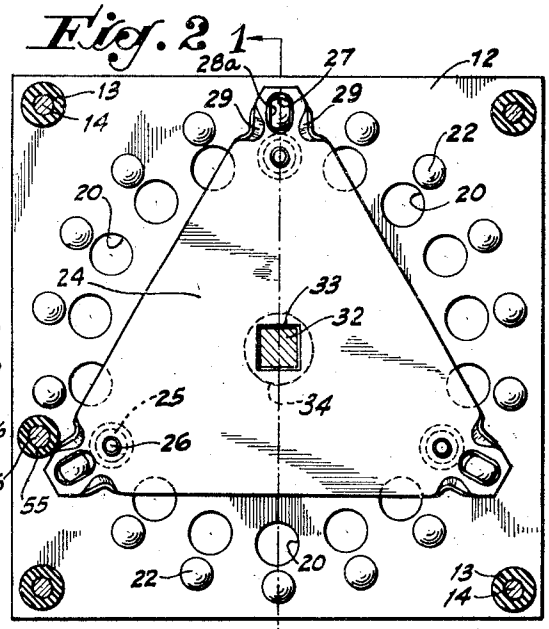


Fig. 3

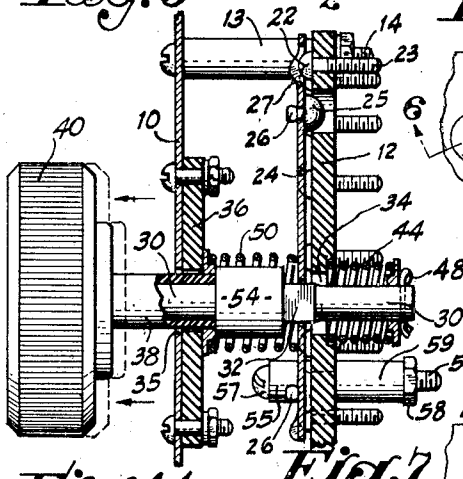


Fig. 4

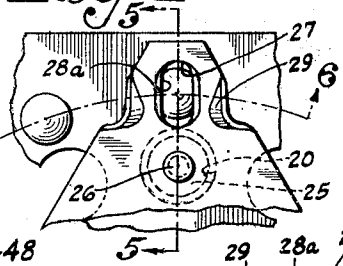


Fig. 5

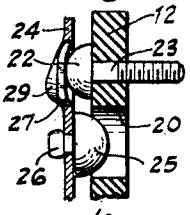


Fig. 6

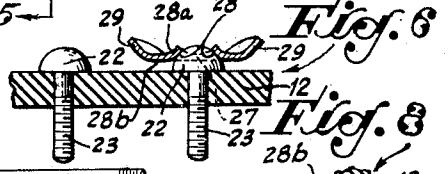


Fig. 7

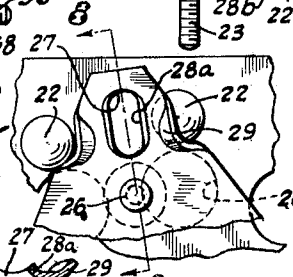


Fig. 8

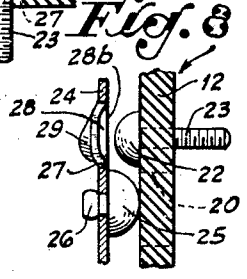


Fig. 11

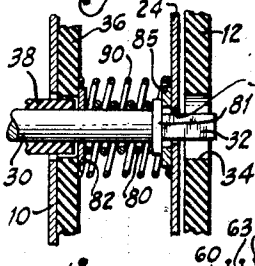
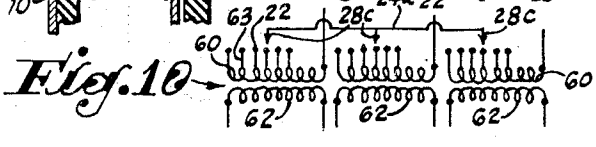


Fig. 9



Fig. 10



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2,422,339

TAP-CHANGING SWITCH

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Application April 18, 1944, Serial No. 531,539

20 Claims. (Cl. 200—4)

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This invention relates to electrical switches and, more particularly, to a tap-changing switch particularly useful for changing the connections on the primary side of Y-connected three-phase transformers to modify the secondary potentials, although it is equally applicable to any other situation where it is required to make and break contacts simultaneously at a plurality of points.

