May 2, 1961 J. W. FORREST 2,982,824

MULTIPOINT SWITCH

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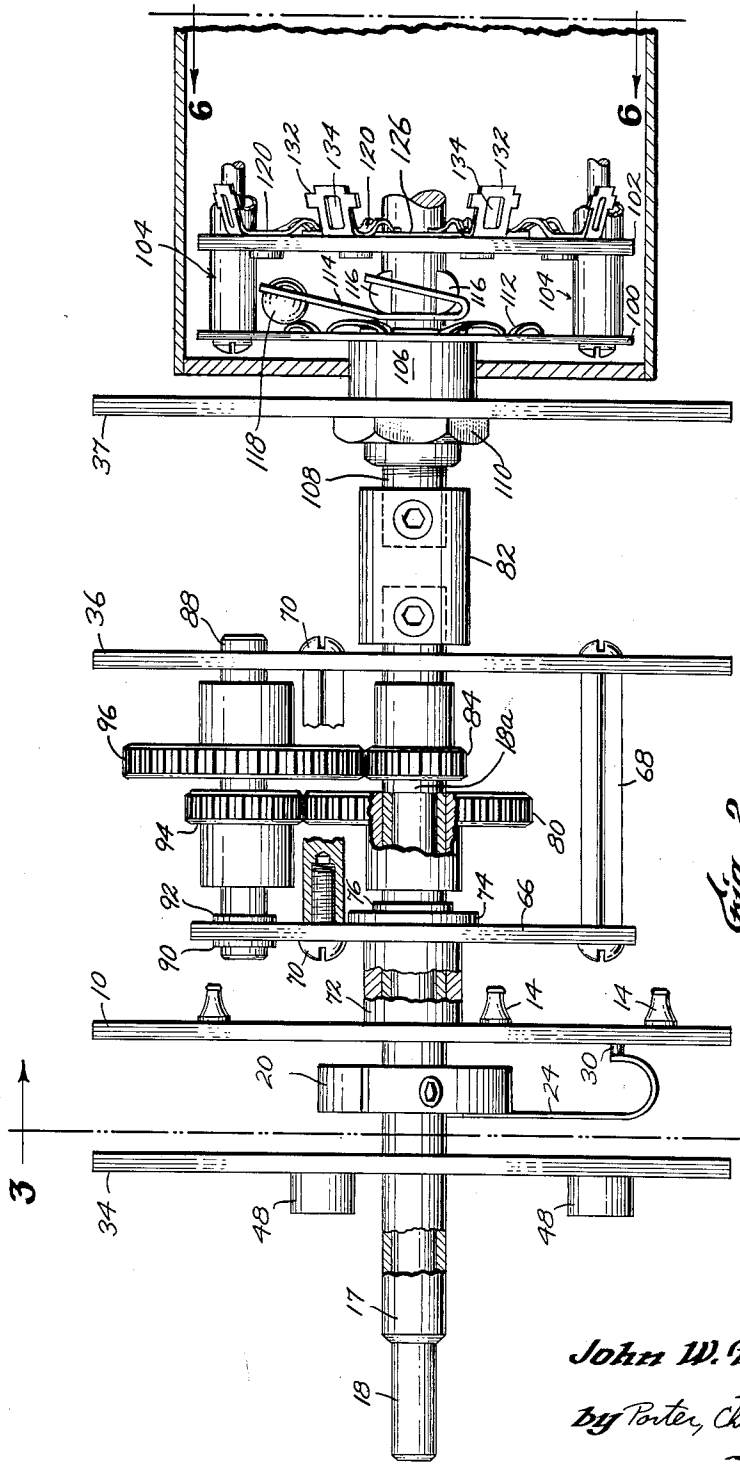

