NONAMBIGUOUS SWITCH SYSTEM

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ABSTRACT OF THE DISCLOSURE

In a switch having a plurality of output tracks continuously moved past sensing stations, nonambiguous sensing for each track is achieved by having a pair of separated sensing brushes at each said station, the brushes of each pair being rectifier-connected to signal sources which are selectively energized.

The present invention relates to a system for nonambiguous discrete switching in connection with a movable switch element which is movable in a continuous, as distinguished from a step-by-step, manner.

Switches employing continuously movable control elements, and which are usually designed to control the actuation of a plurality of external circuits, are widely used. A typical application, in connection with which the invention is here specifically disclosed, is an adjustable coding switch designed for use in conjunction with an electronic counting arrangement. Such coding switches are provided with a plurality of conductive and nonconductive portions arranged along the track length, and brushes are provided for each track, one of those brushes being connected to an external circuit and sequentially moving over the conductive and nonconductive track portions in order to actuate its associated external circuit in accordance with whether it is in engagement with a conductive or nonconductive track portion. It is important that the shifting of the brushes of the various tracks from one track portion to another occur in an accurately synchronized manner. For any position of the movable switch element, predetermined tracks should have their conductive sections operatively engaged by the brushes and other tracks should have their nonconductive portions engaged by their associated brushes. To attempt to accomplish this result in a strictly mechanical fashion calls for a very high degree of precision not only in locating the tracks relative to one another but also in locating the brushes relative to one another. Accuracy of track location is a source of appreciable expense, and the greater the maximum number of conductive-nonconductive transition points in a switch of given size, the more difficult and expensive it is to achieve this accuracy. Brush relationship is even harder to achieve, and when a very high degree of accuracy is required it is almost impossible to maintain because of the susceptibility of those brushes to bend or otherwise change their shape.

These problems are particularly troublesome when the switch is designed to function in a digitally coded manner, with the tracks having their conductive and nonconductive portions arranged in a fashion corresponding to some predetermined coding scheme, such as a binary coded decimal system. In such a system a plurality of tracks control different output circuits, each circuit being designed to be in one or another of a pair of operative conditions, a particular number being code-represented by a unique combination of operative conditions for said circuits. It is essential in such a system that when the movable switch element is in a given position the particular desired actuation of the external circuits, and none other, be accomplished without fail, since if one of those circuits remains "on" instead of being turned "off" the over-
reliably remain. Any shift in position of the brushes due to wear, shock or the like will be sufficiently small so that the accuracy produced by the nonambiguity system will not be impaired.

Spatial requirements place a limit on the number of individual conductive and nonconductive portions which can be placed on the periphery of a given drum. In order to expand the counting capabilities of a system utilizing such a drum, a second drum is associated therewith which is driven-connected thereto so as to rotate at a slower speed, the second drum having a plurality of output tracks thereto. Thus, the first drum may, through the use of eight output tracks, provide for counting from zero to 99 in accordance with a binary decimal coded system, the second drum may be rotated at 1/8 the speed of the first drum and provided with an additional four-codes tracks to provide for counting for an additional multiple of 10, up to 999. In order to provide for nonambiguity in the output of this second drum, the brush pairs to its output tracks are connected to separate sources via rectifiers and the selection of one or the other of those sources is accomplished by means of a transfer track on the first drum that transfer track preferably being provided with a spaced pair of output brushes which are alternatively rendered operative along with the pairs of output brushes for the output tracks on the first drum.

The two drums are preferably mounted coaxially, either on the same support or on two rigidly connected supports, and the gearing interposed between the two drums is located physically between them and within the confines of their axial projections. In this way a compact and positively actuating unit is produced.

