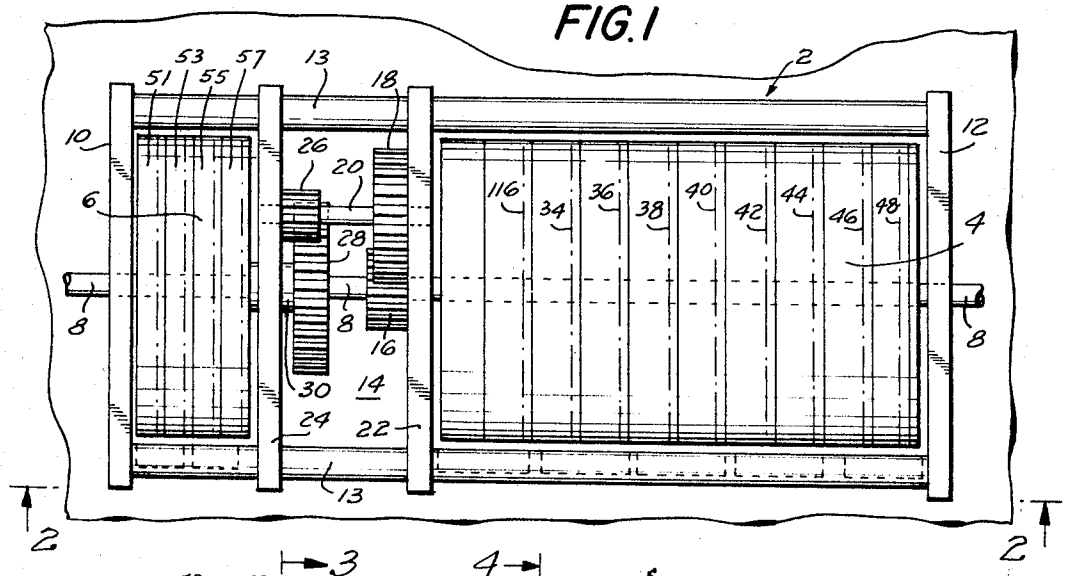
March 11, 1969 J. J. LA PORTA 3,432,848

NONAMBIGUOUS SWITCH SYSTEM

Filed Aug. 2, 1965 Sheet 1 of 3

FIG. 1



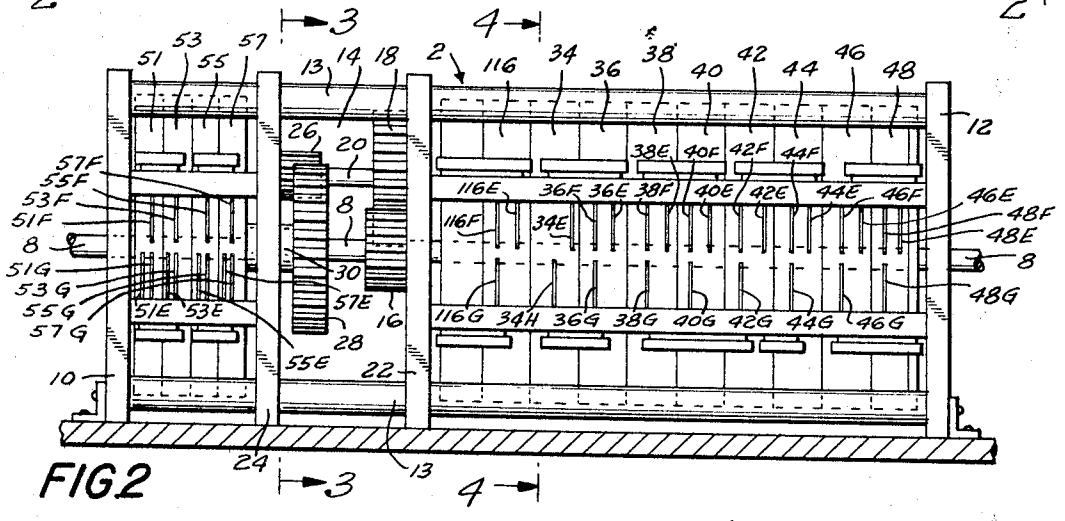
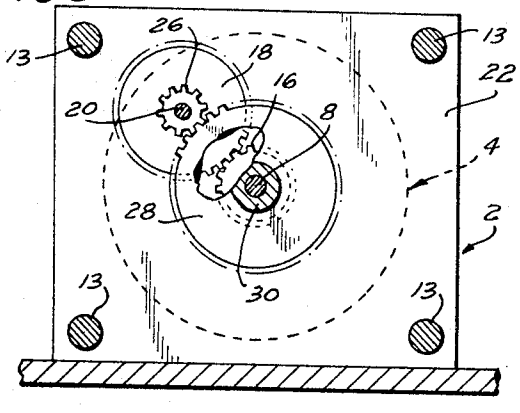