One object of the invention is to provide a simple voltage-regulating or tap-changing switch which may be easily operated by hand, but will at the same time afford high contact pressure and positive action. In this connection, it is a further object of the invention to provide a switch having a rotary contact member normally held in circuit-closing position by a main spring which is releasable, preparatory to a change in position of the switch member, to facilitate the switching operation, and to provide a supplementary spring relatively weaker than the main spring for urging the rotary contact member toward its cooperating contacts at all times. This not only reduces the wear and prolongs the life of the switch, but also greatly reduces the torque required for the operation of the switch.

A further important object is to provide an electric switch of the type indicated wherein the make-and-break points of contact, both on tap contacts and on a movable contact member, are spaced from the points of operating contact. In this way, pitting of the contacts, which may be caused by arcing when making or breaking inductive circuits, will occur at points on the contacting parts which are remote from the points of normal operating contact.

The invention contemplates also, among its objects, a novel cam means for positively lifting a contact member from a cooperating contact button after a predetermined sliding engagement therebetween.

Another object of the invention is to provide a switch of the stated type wherein a plurality of contacts is simultaneously made or broken which shall have sufficient play or flexibility of operation that good contact will occur in each position by reason of automatic adjustment resulting from said play or flexibility, even though small manufacturing variations in dimensions may exist. In this connection, it is a further object of the invention to provide two groups or series of contacts arranged about an axis and rotatably movable relative to each other, each of the contacts of one group providing two substantially radial contact portions disposed to simultaneously engage two areas of a contact of the other

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group, together with flexible means permitting relative axial and eccentric movements of the groups to insure good electrical contact between the contacts of the two groups.

Important features of the invention reside in an insulating panel having a plurality of series of contact buttons arranged in circular order and a rotating contact member having a plurality of radially directed elongated depressions, equal in number to the number of the plurality of series mentioned, whose edges normally engage the sides of the contact buttons at primary contact points, together with means, preferably a cam means, to move the contact member away from the contact buttons after the contact member has been turned to engage the contact buttons at secondary contact points. Arcing thus occurs only at the secondary contact points. The invention also extends to the employment of a contact member with contact edges of a depression sliding along a round-headed or tapered contact button, together with means to raise the contact edges from engagement with the contact button only after the edges have passed beyond the crest of the contact button.

In a preferred form of the invention, the contact member is moved by means of a shaft loosely traversing the contact member and insulating panel in such manner that a small amount of lost motion is permitted so that the contact member may readily adjust itself and settle into good contact with a plurality of the contact buttons.

A preferred embodiment of the invention is shown in the accompanying drawing, for illustrative purposes only. In these drawings:

Figure 1 is a vertical transverse section taken approximately from the line 1—1 of Figure 2;

Figure 2 is principally a plan view, taken from the line 2—2 of Figure 1, certain connecting portions being shown in section;

Figure 3 is a fragmentary transverse section corresponding with that of Figure 1 but showing the shaft shifted toward the left in the direction of the arrows against the action of the main spring;

Figure 4 is a fragmentary detail in plan indicating the normal circuit-closing position of one pair of contacts;

Figure 5 is a sectional detail taken along the line 5—5 of Figure 4;

Figure 6 is a sectional detail taken along the line 6—6 of Figure 4;

Figure 7 is a fragmentary detail in plan, similar to Figure 4 but showing the parts after the

contact member has been turned through a small angle and after the contact parts have separated a small distance;

Figure 8 is a sectional detail taken along the line 8—8 of Figure 7;

Figure 9 is a sectional detail, similar to Figure 6 but showing the relationship of the contact parts just prior to breaking contact;

Figure 10 is a wiring diagram indicating how the switch is employed in changing the connections of a Y-connected three-phase transformer; and

Figure 11 is a fragmentary sectional view of another form of spring arrangement which can be employed.

The switch exemplified in the drawing is shown as being mounted on a rigid support 10, such as a plate or the wall of any housing or cabinet for associated electrical equipment. The support 10 rigidly carries a switch base in the form of a panel 12 formed of suitable insulating material, this panel being spaced from the support 10 by spacing sleeves 13 mounted on bolts 14. The heads of these bolts may be disposed on the forward side of the support 10, and the structure can be clamped together by use of washers 16 and nuts 18 on the rear of the panel 12.

The panel 12 is provided with a number of depressions, which are shown as cylindrical openings 20 extending through the panel, these openings being arranged circularly in three series of six openings each. The edges of the openings 20 and the forward surface of the panel 12 between these openings serve as cam-engaging surfaces, as will be presently explained.

