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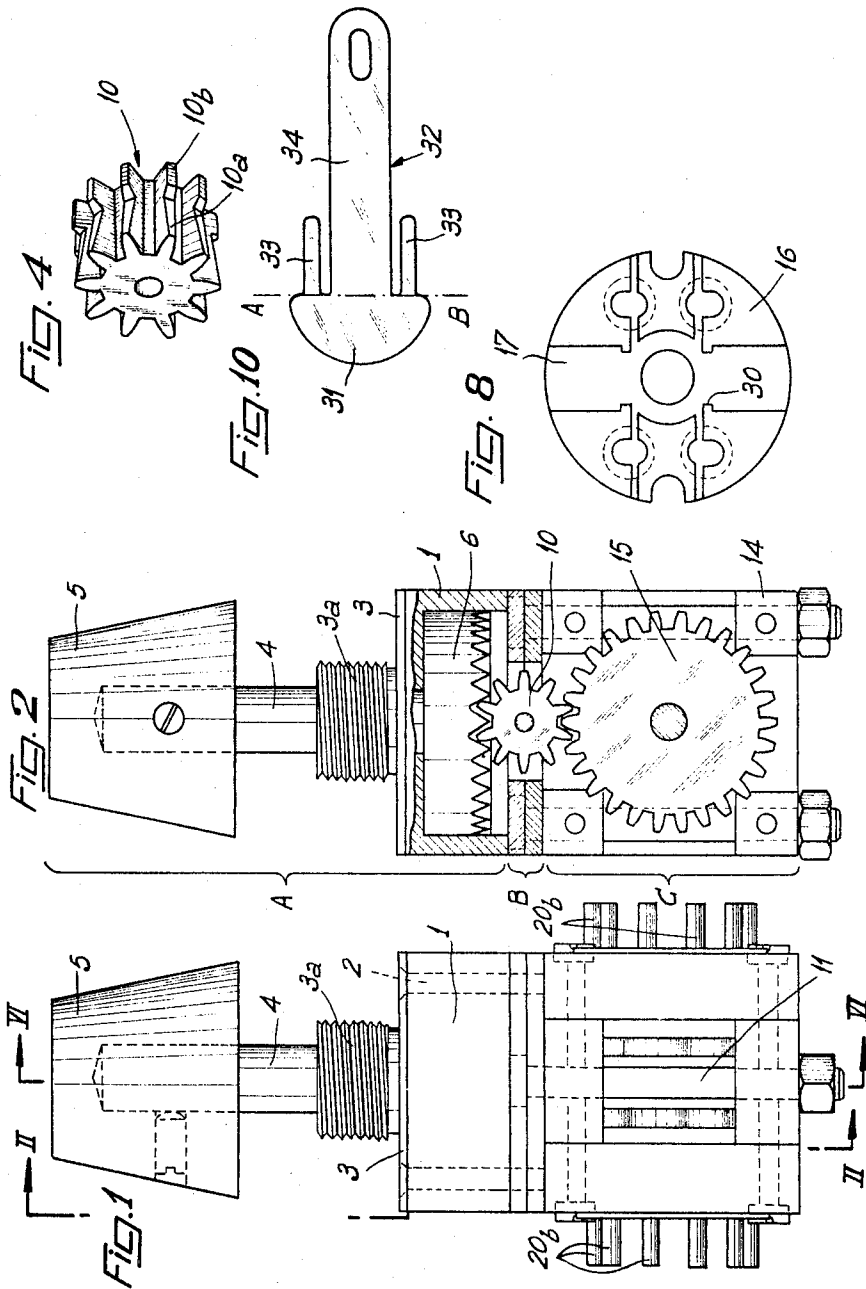
M. H. DELTOER