To the accomplishment of the above, and to such other objects as may hereinafter appear, the present invention relates to the structural and electrical arrangement of a nonambiguity switch system, as defined in the appended claims and as described in this specification, taken together with the accompanying drawings, in which:

FIG. 1 is a top plan view of a preferred embodiment of the switch structure for the present invention;

FIG. 2 is a side elevational view thereof;

FIG. 3 is a cross sectional view taken along the line 3–3 of FIG. 2;

FIG. 4 is a fragmentary cross sectional view taken along the line 4–4 of FIG. 2; and

FIG. 5A and 5B together represent a circuit diagram of an electrical system embodying the present invention, the location and arrangement of the tracks and their respective brushes being schematically indicated thereon.

As disclosed in FIGS. 1–4, the switch structure comprises a support generally designated 2 on which a pair of drums 4 and 6 are rotatably mounted. A control shaft 8 is rotatably journaled on the end plates 10 and 12, which are held together by tie-rods 13. The drum 4 is fixed to shaft 8 for rotation therewith. The shaft 8 passes through the drum 6, but the drum 6 is freely rotatably mounted thereon. The drums 4 and 6 are separated by a space 16, and the geared driving connection between those drums is located within that space. That connection comprises a pinion 16 fast on the shaft 8 which meshes with a gear 18 fast on shaft 20. Shaft 20 is journaled in intermediate end plates 22 and 24 respectively, and carries pinion 26 which meshes with gear 28, the latter having hub 30 freely rotatably received on shaft 8 and extending to and being connected with the drum 6. Consequently rotation of the input shaft 8 causes rotation of the drum 4 at the same rate and, through the gearing 16, 18, 26, 28, causes rotation of the drum 6 at a different rate, such as one-tenth that of the drum 4. Location of the gearing connection between the two drums, and particularly substantially within the confines of the axial projections of the coaxially mounted drums 4 and 6, makes for a compact mechanical arrangement.

The drum 4 has an outer wall 32 which is formed in whole or in part of electrically insulting material. A plurality of conductive tracks are mounted or deposited on, or otherwise secured to, the outer surface of the wall 32 so as to extend around the drum 4 in axially spaced arrangement. The number of tracks will depend upon the particular operation to be performed by the switch. In the form here specifically disclosed, eight output tracks, designated 34–48, are employed. For purposes of clarity of illustration, in FIGS. 1 and 2 these tracks are represented only in schematic form, by dotted lines. The actual configuration of the tracks is indicated fragmentarily in FIG. 5A. In the embodiment here specifically disclosed the tracks are designed to function in a binary coded decimal system to represent consecutive numbers from zero to 99. To that end output tracks 34–40 are utilized to represent the "units" from 1–9 and output tracks 42–48 are utilized to represent the "tens" from 10 to 100. The track 34 will also function as the nonambiguous control track in a fashion to be described below.

Each of the tracks is formed of two sections A and B, the track section A being continuously conductive around the periphery of the drum 4 and the track section B comprising conductive portions C alternating, around the periphery of the drum 4, with insulating areas D. The track section A is electrically connected to the conductive portions C of the track sections B, as by being formed integrally therewith. The widths of the conductive portions 34C and nonconductive portions 34B of the track section 34B correspond to the least significant bit of information (counting) to be controlled by the switch. The widths and spacings of the conductive portions C and nonconductive portions D of the sections B of the other tracks 36–48 will vary in accordance with the output desired. In this case the particular binary coded decimal system employed. The relative rotative locations of the tracks 34–48 on the outer periphery of the drum 4 will be aligned with one another in some predetermined fashion, again in order to produce the desired output. One convenient form of such alignment is to have the lines of demarcation between adjacent conductive and nonconductive portions C, D of the respective strips 34–48, for a nominal "zero" position, fall along a straight line on the periphery of the drum 4 which is parallel to the axis of rotation thereof. This "zero" position orientation is illustrated in FIG. 5. (The circled portions 50, 52, 54 and 56 represent enlarged views of those parts of the tracks 34–40 respectively which are, for the illustrated position of the drum 4, in operative position.)