Radially aligned with each of the openings 20 and disposed to protrude from the forward face of the panel 12 is a contact button 22 having a smooth convex head which may be either rounded, as shown, or beveled. In either instance, the contact button provides sloping side walls presenting guiding surfaces leading to the crest of the contact button. These contact buttons 22 are also arranged circularly in three series, each having six contact buttons, as shown. Each contact button 22 has a shank 23 extending through the panel 12 and protruding from the rear thereof for connection with a tap wire in any suitable manner, such as by utilization of the indicated threads or by soldering. The shanks 23 may be threaded or pressed into the panel to hold the contact buttons 22 in place, and, if desired, each of the heads of the contact buttons may provide a screwdriver slot, without departing from the spirit of the invention.

A metal contact member 24 is positioned to face the panel 12 and to cooperate with the contact buttons 22 and the openings 20. As shown, the contact member 24 is triangular in form and each corner carries a contact means and a cam element respectively cooperating with the contact buttons 22 of one series and with their associated openings 20. The cam element at each corner of the contact member 24 includes a convex or beveled lifting button 25 cooperating with the openings 20 and the surface of the panel 12 therebetween in providing a cam means. Each lifting button 25 has a portion projecting through the contact member 24, this portion being headed at 26 to retain the lifting button in place. The contact means at each corner of the contact member 24 is positioned radially beyond each lifting button 25 and constitutes a depression, preferably in the form of an elongated opening 27, the direction of elongation being radial. In the preferred structure, the opposite side walls of each elongated opening 27 are curved or beveled to present radially-extending contact edges 28, as best shown in Figures 4 and 6, for the purpose of making good sliding contact with opposite sides of the contact button 22. Such contact edges 28 are shown as being formed by forwardly deforming the metal of the contact member 24 adjacent the sides of the openings 27 to produce lips 28*a* flaring forwardly beyond contact faces 28*b* on opposite sides of the lips. The edges of the triangular portions of the contact member 24 are preferably forwardly deformed beyond the contact faces 28*b* to form upstanding ears 29.

Rotation of the contact member 24 with respect to the panel 12 is effected by means of a shaft 30 which has a square section 32 disposed in a somewhat larger square opening 33 of the contact member 24. The fit is sufficiently loose to permit a small amount of lost motion between the shaft 30 and the contact member 24 to permit both a small angular play therebetween and some degree of sidewise shifting of the contact member 24 with respect to the axis of the shaft. In addition the loose fit between the shaft and the contact member permits free axial movement of the shaft 30 relative to the contact member or vice versa, for a purpose to be later described.

The square section 32 of the shaft 30 also passes freely through a substantially larger circular opening 34 in the panel 12. By virtue of this loose fit, the square section of the shaft 30 can move laterally a limited distance with respect to the panel 12, thus increasing the available sidewise displacement of the contact member 24 with respect to the panel 12 and its associated contact buttons 22, for a purpose to be later described.

The forward end of the shaft 30 passes freely through an opening 35 in the support 10, and a portion of the shaft 30 is journalled relatively loosely in a block of insulating material 36 secured to the support, as by means of short bolts 37. A suitable sleeve 38, formed of insulating material, is disposed about the shaft 30. The external size of this sleeve is sufficiently smaller than the journalling opening of the block 36 and sufficiently smaller than the opening 35 of the support 10 to permit a small amount of rocking of the shaft 30 as permitted by the loose fit between the square section 32 and its associated opening 34. The sleeve 38 may be loosely mounted on the shaft 30 in engagement with a manipulating knob 40 retained in fixed position on the shaft by means such as a pin 42.

Surrounding the rear end of the shaft 30 is a main tensioning spring 44 whose inner end is seated in a counterbore 45 of the panel 12 around the opening 34. The outer end of the main spring 44 is retained and positioned by means of a washer-like seat member 46 held at the rear end of the shaft, as by means of a cotter key 48, so that the spring is in compression and tends to move the shaft 30 inwardly or to the right as viewed in Figure 1.

Located between the contact member 24 and the block 36 is an auxiliary spring 50. The forward end of this spring rests on a stepped washer-like seat 52 surrounding the sleeve 38 and bearing against the block 36. The rear end of this auxiliary spring 50 presses against the contact member 24 and urges the same constantly toward the panel 12. To center the rear end of the auxiliary spring 50, the shaft 30 provides a hub 54 formed integrally therewith or suitably

fixed thereto. The forward end of the hub 54 engages the adjacent end of the insulating sleeve 38. This hub 54 represents an engagement means for the contact member 24 as the rear end of the hub is adapted to bear resiliently against the contact member 24 under the action of the main spring 44.