3,280,290

MULTIPOSITIONAL ROTARY SWITCH

Filed Jan. 11, 1965

3 Sheets-Sheet 1



Inventor

Marcel H. Deltoer
By Sterens, Davis, Miller & Mosher
Attorneys

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M. H. DELTOER

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3 Sheets-Sheet 2

By Stevens, Davis, Miller & Mosher

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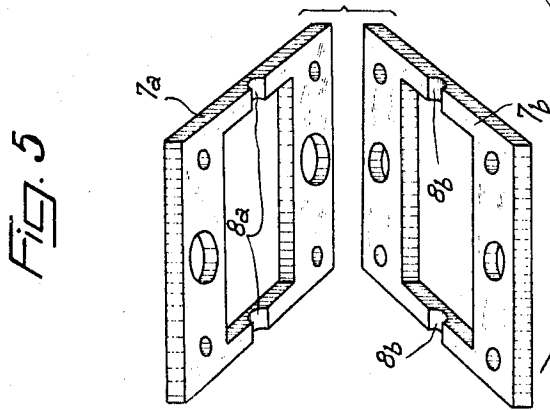
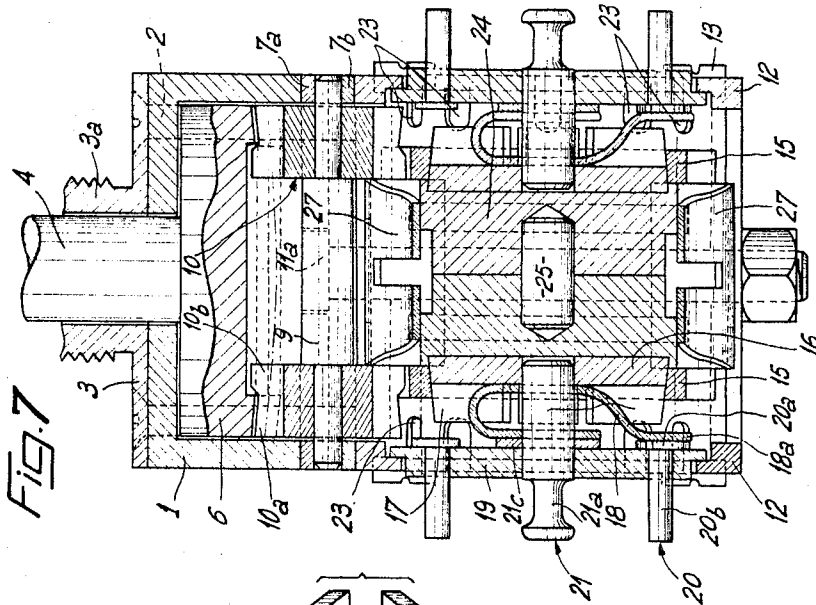
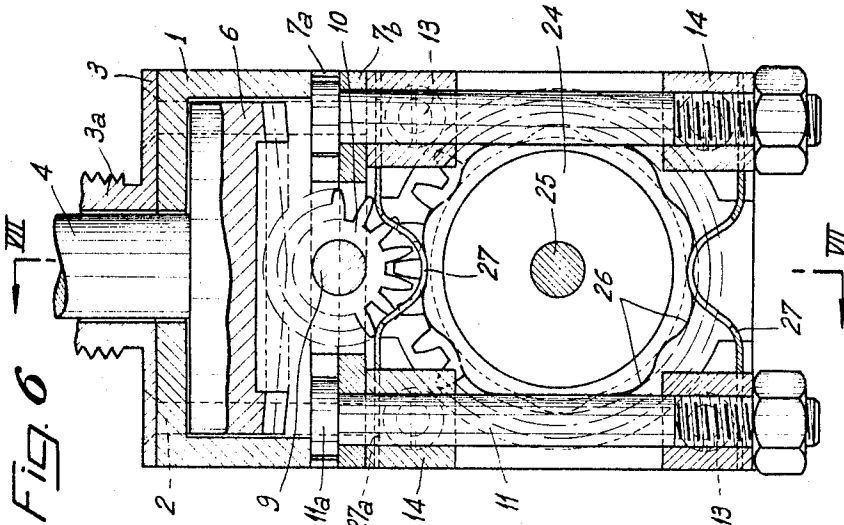
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3 Sheets-Sheet 3



Inventor
 Marcel H. Deltoer
 By Steven Davis Miller & Mosher
 Attorneys

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MULTIPOSITIONAL ROTARY SWITCH

Marcel H. Deltoer, 22 Rue Ravon, Bourg-la-Reine, France
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This invention relates to switching apparatus of the type in which a slider contact is rotatable, usually by means of a manual knob, for selectively engaging any of a circular series of stationary contacts connected with external circuitry to alter the circuit configurations thereof.