Fixedly mounted on the support 2, and adapted to cooperate with the tracks 34–48, are track-engaging brushes. Each track is provided with a brush E which engages and slides over the continuously conductive track section A. Each of the tracks 36–48 is provided with a pair of brushes F and G which are adapted to engage and slide over their respective track sections B, thereby being in engagement either with the conductive portions C or the nonconductive portions D thereof, depending upon the particular rotative position of the drum 4 and upon the shaping and arrangement of their respective track sections B. (In the drawings the track sections and portions and the brushes are identified by numbers corresponding to the track and by letters corresponding to the brush part, e.g. track section 36A, or brush 48G.) The F and G brushes are arranged so that they engage with their respective track sections B at points which are spaced from one another in the direction of movement of those tracks. As here specifically disclosed the brush F are the upper or forward brushes and the brushes G are the lower or rearward brushes, it being understood that these descriptive designations are arbitrary. The brushes F and G are respectively operatively aligned so that all of the brushes F are in operative line with one another and all of the brushes G are in operative line with one another. When, as is here specifically disclosed, the alignment
between the tracks is such that the "zero" position lines of demarcation between the conductive and nonconductive portions D of all of the tracks are in physical line with each other, then the brushes F will all be in similar physical line and the brushes G will all be in similar physical line.

The track 34, which doubles as an output track and as the control track for the nonambiguous feature of the instant system, has but two brushes, a brush 34F which slides over the continuously conductive track section 34A, and a brush 34H which engages and slides over the alternately conductive and nonconductive track section 34B. The brush 34H is preferably positioned so that the point where it engages the track section 34B is rotatively located between the points of engagement of the brushes F and the brushes G with their respective tracks. This is clearly illustrated in FIG. 5A, as well as in FIG. 2. The broken line 57 on FIG. 5A representing the rotative position of the brush 34H relative to the track section 34B will be seen to extend between the brush sets F, G for each of the tracks 36-49. The best error-minimization situation exists when the space between the brushes F and G corresponds to one-half the width of the least significant bit.

Each of the brushes 34F-34E is connected by a lead 58 to an individual output circuit 60. (For ready identification, input and output circuits 60 are identified by additional numbers corresponding to their associated output tracks, e.g. 58-38 and 60-42.) In the form here specifically disclosed the output circuits 60 comprise bistable transistorized circuits including a transistor 62 the base of which is connected by resistor 64 to the lead 58, that being further connected by rectifier 66 and resistor 68 to ground. The point 70 between the rectifier 66 and the resistor 68 is connected to first output lead 72. The emitter of transistor 62 is connected by lead 74 to ground, and its collector is connected by resistor 76 to a positive potential line 78, the point 89 between the transistor collector and the positive potential line 78, the output stage being connected to second output lead 82. When an appropriate bias potential is applied to the lead 58 the transistor 62 will be rendered conductive and an output potential will appear at the second output lead 82, but not at the first output lead 72. When the lead 58 is not properly biased, there will be no output on lead 82 but there will be an output at first output lead 72. Thus the existence of an output signal either on output lead 72 or on output lead 82 will be determined by whether or not the input lead 58 is appropriately energized. This in turn will be determined by whether the brush F or G, depending upon which is operating at a given moment, engages a conductive track portion C or a nonconductive track portion D.

The brushes F and G for each of the tracks 36-48 are connected by leads 84 and 86 respectively to one another and to a control unit 88. (See FIG. 5B.) This control unit 88 comprises a pair of alternately operational switch sources 90 and 92 to which the leads 84 and 86 are respectively connected. Selection of the particular source 90 or 92 which is operative at any given moment is determined by input 94 to the unit 88. Typically, the unit 88 may comprise a bistable circuit provided with a biasing potential 96 and adapted to have an operative signal potential either at 90 or at 92 depending upon whether or not an appropriate signal is provided at input 94.