Since the contact means at each corner of the contact member 24 is to operate back and forth across only one of the three series of contact buttons 22, it is desirable to limit the rotation of the contact member through an angle of substantially 120°. To accomplish this, a stop sleeve 55, formed of insulating material, is positioned in the path of movement of two adjacent corners of the contact member 24. This stop sleeve 55 is mounted near the edge of the panel 12 by means of a bolt 56 having a head 57 engaging the sleeve 55. The bolt 56 extends through the panel 12 and carries a retaining nut 58 engaging a spacing sleeve 59 which positions the nut beyond the adjacent shanks 23 of the contact buttons 22.

The invention is particularly adapted for simultaneously changing taps on three Y-connected windings of a transformer. In Figure 10, such a transformer is suggested as having three Y-connected primary windings 60 and three secondary windings 62. One end terminal of each primary winding is connected to the three-phase line. Each primary winding provides six tap wires 63 respectively connected to the six contact buttons 22 of one series. In Figure 10, the contact member 24 is represented by a conductor 24a and the contact means at each corner of the contact member is represented by arrows 28c corresponding to the contact edges 28 previously described. As will be apparent from Figure 10, if the contact means indicated by arrows 28c are shifted simultaneously from one tap to another, representing a shifting of the contact edges 28 from one trinity of contact buttons 22 to the next trinity, the connections on each primary winding are simultaneously changed to simultaneously effect an increase or decrease in the induced secondary potentials.

The operation of the switch can best be understood by considering, first, that the positions of the elements are as shown in Figures 1, 2, 4, 5, and 6. When thus positioned, the contact member 24 is resiliently urged toward the panel 12 by the dual action of the main spring 45 and the auxiliary spring 50. Correspondingly, there is a strong spring pressure causing the contact edges 28 of the contact member 24 to bear against a trinity of contact buttons 22 to insure positive circuit-closing contact.

When in this disposition, the elements can be said to be in a first or normal operating position. As best shown in Figures 1, 2, 4, 5, and 6, the two contact edges 28 at each corner of the contact member 24 will engage the opposite sides of a corresponding contact button 22 to assure dual contact at primary contact points. The crest of the contact button 22 will project a distance into the elongated opening 27. Due to the floating action of the contact member 24, each of the three contact buttons will be engaged by the corresponding contact edges at two opposed primary contact points, even though there are minor manufacturing irregularities in the disposition of the contact buttons, the contact member 24 shifting laterally under the action of springs 44 and 50 to accomplish this result.

When it is desired to change tap connections, the contact member 24 is rotated in one direction or another to engage another trinity of contact buttons 22. While this turning can be effected by applying a strong twist to the knob 40, without pulling the same forward, the turning torque can be very substantially lessened by first pulling the knob forwardly into the position shown in Figure 3 against the action of the main spring 44. This separates the hub 54 from the forward face of the contact member 24 to relieve the contact member from the biasing action of the main spring. However, the auxiliary spring 50 still biases the contact member 24 toward the panel 12 and insures adequate circuit-closing contact with the contact buttons 22. When the knob is thus withdrawn, the contact member 24 can be turned relatively easily to engage the desired trinity of contact buttons 22. In thus moving from engagement with one contact button into engagement with an adjacent contact button, the operation of the contact member 24 is as follows.

As the contact member 24 first starts to turn from its position shown in Figures 1, 2, 4, 5, and 6, the contact edges 28 ride up on the sides of the corresponding contact button 22 until the crest of the button engages and slides along one of the contact faces 28b, depending upon the direction of rotation of the contact member 24. This position is shown in Figure 9 and can be considered as a second position. The cooperating contacts are still in circuit-closing engagement in this second position. In moving from the first position to the second position, the contact member 24 has been moved slightly away from the panel 12 because of the sliding of the contact edges 28 along their respective contact buttons. However, the corresponding lifting buttons 25 are sufficiently smaller than their adjacent openings 20 to prevent any cam action therebetween until the second position is reached.

Further movement of the contact member 24 from the second position to a third position, indicated in Figures 7 and 8, will bring the cam means into operation to lift the contact member 24 from engagement with the trinity of contact buttons 22 into circuit-breaking position. During the movement from the second to the third position, the sloping surfaces of the lifting buttons 25 engage the cam surfaces provided by the edges of the corresponding openings 20 to lift the contact member 24 quickly into circuit-opening position, suggested in Figures 7 and 8. During any prior movement of the contact member 24, no arcing between the contact member and the contact button 22 takes place due to the sliding and wiping movement therebetween. However, when the actual circuit-opening operation commences, there may be a tendency to arc between the crest of the contact button 22 and the adjacent contact face 28b, namely, adjacent secondary points of contact, immediately before the circuit starts to open. Such arcing, if severe, may tend to pit the crest of the contact button and the contact face 28b. However, it is a feature of the invention that any tendency to arc will be at secondary points of contact spaced from the primary points of contact provided when the switch is in normal operating position. Correspondingly, pitting caused by arcing will not interfere with the good circuit-closing engagement at the primary points of contact suggested in Figure 6.