In multipositional rotary switches of this type, it has been customary to provide one or more rotors each carrying one (or more) slider contacts thereon, and directly secured on a drive shaft rotatable by means of the manual knob or other actuating member. The circular series of stationary contacts cooperating with each rotor was carried by a disk of insulating material supported in the frame of the device coaxially with the rotor around said drive shaft. This widely-used arrangement, while attractively simple from a mechanical point of view, exhibits a number of inconveniences from an electrical standpoint, especially when it is to be used in conjunction with contemporary electric and electronic systems involving miniature components and printed-circuit techniques.

The necessity of providing a central drive shaft extending the length of the switching assembly sets a limit to the reduction in radial dimensions that can be accomplished. Further, the terminal connections with the stationary contacts and the slider contacts have to extend radially into the generally cylindrical contour of the switch assembly, thereby rendering access difficult for soldering and other connecting and disconnecting operations. Moreover there exists a definite danger of short-circuiting between the stationary contacts of adjacent series because these are spaced a short distance in the axial direction of the switch assembly.

Objects of this invention are to provide a novel multipositional rotary switch assembly in which the above difficulties will be eliminated owing to a completely modified geometric layout of the components of the assembly; to provide such a switch assembly in which a central drive shaft is eliminated, and wherein the series of stationary contacts are supported in planes that are lateral, rather than transverse, to the general axis of the switch assembly, whereby to provide extremely convenient access to the contact terminals from the sides of the assembly; to provide the terminal connections of the switch assembly in the form of laterally projecting pins or the like for convenient plugged and/or soldered connection therewith, e.g. by means of printed circuit cards replaceably insertable thereon; and wherein respective series of stationary contacts of the assembly are axially spaced a substantial distance to eliminate the danger of shorting flash-over therebetween.

Other objects are to provide a multipositional rotary switch construction having the above-enumerated advantageous features, and which will be relatively simple and inexpensive to produce and assembly in large numbers, and will be extensible, if desired, in that additional sets of stationary contacts and sliding contacts may be added thereto in case of requirement.

In an important aspect of the invention there is provided a multipositional rotary switch assembly comprising a frame, a drive shaft journaled in the frame, and a pair of rotors journaled in the frame for separate rotation about a common axis transverse to the drive shaft. Bevel gearing is provided for driving the two rotors in reverse directions about their common axis on rotation of the drive shaft, as with a knob. The rotors carry slider con-

tacts on their outer sides, and these slider contacts cooperate with two circular series of fixed contacts supported in the frame coaxially with said transverse axis and in axially spaced relation outwardly of the rotors. Terminal pins connected with said contacts project outwardly in opposite lateral directions for ready connection with external circuitry.

An embodiment of the invention will now be described for purposes of illustration but not of limitation with reference to the accompanying drawings, wherein:

FIGURE 1 is a general view in side elevation illustrating an improved multipositional rotary switch assembly in accordance with the exemplary embodiment of the invention.

FIGURE 2 is a view in sectional elevation of the assembly on a plane at right angles to that of FIGURE 1 as indicated by the line II—II in FIGURE 1.

FIGURE 3 is an exploded view illustrating the main components of the assembly.

FIGURE 4 is a large-scale view in perspective illustrating one of the two transfer pinions used, and including unitarily connected spur and bevel pinions.

FIGURE 5 is a large-scale view in perspective illustrating the pair of complementary recessed frame plates serving to house and journal the said transfer pinions.

FIGURE 6 is a partial sectional view of the assembly on line VI—VI of FIGURE 1, on an enlarged scale.

FIGURE 7 is a partial sectional view of the assembly on line VII—VII of FIGURE 6.

FIGURE 8 is a front view of a slider-carrier hub forming part of either rotor of the switch assembly.

FIGURE 9 is a front view of a stationary contact-carrier disk used in a modified form of the invention; and

FIGURE 10 shows a contact plate two of which are used in the modification of FIGURE 9.