The brush E for track 34 is not only connected by lead 58-34 to output circuit 60-34, but is also connected by lead 58 and resistors 100 and 102 to a negative potential point 104, the lead 58 being connected to the control unit 88 connected to point 106 between the resistors 100 and 102. The brush 34H is connected, as indicated in FIG. 5A, by lead 108 to a positive potential point 109. Thus when the brush 34H is in engagement with a conductive track portion C, a circuit is completed between the positive and negative voltage points 109, 104, an appropriate biasing potential is applied to the input 94 of control unit 88, and one or the other of the sources 90 and 92 is rendered operative, thereby sending a signal through lead 84 or 86 to the brush F or the brush G, as the case may be, for each of the tracks 36-48. Whenever an operative brush F or G is in engagement with conductive track portion B of its associated track a signal will be sent through the brushes 34F-48F will be associated lead 58 to the corresponding output circuit 60. When an operative brush F or G is in engagement with a non-conductive track section D, no such signal will be sent to the corresponding output circuit 60. Hence one or the other of the output leads 72, 82 of each output circuit 60 will be rendered effective depending upon whether the then-operative brush F or G of that track is in engagement with a conductive track portion C or non-conductive track portion D. Control of which of the brushes F or G is energized at any moment is effected by the control track 34 and its brush 34H via the control unit 88.

The nonambiguous nature of the results derived from this arrangement can be best understood from an examination of FIG. 5. For the position of the drum 4 there specifically illustrated, all of the brushes F and G, as well as the brush 34H, are in engagement with conductive track portions B. Since the brush 34H is thus free to present an operative signal is presented to the unit 88 which energizes lead 86 and renders brushes G operative, the brushes F being inoperative. If now the drum is rotated so that the tracks move a small amount downwardly as illustrated in FIG. 5A, the inoperative brushes 36F-48F will move onto nonconductive track portions D while the operative brushes 36G-48G remain in engagement with conductive track portions C. The brush 34H also remains in engagement with a conductive track portion 34C. With this small movement of the drum, representing less than half the width of a conductive track portion 34C, there is no change in output, even if, because of inaccuracy of misalignment, some of the brushes F remain in engagement with conductive track portions C.

If the drum rotation is continued, however, until the brush 34H moves off of the conductive track portion 34C, the circuit to the input 94 of the control unit 88 is broken, and brush energization is shifted from lead 86 to lead 84, thus simultaneously rendering inoperative all of the brushes G and rendering operative all of the brushes F. When this small movement of the drum, representing less than half the width of a conductive track portion 34C, there is no change in output, even if, because of inaccuracy of misalignment, some of the brushes F remain in engagement with conductive track portions C.

During the time that both of the brushes F and G for a particular track are in engagement with a conductive track portion C (as obtains for each pair of brushes in the position illustrated in FIG. 5), those two brushes will be electrically connected, and since each brush F is electrically connected to each other brush F and similarly for the brushes G, this could result in simultaneous energization of brushes F and G, thus destroying the nonambiguous nature of the system. To prevent this, while still maintaining circuit simplicity, each lead 84 to a brush F is provided with a rectifier 108 and each lead 86 to a brush G is provided with a rectifier 110, the two rectifiers being similarly poled, thereby permitting energization of the particular brush F or G associated therewith from the control unit 88 but preventing any feedback from that brush to the other brushes electrically connected thereto.

While the track 34 is shown as providing an operative output through output circuit 60-34 and also providing nonambiguous control through the lead 98, it will be
apparent that separate tracks could be employed for these two functions if desired. Through the use of the arrangement thus described, the required dimensional accuracy for location of tracks and brushes is greatly reduced. Thus a drum having a diameter of but 1 1/2 inches can readily be made capable of output circuits from zero to 99 by providing on track 34 one hundred hits each of 0.047 inch width (this being the combined width of a pair of adjacent conductive and nonconductive portions C and D) with the location of the various tracks on the drum, and the location of the brushes 7 apparent that separate tracks could be employed for these two functions if desired. Through the use of the... tracks 1 through 48. The input circuits 60 associated with the output tracks 34 through 48 on drum 4. Each of the brushes F and G which slide over the track section B. Each of the brushes 51E through 57E is connected by a lead 58 to its own output circuit 60 which may be similar to the binary coded decimal system. Each of these tracks 51 through 57 is provided with brush E which engages the conductively in the first sections of said output tracks, and first and second brushes engage the first track sections of their associated tracks respectively at points spaced from one another in the direction of said track length, said third brushes engaging the second sections of their associated tracks respectively; means for causing relative movement between all of said tracks as a unit and said brushes as a unit; first electrical connections between each of said first brushes and a first signal source and second electrical connections between each of said second brushes and a second signal source, each of said electrical connections comprising a rectifier in series with each of said first and second brushes; and means for selectively energizing said first and second signal sources.