As the contact member 24 turns beyond the aforesaid third position, the crests of the three lifting buttons 25 ride along the forward face

of the panel 12, retaining the contact member 24 spaced from the panel 12, until these lifting buttons reach the adjacent three openings 20. As soon as the central axis of each lifting button moves beyond the edge of the opening 20 which it is approaching, it tends to drop rapidly therein under the action of the auxiliary spring 50, thus rapidly bringing the adjacent contact face 28b first into engagement with the crest of the next contact button, then sliding same therealong until this contact button tends to drop into the longitudinal opening 27. The angles of the lips 28a and the contact button 22 are such that the contact member 24 will snap quickly into its position suggested in Figure 6, where the contact edges 28 engage opposite sides of the new contact button 22. This snap action is very desirable in quickly closing the circuit and the play between the contact member 24 and the square section 32 of the shaft is sufficient to permit this snap-action, switch-closing movement during which the movement of the contact member leads that of the knob 40. The knob 40 is then released to move the shaft inwardly under the action of the main spring, thereby further increasing the contact pressure between the contact member 24 and the newly-engaged contact buttons 22.

The floating action of the contact member 24 is a very desirable feature as it compensates for slight manufacturing irregularities. For example, if the contact buttons 22 are not exactly equally spaced or are not exactly at equal radial positions, the contact member 24 will shift sidewise to insure dual contact on opposite sides of each of the trinity of contact buttons. This is particularly true if the openings 27 are elongated radially, as shown. The floating action of the contact member 24 is made possible by its loose fit in the square section 32 and by the ability of the rear end of the shaft 30 to move sidewise with respect to its opening 34 in the panel 12. In effect, the floating action permits a self-centering action of the contact member with respect to a plurality of contact buttons to insure dual contact with each of these buttons. It is believed new to provide such automatic adjustment by permitting sidewise displacement of the contact member 24 to permit sidewise movement in any direction.

The cam means is also an important feature of the invention. The preferred embodiment permits sliding or wiping engagement between the contact member 24 and the contact button 22 to shift to a second point of contact before operation of the cam means, which physically lifts the contact member 24 from its circuit-closing engagement with the contact button. The cam means also retains the contact member in this lifted position until nearing the adjacent contact button and then acts very advantageously in snapping the contact member into proper engagement with this adjacent button. In effect, the invention can be said to employ two cam actions, the first being made possible by interengagement of the contact member 24 with a contact button 22 and serving to lift the contact member 24 from the first position shown in Figure 6 to the second position shown in Figure 9, the second cam action being produced by interengagement of the lifting buttons 25 and their respective openings 20 to effect further lifting of the contact member 24 into the position suggested in Figure 8.

In some instances, the alternative dual-spring

arrangement shown in Figure 11 is preferred. Here, the squared portion 32 of shaft 30 terminates just rearward of the enlarged circular opening 34 of the panel 12. The main spring, indicated here by the numeral 80, is immediately around the shaft, compressed between an enlargement 81 of the shaft and a washer 82 slidably receiving the shaft and bearing against the block 36. As before, the squared portion 32 passes through the somewhat larger square opening 33 of the contact member 24, but a ring 85 is attached to the contact member 24 and provides a square opening aligning with the opening 33. The enlargement 81 is held, under the action of the main spring 80, in contact with the ring 85 and normally urges the contact member to the right to apply the large contact pressure discussed above. However, upon drawing the shaft 30 slightly forward or to the left, the contact member 24 is relieved of pressure of the main spring 80 but is still urged resiliently to engage the associated contact buttons by the action of lighter auxiliary spring 90. In this embodiment, this auxiliary spring 90 is compressed between the contact member 24 and the block 36 and is retained substantially concentric with the main spring 80 by the washer 82 and the ring 85. Aside from the above differences, the construction and mode of operation of this alternative embodiment are similar to that described with reference to Figures 1 to 10.

Various changes and modifications can be made in the exemplified embodiments without departing from the spirit of the invention as defined in the appended claims.