Fig. 2

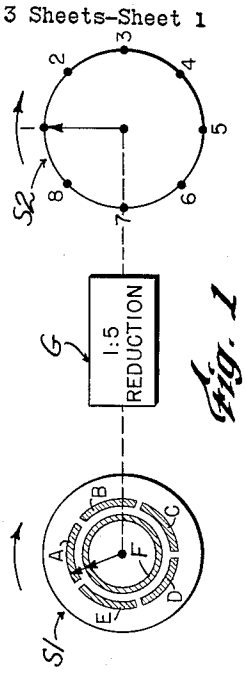

Fig. 1

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Fig. 4

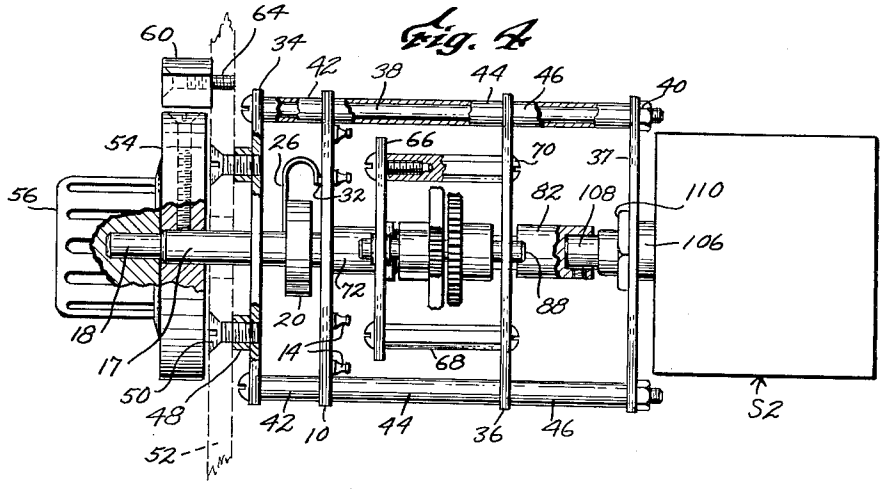


Fig. 6

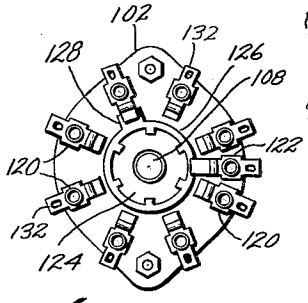


Fig. 5

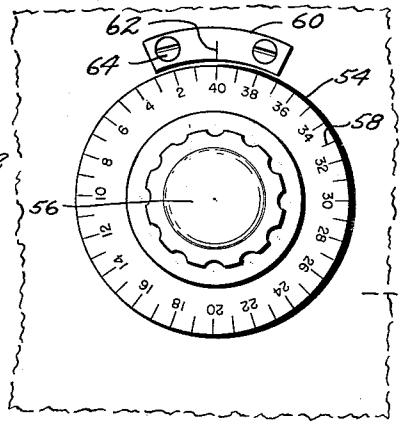
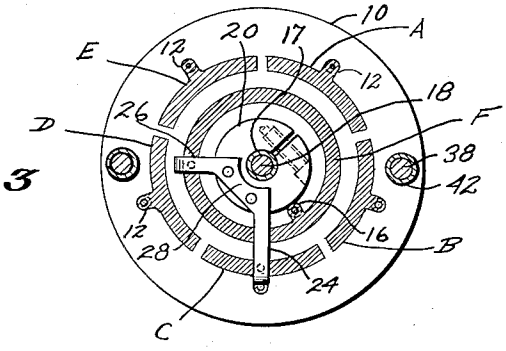


Fig. 3



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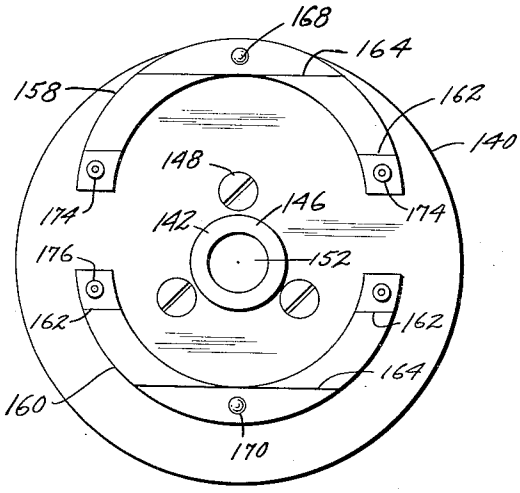