2. In the switch system of claim 1, a drum on which said tracks are formed, a support on which said brushes and said drum are mounted and means for causing relative rotation between said drum and said support.

3. In the switch system of claim 2, a control track having a first section which is alternatively conductive and nonconductive and a second section which is conductive and nonconductive allowing said control track to be selectively energized by said control brushes at said control brushes are engaged with said control track and said signal sources are energized in accordance with the portion of said first section of said control track which is engaged by said first brush.

4. In the switch system of claim 2, a control track having a first section which is alternatively conductive and nonconductive and a second section which is conductive and nonconductive allowing said control track to be selectively energized by said control brushes at said control brushes are engaged with said control track and said signal sources are energized in accordance with the portion of said first section of said control track which is engaged by said first brush.
second sections of said control track, said first and second brushes of said output tracks being respectively rotatively aligned and thereby engageable with said first section of said control track being located between said aligned first and second output track brushes, one of said brushes being connected to a source of energy, and means operatively connecting the other of said brushes to said means for selectively energizing said first and second signal sources and effective to control which of said signal sources is energized in accordance with the portion of said first section of said control track which is engaged by said first brush.

5. In the switch system of claim 2, a control track having a first section which is alternatively conductive and non-conductive and a second section which is continuously conductive along the length of said control track, the conductive portions of said first section being electrically connected to said second section, the points of transition between conductive and non-conductive portions on the first section of said control track being aligned with similar transition points on the first sections of said output tracks, and first and second brushes engageable with the first and second sections of said control track respectively, one of said brushes being connected to a source of energy, and means operatively connecting the other of said brushes to said means for selectively energizing said first and second signal sources and effective to control which of said signal sources is energized in accordance with the portion of said first section of said control track which is engaged by said first brush, means for selectively energizing said first and second signal means comprising a bistable circuit having two alternatively operative outputs, said outputs being connected to said first and second brushes of said output tracks respectively, said other brush of said control track being operatively connected to said bistable circuit for rendering operative a selected one of said outputs.

6. In combination with the switch system of claim 2, a second drum having a plurality of conductive tracks thereon, each having said first and second sections and each having first, second and third brushes associated therewith as defined in connection with said first mentioned drum, a second support on which said second drum and associated brushes are mounted, means drivingly connecting said first and second drums for simultaneous rotary movement at different speeds relative to their respective supports, electrical connections between said first and second brushes of said output tracks and said first and second drums being rotatively associated therewith as defined above, said first and second brushes of said output tracks being rotatively and electrically connected via rectifiers to said first and second signal sources respectively, and means for connecting said third brush of said output track to said means for selectively energizing said first and second signal sources and effective to render operative one of the other of said signal sources depending upon the position of said output track relative to its associated brushes.

7. In combination with the switch system of claim 2, a second drum mounted on said support coaxially with said first drum and having a plurality of conductive tracks thereon, each having said first and second sections and each having first, second and third brushes associated therewith as defined in connection with said first mentioned drum, said brushes being mounted on said support, means drivingly connecting said first and second drums for simultaneous rotary movement at different speeds relative to said support, electrical connections between said first and second brushes of said second drum and third and fourth signal sources respectively, each of said electrical connections comprising a rectifier in series with each of said first and second brushes, and means for selectively energizing said third and fourth signal sources, said means comprising a transfer track on said first drum having first and second sections and first, second and third brushes associated therewith as defined above, said first and second brushes of said second drum being electrically connected via rectifiers to said first and second signal sources respectively, and means for connecting said third brush of said output track to said means for selectively energizing said first and second signal sources and effective to render operative one of the other of said signal sources depending upon the position of said output track relative to its associated brushes.