I claim as my invention:

1. In a switch structure, the combination of: a plurality of series of contact buttons arranged circularly about an axis; a rotatable contact member providing a corresponding plurality of contact means for simultaneously engaging a contact button of each series, each contact means comprising a radially-elongated depression selectively engaging the contact buttons of one series when said contact member is rotated, said contact member providing an opening; and an operating shaft of a size to extend loosely through said opening in driving relationship with said contact member and with substantial play between the shaft and the contact member to permit sufficient sidewise shifting of said contact member with respect to said shaft to insure good electrical contact between said contact means and each of the simultaneously-engaged contact buttons even with minor irregularities in the spacing of said contact buttons.

2. In a switch structure, the combination of: three series of contact buttons arranged circularly about an axis, related contact buttons of each series being spaced approximately 120° from each other; a rotatable contact member providing three contact means spaced approximately 120° from each other for selective engagement with sets of three related contact buttons of said three series, each of said three contact means providing at least one substantially-radially-disposed contact edge adapted to engage selectively the sides of the contact buttons of one of said three series; and means for mounting said contact member for substantial sidewise motion relative to said axis during its rotation to insure good electrical contact between said three contact means and each of the three related contact buttons of any set irrespective of minor irregularities in the spacing of the contact buttons.

3. In a switch structure, the combination of: a series of convex contact buttons arranged substantially circularly about an axis; a rotatable contact member providing a radially elongated opening having opposed upturned lips providing contact edges adapted to engage opposite sides of a selected contact button when straddled by said upturned lips, said contact edges extending outwardly beyond the center of each of said contact buttons to compensate for irregularities in the radial spacing thereof from said axis while insuring dual contact between said contact edges and said opposite sides of each contact button; and means for rotating said contact member.

4. In a switch structure, the combination of: a plurality of series of contact buttons arranged circularly about an axis, each contact button providing opposed sloping sides; a rotatable contact member providing radially-elongated means corresponding in number to the number of series of contact buttons, each means having opposed contact edges adapted to simultaneously engage said opposed sloping sides of a selected contact button; and means for mounting said contact member to shift sidewise in any direction relative to said axis during its rotary motion to insure engagement of said opposed contact edges with both opposed sloping sides of each of the engaged contact buttons irrespective of minor irregularities in the radial or circumferential spacing of said contact buttons.

5. In a switch structure, the combination of: a panel; a plurality of series of contact buttons mounted circularly on said panel about an axis thereof, each contact button providing opposed sloping sides; a rotatable contact member carrying a plurality of contact means corresponding in number to the number of said series, each of said contact means comprising a pair of contact edges extending substantially radially from said axis and adapted to engage simultaneously the opposed sloping sides of a selected control button, each of said contact means being adapted to engage the contact buttons of its series sequentially as said contact member is turned, said contact member providing an irregularly-shaped opening; and a shaft extending loosely through said opening and being so shaped with respect thereto as to permit a limited rotary play therebetween and to permit sidewise displacement of said contact member with respect to said shaft to facilitate simultaneous engagement of all of said contact means with corresponding contact buttons.

6. In a switch structure, the combination of: a panel; a plurality of contact buttons mounted circularly on said panel about an axis thereof; a rotatable contact member providing a contact means adapted to engage said contact buttons sequentially when said contact member is rotated; means for mounting said contact member for such rotation and for bodily movement toward and away from said panel whereby said contact member can be moved away from said panel sufficiently to disengage said contact means from said contact buttons during its rotation, said means including an axially-movable shaft operatively connected to said contact member; a spring for normally biasing said contact member resiliently in a direction toward said contact buttons; and means for operatively connecting said spring to said shaft to relieve said bias upon axial movement of said shaft.

7. In a switch structure, the combination of: a panel; a plurality of contact buttons mounted circularly on said panel about an axis thereof; a rotatable contact member providing a contact means adapted to engage said contact buttons sequentially when said contact member is rotated; means for mounting said contact member for such rotation and for bodily movement toward and away from said panel, said means including an axially-movable shaft; an auxiliary spring constantly biasing said contact member toward said panel; a main spring for additionally biasing said contact member toward said panel; and means for operatively connecting said main spring to said shaft to relieve its biasing action on said contact member upon axial movement of said shaft.