As best shown in FIGURES 1 and 2, the improved switch assembly can be seen to comprise three main sections: a drive section A, a motion-transfer section B and a switching section C. As will be later understood, there may be provided more than one group each consisting of a motion-transfer section B and a switching section C, associated with a common drive section A.

The drive section A comprises a box-shaped casing 1 formed with a cylindrical recess in it, having a gear annulus 6 rotatable therein. Annulus 6 is secured on a spindle 4 which has an actuating knob 5 secured to its outer end, and said shaft or spindle 4 is rotatable in an externally threaded sleeve 3a projecting from a plate 3 secured to the upper surface of casing 1 through means not shown.

The motion-transfer section B comprises a pair of recessed square plates 7a and 7b in face-to-face relation, with plate 7a being supported against the open lower end of casing 1. As best seen in FIGURE 5, the plates 7a, 7b are each formed with opposite, semi-cylindrical grooves 8a, 8b respectively, which cooperate to define a pair of opposite bearings for supporting the opposite ends of a spindle 9 having pinions 10 freely rotatable on its opposite ends. The pinions 10 are arranged to mesh with the axially projecting set of gear teeth provided on the lower end of bevel gear annulus 6.

Screws 2 having countersunk heads inserted in sockets formed in plate 3 extend through holes formed in casing 1 and aligned holes in plates 7a, 7b, the latter being threaded, thereby to maintain the sections A and B in assembly as shown. Further, the upper plate 7a is formed with opposite holes in which are seated the heads 11a of bolts 11 the shanks of which project downwardly through holes in the lower plate 7b for assembling the switching section as presently described.

The switching section C comprises a frame composed of a pair of recessed square sideplates 12 having their

upper sides or edges supported against the under face of plate 7b along opposite sides of said plate. The side-plates 12 are interconnected by four spacer members 15 each having its opposite ends engaging the inner faces of the respective side-plates 12 at corresponding corners of said plates, and being assembled thereto by means of screws 13 extending through aligned holes in the side-plates and spacers. The spacers 14 are further formed with vertical holes through which the shanks of the aforesaid bolts 11 extend. Nuts threaded on the lower ends of the bolts 111 and engaging the under sides of spacers 14 serve to retain the section C in assembly with section B and therethrough with section A.

It may here be mentioned that in case more than one B- and C-sections are associated with the A-section, then the bolts 11 may be provided of increased length so as to project downward beyond the lower spacers 14, and to receive an additional transfer section (B) followed by an additional switching section (C) thereon, this alternate arrangement of B- and C-sections being, if desired, repeated more than once along the lengths of the bolts 11.

Each of the pinions 10, as best seen from FIGURE 4, is formed in this example as a unitary integral group of two pinions, including a bevel pinion section 10a and a spur pinion section 10b, the respective teeth of the two pinion sections of each pinion 10 being integrally formed, as shown. The bevel pinion sections 10a which are outermost on spindle 9 are in mesh with the upper bevel gear annulus 6 as mentioned above.

The internal construction of the switching section C will now be described.

Housed in the space defined between the side-plates 12 are two rotor structures which are supported, through means presently described, for separate rotation about a common geometric axis which is transverse to the axis of driver shaft 4. Each rotor structure comprises three coaxial sections: a spur gear section 15 having gear teeth adapted to mesh with the inner, spur gear sections 10b of the respective pinions 10; a switch hub section 16 disposed outwardly of the gear section; and a detent disk section 24 inwardly of the gear section 15, and having undulating detent projections 26 around its periphery. It will be understood that in each rotor unit, the hub 16, gear 15 and detent disk 24 are rigidly interconnected and may constitute an integral moulding.

The hub section 16 of each rotor unit has a central opening into which projects the cylindrical inner portion of a pin 21 made of conductive material. The outer end of the cylindrical portion of pin 21 is secured in a central aperture formed in a related one of two switch carrier disks 19, made of insulating material. The disks 19 are securely inserted in generally circular apertures formed in the respective square side plates 12. It will be noted that each disk 19 has castellations 22 formed around its periphery, and which are adapted to interfit with projections 23 formed in the inner surface of the related aperture in disk 12.