Fig. 7

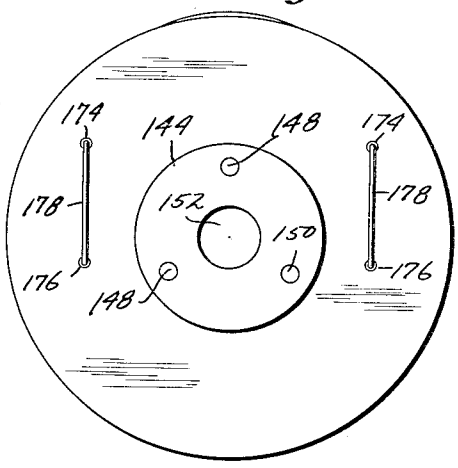

Fig. 8

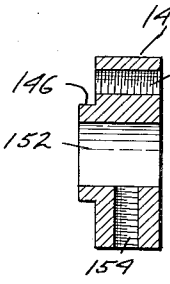

Fig. 11

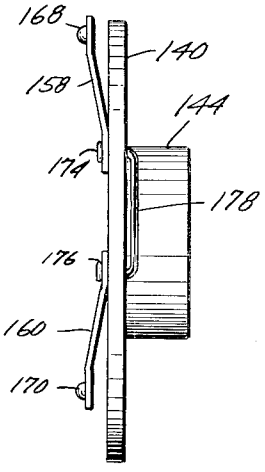

Fig. 9

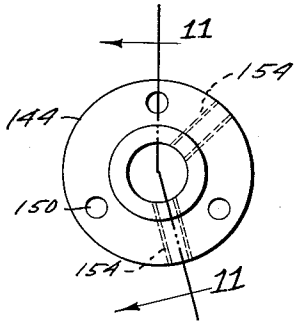

Fig. 10

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MULTIPOINT SWITCH

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Filed Apr. 30, 1959, Ser. No. 810,085

3 Claims. (Cl. 200—24)

This invention relates to multiple-point rotary electrical switch assemblies.

A common requirement in the electrical and electronics industries is to provide switching devices which will permit simultaneous and variable selection of single signals from two groups of signals whereby the selected signals may be combined electrically or functionally to control, modify, initiate, or terminate operation of suitable devices, as, for example, a gate circuit. Conventionally, this is achieved by providing a switch assembly having a plurality of switch positions equal in number to the total number of possible combinations of signals with each position having a plurality of contact terminals equal in number to the number of groups of signals from which signals are to be selected. Obviously, the greater the number of combinations of signals, the more complex and expensive will be the switch assembly. Moreover, it will be more difficult to wire and check.

Accordingly, the primary object of this invention is to provide a multiple-point rotary electric switch assembly which is compact, economical, easy to manufacture, and easy to wire.

A more specific object of this invention is to provide an electric switch assembly capable of a relatively large number of switching combinations and which comprises a conventional multipoint switch coupled to a segmented commutator switch through a reverted gear train.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the invention becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Fig. 1 is a schematic representation of the switch assembly of the present invention;

Fig. 2 is a side elevation, partly in section, of the switch assembly;

Fig. 3 is a sectional view taken along line 3—3 of Fig. 2;

Fig. 4 is a plan view, partly in section, of the same switch assembly;

Fig. 5 is a front end view of the dial section of the switch assembly;

Fig. 6 is a view taken from the standpoint of line 6—6 in Fig. 2;

Fig. 7 is a rear view of a second form of contact assembly for the commutator switch;

Fig. 8 is a front view of the same contact assembly;

Fig. 9 is a side view in elevation of the same contact assembly;

Fig. 10 is a rear view of the hub element of the same contact assembly; and

Fig. 11 is a sectional view taken along line 11—11 of Fig. 10.