8. In a switch structure, the combination of: a panel; a plurality of contact buttons mounted circularly on said panel about an axis thereof; a rotatable contact member providing a contact means adapted to engage said contact buttons sequentially when said contact member is rotated, said contact member providing an opening; an axially-movable shaft extending through said opening for rotating said contact member; engagement means carried by said shaft in a position to bear against said contact member when said shaft is moved axially in one direction; a main spring for resiliently biasing said shaft in said one direction to exert a resilient force on said contact member through said engagement means and in a direction toward said panel; an auxiliary spring for exerting a resilient biasing force on said contact member urging same toward said panel; and means for axially moving said shaft to disengage said engagement means and said contact member preparatory to a rotation of said contact member, thereby relieving said contact member from the biasing action of said main spring to permit rotation of said contact member while resiliently urged toward said panel exclusively by said auxiliary spring.

9. In a switch structure, the combination of: a support means; a panel spaced from said support means; a plurality of contact buttons mounted circularly on said panel about an axis thereof; a contact member disposed between said support means and said panel, said contact member providing an opening and providing a contact means adapted to engage said contact buttons sequentially when said contact member is rotated; a shaft extending through said opening of said contact member, said contact member being bodily movable in a direction parallel to the axis of said shaft to move in a direction toward and away from said panel; main and auxiliary springs normally urging said contact member toward said panel; and means for relieving the action of said main spring preparatory to a rotation of said contact member whereby such rotation is effected under the exclusive biasing action of said auxiliary spring.

10. A combination as defined in claim 9, in which said shaft is axially movable and provides an engagement means for pressing against said contact member when said shaft is moved inwardly, said shaft also providing a seat member, said main spring being compressed between said seat member and said panel, said auxiliary spring being compressed between said support means and said contact member.

11. In a switch structure, the combination of: a panel; a plurality of series of contact buttons mounted on said panel and arranged circularly about an axis thereof, each contact button providing opposed sloping sides; a rotatable contact

member providing radially-elongated means corresponding in number to the number of series of contact buttons, each means having opposed contact edges adapted to simultaneously engage said opposed sloping sides of a selected contact button of a corresponding series, said contact member providing an opening; an axially-movable shaft extending loosely through said opening to permit a limited amount of rotary play therebetween and to permit sidewise displacement of said contact member relative to said axis during its rotary motion to insure engagement of said opposed contact edges with both opposed sloping sides of the engaged contact buttons irrespective of minor irregularities in the radial or circumferential spacings of said contact buttons; an auxiliary spring constantly urging said contact member toward said panel; an engagement means on said shaft normally bearing against said contact member; a seat member carried by said shaft; and a main spring compressed between said seat member and said panel for normally exerting an additional resilient force urging said contact member toward said panel by engagement of said engagement means with said contact member, said additional force being relievable by axial movement of said shaft in a direction to move said engagement means away from said contact member.

12. In a switch structure, the combination of: a panel; a plurality of series of contact buttons mounted on said panel and arranged circularly about an axis thereof, each contact button providing a sloping side and a crest; a rotatable contact member providing a plurality of contact edges simultaneously engageable with said sloping sides of a corresponding number of said contact buttons whereby rotation of said contact member causes a contact edge to ride up the sloping side of its engaged contact button to bring the crest of said button into engagement with said contact member; and cam means operable upon further rotation of said contact member to move said contact member away from said panel to separate said contact member and the crests of the previously-engaged contact buttons.

13. In a switch structure, the combination of: a panel; a plurality of series of contact buttons mounted on said panel and arranged circularly about an axis, each contact button providing a sloping side; a contact member providing a contact means for each series of contact buttons; means for mounting said contact member for rotation of said contact means about said axis and for movement of said contact member toward and away from said panel; means for resiliently urging said contact member toward said panel to retain said contact means in engagement with the sloping sides of a set of contact buttons whereby rotation of said contact member causes each of said contact means to ride up the sloping side of its engaged contact button to move said contact member bodily away from said panel and to bring the crests of the engaged contact buttons into engagement with said contact member; and cam means operable upon further rotation of said contact member to move said contact member bodily away from said panel a sufficient distance to separate same from the crests of the previously engaged contact buttons.

14. In a switch structure, the combination of: a panel; a plurality of contact buttons mounted on said panel and arranged circularly about an axis thereof; a contact member providing a contact means for selectively engaging said contact buttons; means for mounting said contact member for rotation of said contact means about said axis and for bodily movement of said contact member toward and away from said panel; a spring for urging said contact member toward said panel; cam means operable upon rotation of said contact member for moving same away from said panel against the action of said spring a sufficient distance to separate said contact means from said contact buttons, said cam means including a plurality of circularly-arranged depressions in said panel spaced from each other an angular distance corresponding to the angular spacing of said contact buttons; and a lifting button on said contact member in a position to successively enter said depressions as said contact member is rotated.