FIG. 2

FIG. 3



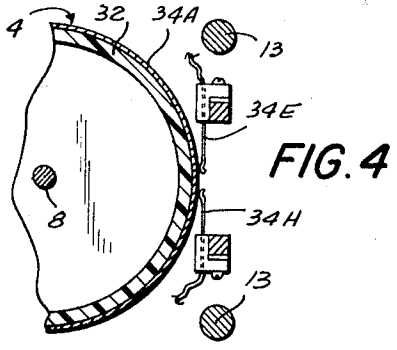


FIG. 4

INVENTOR
JOHN J. LA PORTA
BY James and Franklin
ATTORNEY

March 11, 1969 J. J. LA PORTA 3,432,848

NONAMBIGUOUS SWITCH SYSTEM

Filed Aug. 2, 1965 Sheet 2 of 3

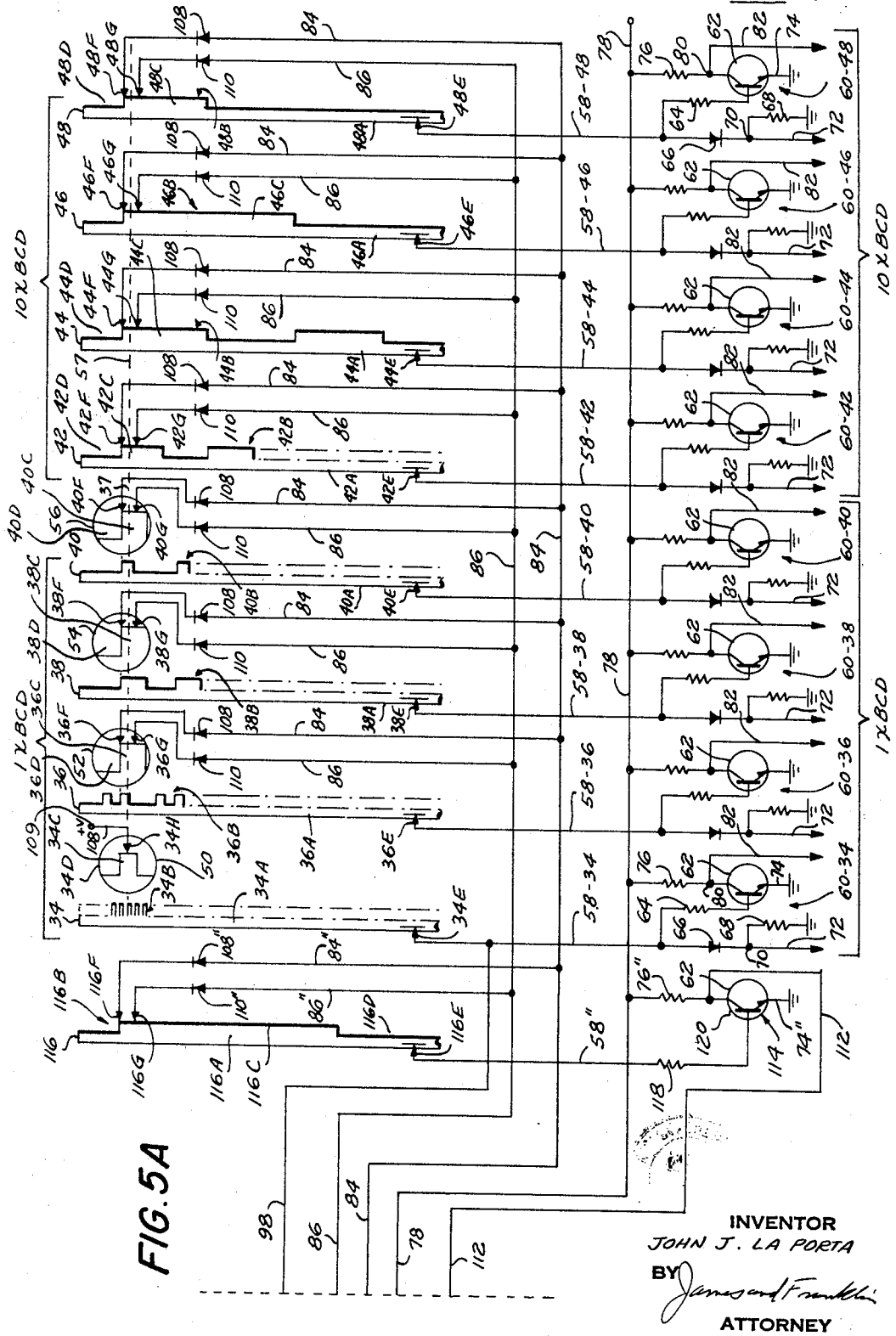


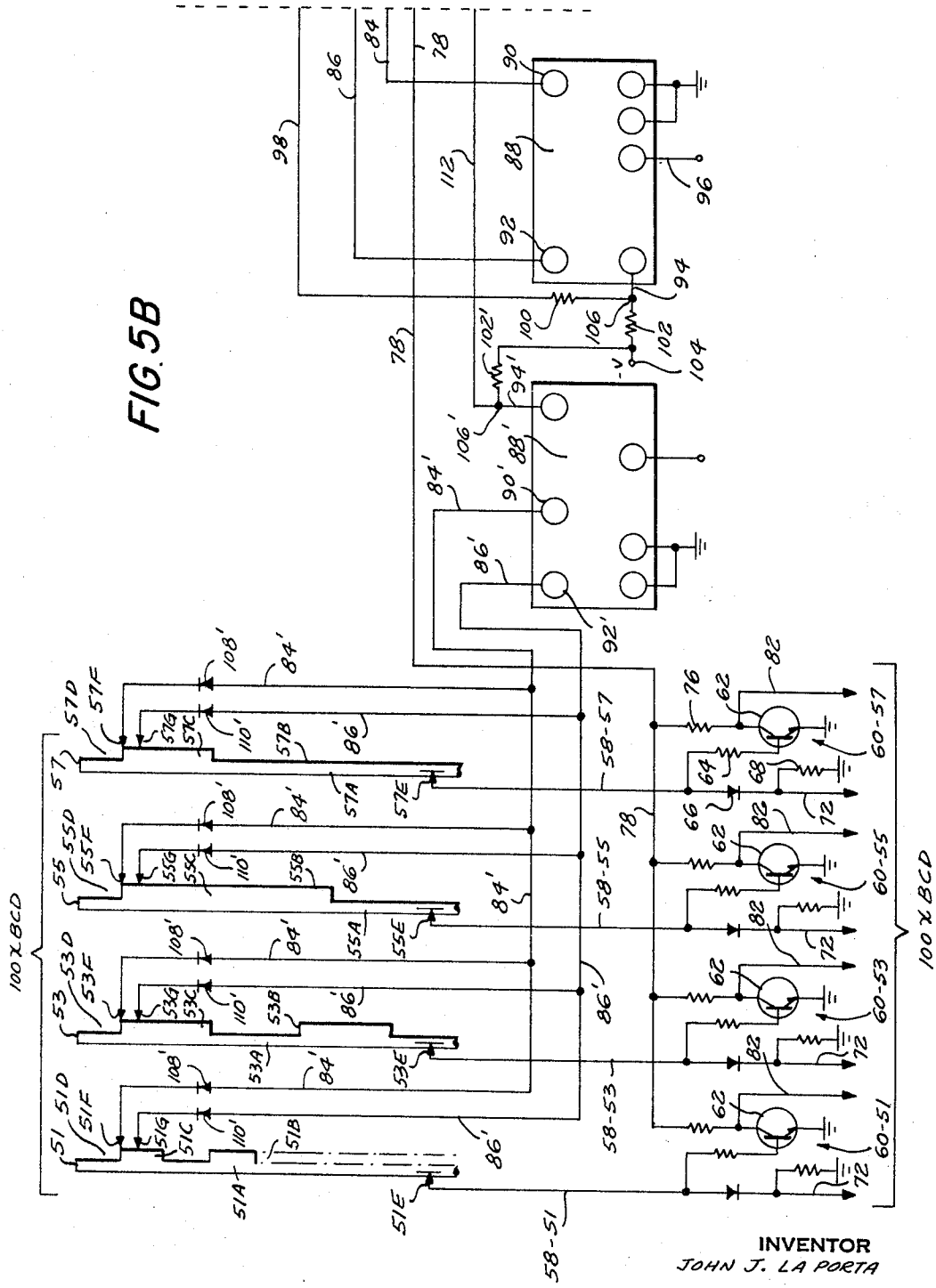
FIG. 5A

March 11, 1969 J. J. LA PORTA 3,432,848

NONAMBIGUOUS SWITCH SYSTEM

Filed Aug. 2, 1965 Sheet 3 of 3

FIG. 5B



INVENTOR
JOHN J. LA PORTA
BY James and Franklin
ATTORNEY

United States Patent Office 3,432,848 Patented Mar. 11, 1969

3,432,848

NONAMBIGUOUS SWITCH SYSTEM

John J. La Porta, Allandale, N.J., assignor, by mesne assignments, to Spedcor Electronics, Inc.

Filed Aug. 2, 1965, Ser. No. 476,598
U.S. Cl. 340—357 20 Claims
Int. Cl. G08c 19/00; H03k 17/00; H04q 1/00

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 tracks having 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 occurs 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 is it 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 overall indication will be of a different number than that which is designed to correspond to the setting of the movable switch element.

It has been proposed in the past, in connection with conductive track switches of the type under discussion, that the operative tracks be provided with a pair of brushes which are engageable with the conductive and nonconductive portions of the tracks, the brushes of each pair being spaced from one another in the direction of travel of the movable switch element, and that means be provided for rendering one or the other of those pairs of brushes operative for a given position of the movable switch element. However, such structures and electrical arrangements as have been proposed along this line have been exceedingly complex both mechanically and electrically.

It is the prime object of the present invention to provide for nonambiguity of a switch system of the type under discussion by means of a structure and electrical arrangement which are both highly simplified and relatively inexpensive, which do not require any excessive degree of mechanical accuracy, which may be incorporated into a unit of minimal size, and which will function with a very high degree of reliability and accuracy.