Each disk 19, in addition to the central hole through which the pin 21 projects, is formed with a circumferential series of holes corresponding in number and position to the castellated teeth projecting from the periphery of the disk, and adapted to receive therethrough a series of contact pins 20 made of conductive material. Each contact pin 20 is provided with a contact head 20a which seats on the inner side surface of the disk 19, and a terminal shank 20b projecting outwardly beyond the outer side of the disk for connection to an electric circuit. It will also be observed that the central pin 21 has an outwardly projecting terminal stem portion 21a adapted for connection with the circuit.

The hub 16 of each rotor unit has a diametric groove 17 formed in its outwardly facing surface. In this groove is seated a slider contact member 18, which as shown is formed from a strip of resilient conductive metal bent

double so as to have two spaced, generally parallel legs. These legs are formed with aligned holes through which the related pin 21 extends. The axially inner leg of the slider 18 has a radially extended portion 18a which is bent outward and into the plane of the outer, shorter leg, as best seen in FIGURE 7. The arrangement is such that the slider 18 is firmly set in the diametric groove 17 of the related rotor hub 16, so as to be rotatable with the rotor unit, and that the extended leg 18a of the slider resiliently engages the heads 20a of the array of contacts 20 in the related disk 19 and sweeps past the array when the rotor unit is rotated. A perforate flange or washer 21c of conductive material, secured around the periphery of centre pin 21 and seated against the inner side of disk 19, engages the outer, shorter, leg of slider 18 (see FIGURE 7) so as to ensure permanent electric contact between the pin 21 and slider 18.

A cylindrical pin 25 has its respective halves inserted in aligned central recesses formed in the adjacently-disposed detent disks 24 of the respective rotor units to keep both rotor units in coaxial alignment. It will thus be understood that the two rotor units are supported on the three coaxially aligned elements 21 and 25 for coaxial, but independent, rotation about a common geometric axis.

The rounded detent teeth 26 at the peripheries of the two disks 24 resiliently cooperate with the central portions of leaf springs 27 (shown as being unitarily interconnected), the side legs 27a of which are inserted in slots 28 formed near the ends of the upper and lower spacer members 14.

In operation, rotation of the knob 5 rotates shaft 4 and bevel annulus 6, so that the two pinions 10 are rotated in reverse directions on their common axle 9. The two gears 15, and therewith the entire two rotor units, are thus rotated in reverse directions about their common geometric axis defined by the aligned pins 21 and 25. Preferably, as here shown, the drive gear annulus 6 and each of the rotor gears 15 have the same number of teeth. Since further each bevel pinion 10a has the same number of teeth as each spur pinion 10b, the sliders 18 are rotated (in opposite directions) by angles that are equal to the angle drive shaft 4 is rotated by means of knob 5. Thus rotation of knob 5 can bring the sliders 18 into contact with a selected pair of contacts 20a of the respective disks 19.

It will be noted from FIGURE 7 that the projections 23 formed in the apertures in side-plates 12, have their axially-inwardly directed ends extending a substantial amount axially beyond the inner faces of said sideplates and beyond the heads 20a of the contact pins 20 inserted in disks 19. Thus, during rotation of the slider 18, the active end 18a of the slider is cammed axially inwards by the projections 23 between adjacent contacts 20a, thereby positively preventing the occurrence of a short-circuit between the contacts.

The rounded detent teeth 26 provided on the periphery of detent disks 24 are equal in number to that of the contacts 20, and the valleys between said teeth are arranged to engage the detent springs 27 in synchronism with the engagement of the contacts 20 with the slider 18. Thus every time the sliders 18 are engaging contacts 20a, rotation of the rotors is momentarily opposed in a resilient manner due to engagement of the central portions of the springs 27 with the valleys between the detent teeth. In the detent action thus obtained, it will be noted that since each detent disk 24 is integrally rotatable with the related contact slider 18, the desired synchronism between the spring-detent action and the engagement of the switch contacts is at all times retained through the lifetime of the assembly regardless of play and backlash that may develop in the gearing transmission.