15. In a switch structure, the combination of: a panel providing a plurality of series of depressions arranged circularly about an axis; a corresponding plurality of series of contact buttons mounted on said panel and arranged circularly about said axis, there being one depression for each contact button; a contact member providing a contact means for each series of contact buttons and adapted to move from one contact button of this series to the next upon rotation of said contact member; a lifting button on said contact member for each series of depressions and disposed to enter the depressions of such series sequentially when said contact member is rotated, said lifting buttons being of sufficient size to move said contact member away from said panel a sufficient distance to disengage said contact means from previously engaged contact buttons; a spring for resiliently urging said contact member toward said panel; and a shaft loosely connected to said contact member to rotate same, there being sufficient play between said contact member and said shaft to permit said contact member to rotate relative to said shaft under the action of said spring when said lifting buttons enter corresponding depressions thereby snapping said contact means quickly into engagement with corresponding contact buttons.

16. In a switch structure, the combination of: a panel; a plurality of contact buttons mounted on said panel substantially equidistant from an axis, each contact button providing opposed sloping side walls and a crest; a rotatable contact member providing a radially-elongated opening providing opposed upturned contact edges adapted simultaneously to engage opposed opposite sides of a corresponding contact button; means for mounting said contact member for movement toward and away from said panel; a spring resiliently urging said contact member toward said panel whereby a small rotational movement of said contact member relative to said panel causes said upturned contact edges to ride up the engaged walls of said contact buttons to displace said contact member against the action of said spring until said contact member engages the crests of said contact buttons; and cam means operable upon further rotation of said contact member to move same additionally away from said panel to separate said contact member and the crests of said contact buttons.

17. In a switch structure, the combination of: a first and a second group of contacts arranged about an axis, said groups being rotatably movable relative to each other, each of the contacts of at least one of said groups having two substantially radially-extending opposed contact edges adapted to simultaneously engage two areas

of a contact of the other group; and flexible connecting means operatively associating said first and second groups to permit relative axial movement therebetween and relative eccentric movement therebetween for self adjustment of said groups to allow engagement of said opposed contact edges of one group with the corresponding contact areas of the other group.

18. In a switch structure, the combination of: a first group of contacts arranged about an axis; a second group of contacts arranged about said axis for selective engagement with contacts of said first group when said groups are relatively rotated about said axis, each of the contacts of one group having two substantially radially-extending opposed contact edges adapted to simultaneously engage two areas of a contact of the other group; and means for mounting said groups for such relative rotation, said means including interconnecting means allowing relative movement between said groups in a direction toward and away from each other and limited lateral movement between said groups to insure engagement of said opposed contact edges of each contact of said one group with the corresponding contact areas of the engaged contacts of the other group.

19. In a switch structure, the combination of: a shaft; a panel providing a shaft-receiving opening sufficiently larger than said shaft to permit substantial lateral displacement of the shaft as limited by the confines of said opening in said panel; a plurality of series of contact buttons mounted circularly on said panel about said opening; and a rotatable contact member carrying a plurality of contact means corresponding in number to the number of said series, each of said contact means being movable with said contact member to engage sequentially the contact buttons of its series, said contact member providing an irregularly-shaped opening, said shaft extending through said irregularly-shaped opening and providing a portion of corresponding but smaller irregular shape to extend loosely through the irregularly-shaped opening to permit a limited rotary play between said shaft and said contact member and to permit sidewise displacement of said contact member to facilitate simultaneous engagement of all of said contact means with corresponding contact buttons.

20. In a switch structure, the combination of: a panel; a plurality of contact buttons mounted on said panel and arranged circularly about an axis thereof; a contact member providing a contact means for selectively engaging said contact buttons; means for mounting said contact member for rotation of said contact means about said axis and for bodily movement of said contact member toward and away from said panel; a spring for urging said contact member toward said panel; cam means operable upon rotation of said contact member for moving the same away from said panel against the action of said spring a sufficient distance to separate said contact means from said contact buttons, said cam means including a plurality of circularly-arranged openings in said panel spaced from each other an angular distance corresponding to the angular spacing of said contact buttons; and a convex lifting button on said contact member in a position to successively enter said openings as said contact member is rotated, the diameter of said lifting button being substantially less than the diameter of each of said openings to permit limited rotational motion of said contact member while said contact means is in engagement with one of said contact buttons and before said convex lifting button reaches the side of a corresponding opening, further rotation of said contact member while said convex lifting button engages the side of said opening acting to displace said contact member away from said panel and separate said contact means from its previously engaged contact button.

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