The embodiment of the invention selected for description and illustration provides 40 discrete switching combinations with only 15 wiring connections. As illustrated schematically in Fig. 1, the selected embodiment

of the invention comprises a 5-segment commutator switch S1, a conventional 8-position rotary switch S2, and a reverted gear train G coupling switches S1 and S2 which causes the wiper arm of switch S1 to rotate at ⅕ the speed of rotation of the contact arm of switch S2. One complete turn of the contact arm of switch S2 rotates the wiper arm of switch S1 through only one of the five segments, giving eight discrete switch positions. Five turns of switch S2 rotates the wiper arm of switch S1 through all five segments, giving forty discrete positions. Thus, if two groups of signals—one consisting of five different signals and the other consisting of eight different signals—are applied to the segments of switch S1 and the contacts of switch S2 respectively, operation of the switches will yield forty different signal combinations as outputs, each signal combination consisting of one signal for switch S1 and one signal for switch S2. Yet, the total number of electrical connections required to be made to switches S1 and S2 is only 15. A conventional switch assembly would require many more electrical connections to provide the same number of signal combinations.

Turning now to Figs. 2–5, switch S1 comprises a commutator plate 10 preferably formed of a phenolic resin and provided on one side with printed circuit elements comprising a plurality of arcuate conductive segments, A, B, C, D, and E, forming a concentric circle about an inner continuous conductive ring or band F. The circuit elements are flush with the surface of plate 10 and are composed of silver plated over copper. If desired, the silver may be replaced by a plating of rhodium applied over a bright nickel coating on copper.

The spacing between the adjacent ends of the arcuate segments should be kept as small as possible. A spacing of 1/16 of an inch has been found to be satisfactory. The arcuate segments A–E each have a tab 12. These tabs are conductively connected to separate terminals 14 secured to the opposite side of plate 10. Band F has a similar tab 16 conductively connected to another terminal (not shown) secured on the rear side of plate 10.

Extending through an opening in plate 10 located centrally of conductive band F is a first rotatable hollow shaft 17 inside of which is rotatably disposed a second solid shaft 18. Secured to shaft 17 in spaced relation to plate 10 is a split collar 20 which carries an angular conductive member comprising two substantially radially extending arms 24 and 26 formed integral with a connecting portion 28. The latter portion is secured to collar 20. The free ends of arms 24 and 26 are bent back and provided with contact points 30 and 32 respectively. Contact 30 engages the arcuate segments A–E and contact 32 engages conductive ring F.

As seen in Fig. 4, plate 10 and three additional plates 34, 36, and 37 are held in spaced alignment with each other by conventional standoffs comprising two long screwbolts 38, nuts 40, and cylindrical spacers 42, 44, and 46. The foremost plate 34 is provided with tapped bosses 48 to receive screws 50 which are used to attach the entire switch assembly to a suitable plate or chassis wall—e.g., plate 52. Shafts 17 and 18 are made long enough to project through a suitable opening in the plate on which the switch assembly is mounted. Mounted on outer shaft 17 is a dial 54 and mounted on inner shaft 18 is a solid knob 56. Dial 54 has 40 equally spaced graduations 58. An indicator 60 having a single line 62 engraved therein is provided to facilitate reading the setting of dial 54. Indicator 60 is attached by screws 64 to the plate 52 which supports the assembly.

An additional plate 66 is located between plates 10 and 36. Plate 66 is supported from plate 36 by means of a pair of spacers 68 and screws 70 which are screwed into tapped openings provided in the opposite ends of

the spacers. Seated in an opening in plate 66 is a bearing sleeve 72 through which extends shafts 17 and 18. One end of bearing 72 abuts plate 10. The opposite end has a flange 74 which is held in engagement with plate 66 by an O-ring 76 mounted on shaft 17. Shaft 17 terminates at a point intermediate plates 66 and 36. A relatively large gear 80 is mounted on the end of shaft 17. Just beyond gear 80, shaft 18 is enlarged to the same diameter as shaft 17. This enlarged portion of shaft 18 is designated 18*a* in the drawings and extends through and beyond plate 36 and is connected to a removable coupling 82. Mounted on shaft portion 18*a* is a second smaller gear 84.