8. In the switch system of claim 1, a control track having a first section which is alternatively conductive and non-conductive and a second section which is continuously conductive along the length of said control track, the conductive portions of said first section being electrically connected to said second section, the points of transition between conductive and non-conductive portions on the first section of said control track being aligned with similar transition points on the first sections of said output tracks, and first and second brushes engageable with the first and second sections of said control track respectively, one of said brushes being connected to a source of energy, and means operatively connecting the other of said brushes to said means for selectively energizing said first and second signal sources and effective to control which of said signal sources is energized in accordance with the portion of said first section of said control track which is engaged by said first brush.

9. The switch system of claim 8, in which said means for selectively energizing said first and second signal means comprises a bistable circuit having two alternatively operative outputs, said outputs being connected to said first and second brushes of said output tracks respectively, said other brush of said control track being operatively connected to said bistable circuit for rendering operative a selected one of said outputs.

10. The switch system of claim 8, in which said output tracks and said control track are mounted on a member, said brushes and said member are mounted on a support, and there are means for causing relative rotation between said member and said support, and, in combination therewith, a second member having a plurality of conductive tracks thereon, each having said first and second sections and each having first, second and third brushes associated therewith as defined in connection with said first mentioned member, a second support on which said second member and associated brushes are mounted, means drivingly connecting said first and second members for simultaneous rotary movement at different speeds relative to their respective supports, electrical connections between said first and second brushes of said second member and third and fourth signal sources respectively, each of said electrical connections comprising a rectifier in series with each of said first and second brushes, and means for selectively energizing said third and fourth signal sources, said means comprising a transfer track on said first member having first and second sections and first, second and third brushes associated therewith as defined above, said first and second brushes of said second track being electrically connected via rectifiers to said first and second signal sources respectively, and means for connecting said third brush of said output track to said means for selectively energizing said third and fourth signal sources and effective to render operative one of the other of said signal sources depending upon the position of said output track relative to its associated brushes.

11. The switch system of claim 8, in which said output tracks and said control track are mounted on a member, said brushes and said member are mounted on a support, and there are means for causing relative rotation between said member and said support, and, in combination therewith, a second member mounted on said support coaxially with said first member and having a plurality of con-
ductive tracks thereon, each having said first and second sections and each having first, second and third brushes associated therewith as defined in connection with said first mentioned member, said brushes being mounted on said support, means drivingly connecting said first and second members for simultaneously rotary movement at different speeds relative to said support, electrical connections between said first and second brushes of said second member and third and fourth signal sources respectively, each of said electrical connections comprising a rectifier in series with each of said first and second brushes, and means for selectively energizing said third and fourth signal sources, said means comprising a transfer track on said first member having and second and third brushes associated therewith as defined above, said first and second brushes of said transfer track being electrically connected via rectifiers to said first and second signal sources respectively, and means for connecting said third brush of said transfer track to said means for selectively energizing said third and fourth signal sources and effective to render operative one or the other of said signal sources depending upon the position of said transfer track relative to its associated brushes.

12. In the switch system of claim 1, a control track having a first section which is alternatively conductive and nonconductive and a second section which is continuously conductive along the length of said control track, the conductive portions of said first section being electrically connected to said second section, the points of transition between conductive and nonconductive portions on the first section of said control track being aligned with similar transition points on the first sections of said output tracks, and first and second brushes engageable with the first and second sections of said control track respectively, second brushes of said output tracks being respectively rotatably and the brush engaged with said first section of said control track being located rotatably between said aligned first and second output track brushes, one of said brushes being connected to a source of energy and means operatively connecting the other of said brushes to said means for selectively energizing said first and second signal sources and effective to control which of said signal sources is energized in accordance with the position of said first section of said control track which is engaged by said first brush.