If desired, each rotor hub 16 may carry two diametrically opposed sliders in its groove 17 rather than the single slider 18 so far described, for simultaneous cooperation

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with two diametrically opposed contacts 20 of the related switch contact disk 19. In that case the two opposite sliders 37, shown in chain outline in FIGURE 9, are of course insulated from each other, being mounted in spaced relation in the groove 17 and separately retained therein by the lugs 30. The single central contact pin 21 and conductive washer 21c are omitted, and there are instead provided a pair of separate contact plates 31. Each contact plate 31 is desirably formed from a blank 32 (FIGURE 10), cut out of a strip of conducting metal, and having the general shape shown. The blank 32 includes a semi-circular part 31 from which extends a central lug 34 of relatively large length and width and a pair of smaller side lugs 33. The blank is bent on the line AB so that the contact part 31 lies at right angles to the common plane of the lugs 33 and 34. The central lug 34 is inserted through a related one of two parallel spaced slots 34 formed in the contact disk 19 so as to project outwardly and provide an external terminal connector, while the semi-circular contact portions 31 are positioned in contact with the inner surface of disk 19 with their arcuate sides directed away from each other. The small attachment lugs 33 are inserted through holes 36 formed therefor in disk 19 and are bent back to retain the contact plates 32 in assembly. Thus, during rotation of the rotor, the sliders 37 remain in electrical contact with respective contact portions 31 and provide conductive paths therefrom to the switch contacts 20.

If desired, suitable means may be provided for limiting the rotation of the rotor units to one, or less than one, full revolution. For example, a stop lug, not shown, may be provided projecting from drive shaft 4 and cooperating with one or more stops projecting from the frame.

It will be apparent from the disclosure that in the improved multipositional switch device, the provision of the gearing including annulus 6 and the bevel pinions 10 and rotor gears 15, eliminates the need for a continuous central shaft extending through the switch assembly, and thereby makes it possible to reduce the radial dimensions of the assembly, while conveniently arranging the external connections of the device in lateral relation on the opposite sides of the assembly.

In order to increase the number of switch contacts provided while holding the radial dimensions of the contact disks and rotors to a minimum, said disks and the rotor hubs are preferably made from a high-dielectric material such as steatite. The rotor gears 15 and detent disks 24 may be premolded from suitable synthetic resin and the steatite hubs 16 may be molded over said disks as cores.

The switch assembly of the invention is especially well-suited to printed-circuit techniques, since flat printed circuit cards can very conveniently be plugged over the laterally projecting terminals such as 20b, 21b on the opposite sides of the assembly. Access for plugging and/or soldering the connections as well as replacing the cards is greatly facilitated.

It will be evident that a great variety of modifications may be introduced without exceeding the scope of the invention as claimed hereinafter.

What I claim is:

1. A multipositional rotary switch assembly comprising:
 - a frame;
 - a drive shaft journaled in the frame for rotation about a first axis;
 - a pair of rotors journaled in the frame for separate rotation about a second axis transverse to the first axis;
 - bevel gearing including a drive gear on the shaft and driven gears on the rotors drivingly connected with opposite sides of said drive gear for rotating the rotors in reverse directions about their common second axis;
 - slider contacts supported on outer sides of said rotors;

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insulating contact-supporting members supported from the frame in parallel spaced relation outward of said rotors and each having a circular series of contacts coaxial with said second axis, said contacts being positioned on the inwardly directed sides of said members for engagement by the sliders of the respective rotors; and

contact terminals connected to said contacts and extending outward from said members for connection to external circuitry.

2. A multipositional rotary switch assembly comprising:

- a frame;
- a drive shaft journaled in the frame for rotation about a first axis;
- a pair of rotors journaled in the frame for separate rotation about a common second axis transverse to the first axis;
- a bevel gear annulus carried by the shaft;
- a pair of pinion means journaled in the frame for separate rotation about a common axis parallel to said second axis and engaging opposite sides of said annulus for reverse rotation of the pinion means;
- driven gears secured to the respective rotors and engaging said respective pinion means for reverse rotation of said rotors from said shaft;
- slider contacts supported on outer sides of the rotors; and

insulating contact-supporting members supported in the frame in parallel spaced relation outward of said rotors and each having a circular series of contacts coaxial with said second axis, said contacts positioned on the inner sides of said members for engagement by the sliders of the respective rotors.