An idler shaft 88 has its opposite ends supported in suitable openings in plates 36 and 66. Two O-rings 90 and 92 mounted on shaft 88 cooperate with plate 66 to prevent axial but not rotative movement of the shaft. A small gear 94 and a large gear 96 are mounted on idler shaft 88. Gear 94 meshes with gear 80 on shaft 17. Gear 96 meshes with gear 84 on shaft 18. Thus when shaft 18 is rotated by means of knob 56, gear 84 will drive gear 96, gear 96 will drive idler shaft 88, shaft 88 will drive gear 94, gear 94 will drive gear 80, and gear 80 will drive shaft 17 to turn dial 54. In the illustrated embodiment, the four gears are sized to provide a 5:1 speed ratio between inner shaft 18 and outer shaft 17, whereby when shaft 18 is rotated five times, coupling 82 will make the same number of revolutions while shaft 17 and contact member 24 and dial 54 will make a single complete revolution. Dial 54 provides an indication of the degree of rotation of both shafts.

Switch S2 may be of any conventional construction; and as illustrated, it is constructed according to the teachings of U.S. Patent No. 2,012,492.

As seen in Figs. 2 and 6, switch S2 comprises two plates 100 and 102 held together by two standoffs designated generally by numeral 104. Secured to plate 100 is a bushing 106 which surrounds and supports a rotatable operating shaft 108. Bushing 106 extends through a hole in plate 37 and is attached thereto by means of a nut 110. The end of operating shaft 108 is coupled directly to shaft 18 by means of coupling 82. Hence, shafts 18 and 108 rotate at the same speed.

Plate 100 has a plurality of struck up portions 112 symmetrically disposed in a circle around shaft 108 which extends through central openings in plates 100 and 102. A spring member 114 doubled back upon itself is mounted on shaft 108. Spring member 114 is locked to shaft 108 by a pair of wings 116 provided on the shaft. The outer or free end of spring member 114 is provided with an aperture which is adapted to maintain a ball bearing 118 in frictional engagement with plate 100. When shaft 108 is turned, spring member 114 will yield to permit ball bearing 118 to ride over the struck up portions 112; and when the force turning shaft 108 is removed, the ball will automatically seat itself between two of the struck up portions.

Plate 102 is made of non-conductive material and riveted to it are eight contact members 120 arranged symmetrically in a circle. A ninth contact member 122 differing in length is disposed between two contact members 120. Attached to shaft 108 is a rotor 124 which carries a conductive ring 126 provided with a radial tab 128. Contact members 120 terminate short of ring 126 but are long enough to be contacted in turn by tab 128 as shaft 108 is rotated. The ninth contact member 122 is longer than contact members 120 and is in frictional contact with ring 120 constantly. Contact members 120 are disposed so that tab 128 will make contact therewith only when ball bearing 118 is located between two of the struck up portions 112. At their outer ends, contacts 120 and 122 are bent back to form terminal lugs 132 provided with suitable openings 134 into which connecting leads may be soldered. Signals are applied to contacts 120 and picked off by contact 122.

It is to be noted that switch S2 may be modified by adding one or more non-conductive plates like plate 102 and a corresponding number of rotors like rotor 124 so as to increase the number of signals that may be switched by switch S2 without at the same time increasing the number of switching combinations. The latter is determined by the number of conductive segments in switch S1, the number of terminals in switch S2, and the speed ration provided by the reverted gear train G.

Figs. 7–11 shows an alternative form of contact assembly for the commutator swith S1. It may be substituted in place of the contact assembly comprising elements 20—32.