13. The switch system of claim 12, in which said means for selectively energizing said first and second signal means comprises a bistable circuit having two alternatively operative outputs, said outputs being connected to said first and second brushes of said output tracks respectively, said other brush of said control track being operatively connected to said bistable circuit for rendering operative a selected one of said outputs.

14. The switch system of claim 12, in which said output tracks and said control track are mounted on a member, said brushes and said member are mounted on a support, and there are means for causing relative rotation between said member and said support, and, in combination therewith, a second member having a plurality of conductive tracks thereon, each having said first and second sections and each having first, second and third brushes associated therewith as defined above, a second member and associated brushes are mounted, means drivingly connecting said first and second members for simultaneous rotary movement at different speeds relative to their respective supports, electrical connections between said first and second brushes of said second member and third and fourth signal sources respectively, each of said electrical connections comprising a rectifier in series with each of said first and second brushes, and means for selectively energizing said third and fourth signal sources, said means comprising a transfer track on said first member having and second and third brushes associated therewith as defined above, said first and second brushes of said transfer track being electrically connected via rectifiers to said first and second signal sources respectively, and means for connecting said third brush of said transfer track to said means for selectively energizing said third and fourth signal sources and effective to render operative one or the other of said signal sources depending upon the position of said transfer track relative to its associated brushes.
13 depending upon the position of said transfer track relative to its associated brushes.

18. The switch system of claim 1, in which said output tracks and said control track are mounted on a member, said brushes and said member are mounted on a support, and there are means for causing relative rotation between said member and said support, and, in combination therewith, a second member mounted on said support coaxially with said first member and having a plurality of conductive tracks thereon, each having said first and second sections and each having first, second and third brushes associated therewith as defined in connection with said first mentioned member, said brushes being mounted on said support, means drivingly connecting said first and second members for simultaneous rotary movement at different speeds relative to said support, electrical con- nections between said first and second brushes of said second member and third and fourth signal sources respectively, each of said electrical connections comprising a rectifier in series with each of said first and second brushes, and means for selectively energizing said third and fourth signal sources, said means comprising a transfer track on said first member having first and second sections and first, second and third brushes associated therewith as defined above, said first and second brushes of said transfer track being electrically connected via rectifiers to said first and second signal sources respectively, and means for connecting said third brush of said transfer track to said means for selectively energizing said third and fourth signal sources and effective to render operative one or the other of said signal sources depending upon the position of said transfer track relative to its associated brushes.

19. In combination, a support, a first member mounted on said support for rotation about an axis and having an outer insulating surface, a plurality of conductive tracks on said outer surface and extending therearound, a plurality of sets of brushes mounted on said support, each said set of brushes engaging and sliding over a different one of said tracks as said second member is rotated, each of said brush sets of said second plurality having a pair of alternatively energizable brushes, and means including one of said conductive tracks on said first member operatively connected to said alternatively energizable brushes and effective to control which of them is energized in accordance with the position of said one of said conductive tracks on said first member.

20. In combination, a support, a first member mounted on said support for rotation about an axis and having an outer insulating surface, a plurality of conductive tracks on said outer surface and extending therearound, a plurality of sets of brushes mounted on said support, each said set of brushes engaging and sliding over a different one of said tracks as said second member is rotated, a second member mounted on said support in coaxial relation to said first member, gearing axially interposed between and drivingly connecting said members, said gearing being substantially completely received within an axial projection of said members, said second member having a substantially cylindrical outer surface, a plurality of conductive tracks on said outer surface of said second member and extending therearound, a plurality of sets of brushes mounted on said supports, each said set of brushes engaging and sliding over a different one of said tracks as said second member is rotated, each of said brush sets of said second plurality having a pair of alternatively energizable brushes, and means including one of said conductive tracks on said first member operatively connected to said alternatively energizable brushes and effective to control which of them is energized in accordance with the position of said one of said conductive tracks on said first member.

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