3. The assembly defined in claim 2, wherein each of said pinion means comprises a bevel pinion section meshing with said annulus and a spur pinion section meshing with said driven gear.

4. The assembly defined in claim 1, wherein each rotor has a circumferential series of detent projections on the periphery thereof corresponding in number to that of said contacts, and resilient means carried by the frame and engageable with said projections on rotation of the rotors for resiliently restraining the rotation thereof on engagement of a slider with a contact.

5. A multipositional rotary switch assembly comprising:

- frame plate;
- a drive shaft journaled in the frame plate;
- a pair of generally square side frame plates secured to opposite sides of said first frame plate in parallel spaced planes normal to the plane of the first frame plate to partly define a box-shaped housing;
- a pair of rotors supported in said housing for separate rotation about a common axis transverse to said drive shaft;

bevel gearing including a drive gear on the shaft and driven gears on the rotors for rotating the rotors from the shaft;

slider contacts supported on outer sides of the rotors; circular apertures formed in said side plates coaxially with said transverse axis;

insulating contact-supporting disks securely fitted in said apertures each having a circular series of contacts coaxial with said transverse axis said contacts being positioned on the inwardly directed sides of said disks for engagement by the sliders of the respective rotors; and

contact terminals connected to said contacts and extending outward from said disks for connection with external circuitry.

6. The assembly defined in claim 5, wherein said disks and the wall surfaces of said apertures have interfitting projections for securing the disks in determinable settings in said apertures, said projections including portions pro-

jecting axially inwards for camming the sliders in an inward direction away from the plane of said contact when the slider is angularly positioned intermediate adjacent contacts:

7. The assembly defined in claim 5, wherein each rotor comprises an integral unit including three coaxial sections, an outer hub section having means for securing a slider to its outer side, an intermediate section comprising said driven gear, and an inner section comprising a detent disk having peripheral detent projections thereon corresponding in number to that of said contacts, and the assembly further including leaf spring means carried by said housing means and engageable with said detent projections for resiliently restraining the rotation of the rotor on engagement of a slider with a contact.

8. The assembly defined in claim 7, wherein said detent projections comprise rounded undulations on the periphery of said detent disk and said leaf spring means comprise a spring plate having opposite ends attached to said housing means and a rounded central part resiliently engageable with said rounded undulations.

9. The assembly defined in claim 7, wherein each rotor unit comprises a steatite hub section and a synthetic-resin gear section cast thereover.

10. The assembly defined in claim 5, wherein each contact-supporting disk comprises a central contact element engageable by said slider throughout rotation of the rotor, and a central terminal connected to said central contact element and extending outward from said disk for connection with said external circuitry.

11. The assembly defined in claim 5, wherein each rotor has two slider contacts supported from the outer side thereof in insulated spaced relation for engagement with opposite contacts of said series, and each contact-support-

ing disk has two separate contact elements engageable by said respective slider contacts and two central terminals connected to said central contact elements and extending outward from said disk for separate connection with said external circuitry.

12. The assembly defined in claim 5, wherein said bevel gearing includes a pair of pinion means separately rotatable about a common transverse axis parallel to said transverse axis, each of said pinion means including a first pinion section meshing with said drive gear and a second pinion section integral with said first pinion section and meshing with a related one of the driven gears.

13. The assembly defined in claim 12, including a pair of recessed frame plates secured in flat engagement with said first frame plate between it and said side plates, said recessed plates cooperating to define means for journalling said pinion means.

14. The assembly defined in claim 1, including an additional pair of rotors similar to said first rotors, means supporting said additional rotors for rotation in the frame about an axis parallel to said second axis with gears on said second rotors drivingly engaging said gears on respective ones of said first rotors, and an additional pair of contact-supporting members supported from the frame for cooperation with said additional rotors respectively.

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ROBERT K. SCHAEFER, *Primary Examiner*.