The alternative form comprises a circular insulator disc 140 provided with a central opening 142 and a hub 144 having a reduced diameter extension 146 which fits into opening 142. Screws 148 lock the hub to disc 140. Screws 148 extend through openings in disc 140 and are secured in tapped openings 150 in the hub 144. Hub 144 has a central opening 152 to receive shaft 17 and a pair of radially extending tapped holes 154 for receiving set screws for locking the hub to shaft 17.

Mounted on the rear side of disc 140 are two identical contact leafs 158 and 160. Leafs 158 and 160 are of arcuate shape and are bent adjacent their ends as at 162 and also intermediate their ends as at 164 so that their midpoints and their ends lie in different planes. At their midpoints, leafs 158 and 160 are provided with rounded contacts 168 and 170 respectively. The ends of contact leaf 158 are secured to disc 140 along a line corresponding to a first chord of a circle defined by the periphery of the disc. Contact leaf 160 is secured to disc 140 along a line corresponding to a second chord spaced a shorter distance from the center of the disc. When hub 144 is mounted on shaft 17 adjacent commutator plate 10, contact 168 will engage conductive ring F and contact 170 will engage the arcuate segments A–E.

Contact leafs 158 and 160 are secured to the disc 140 by means of metal eyelets 174 and 176 respectively and are conductively connected to each other by bus wires 178 whose ends are soldered in the eyelets.

The contact assembly of Figs. 7–11 has a greater life than the contact assembly shown in Fig. 3. The arms 24 and 26 are supported at only one end; and, therefore, they tend to twist about connecting portion 28 when shaft 17 is rotated. This torsional stress is avoided in the contact assembly of Fig. 7 since both ends of the two contact leafs are anchored and the contacts 168 and 170 are located between the anchored ends.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is to be understood, therefore, that the invention is not limited in its application to the details of construction and arrangement of parts specifically described or illustrated, and that within the scope of the appended claims, it may be practiced otherwise than as specifically described or illustrated.

I claim:

1. A switch assembly comprising a first rotary switch comprising *t* arcuate-shaped contact segments arranged in a circle, a first rotatable shaft, a wiper arm connected to said first shaft and disposed to engage each segment in turn as said first shaft is rotated, a second rotary switch having *n* fixed contacts, a second rotatable shaft, and a contact arm connected to said second shaft and disposed to engage each fixed contact in turn as said second shaft is rotated, means connecting said first and second shafts for driving said first shaft from said second shaft at a speed equal to $1/t$ times the speed of said second shaft when said second shaft is rotated, a circular dial mounted on said first shaft having *n* times *t* graduations inscribed thereon, *n* and *t* both being whole numbers, and means cooperating with the graduations on said dial to indicate the relative positions of said wiper arm and said contact arm.

2. A rotary switch comprising a commutator plate

having a plurality of arcuate-shaped contact segments on one face thereof, said contact segments arranged end to end in a circle with the adjacent ends of successive segments in close-spaced relation with each other, a like plurality of terminals each connected to one of said segments, said plate also having a continuous contact band on said same face in coaxial relation with said circle of contact segments, a terminal connected to said contact band, first and second contact elements each of arcuate shape and constructed of flat, resilient, conductive material, a rotatable member constructed of insulating material, means securing both ends of said contact elements to said rotatable member with the midpoints of said first and second contact elements located at different distances from the center of said rotatable member, said contact elements bent away from said rotatable member so as to be spaced therefrom at their midpoints, said rotatable member located so that said first contact element slidably engages one of said contact segments and said second

contact element slidably engages said contact band, means electrically connecting said first and second contact elements, and means for rotating said rotatable member whereby to advance said first contact element along successive segments while said second contact element is advanced along said contact band.

3. A rotary switch as defined by claim 2 wherein the ends of said first and second contact elements are secured to one side of said rotatable member by means of conductive eyelets, and further wherein said means electrically connecting said first and second contact elements are wires whose ends are soldered in said eyelets.

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