From an electrical point of view these ends are achieved by connecting the corresponding ones of each pair of output brushes together and to separate external sources, and by selecting the particular one of those sources to be operative at a given time by means of a control track on the same movable switch element which carries the output tracks. This control track can also function as an output track, if desired. Since the brushes of a given pair may well both be engaged with the same conductive portion of their associated track at the same time, and since the corresponding brushes of the respective pairs are electrically connected together, simultaneous rather than alternative energization of the brushes of both sets could result, thereby destroying the desired nonambiguity of the arrangement. To prevent this from happening, while at the same time maintaining the advantages inherent in connecting each of the corresponding brushes to the same source, the connection to each brush includes an appropriately poled rectifier which prevents the feedback of energization to nonenergized brushes via a brush which may happen to be track-connected to an energized brush.

The tracks are preferably formed on the external surface of a drum, so that the linear travel of all of the tracks is the same for a given degree of movement of the movable switch element. As here specifically disclosed the drum itself constitutes the movable switch element, the brushes being fixed to the support in which the drum rotates. The subdivision of the control track into alternating conductive and nonconductive portions is carried out so as to provide a minimum spacing for those portions which corresponds to the least significant information bit for the system involved. Only a single brush is employed to engage with the alternating and nonconductive portions of the control track, that single brush controlling the selective energization of the sources to which the pairs of output track brushes are respectively connected. The location of this control track brush relative to track travel preferably corresponds to a point between the pairs of brushes for the output tracks, the arrangement being such that the shift in energization from the forward brushes to the rearward brushes (considered in terms of the direction of movement of the tracks) of each pair of output brushes, or vice versa, is determined by whether the control track brush is in engagement with a conductive portion or a nonconductive portion of the control track. Since the control track is fixedly mounted on the same drum as the output tracks, once a desired alignment of these tracks is achieved that alignment will

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 drivingly connected thereto so as to rotate at a slower speed, the second drum having a plurality of output tracks thereon. Thus while 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 1/10 the speed of the first drum and provided with an additional four-coded 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 interconnection between the two drums is located physically between them and within the confines of their axial projections. In this way a compact and positively acting 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 nonambiguous 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

FIGS. 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 **10**, 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 insulating 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, where the switch is to function in connection with a counting ararngement, 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 dot-dash 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 **6** and the track section B having conductive portions C alternating, around the periphery of the drum **6**, 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 **34D** 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 specific 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 brushes 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 C, D of all of the tracks are in physical line with one another, 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 **34E** which engages and 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 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 **36–48**. The best error-minimization situation exists when the spacing between the brushes F and G corresponds to one-half the width of the least significant bit.

Each of the brushes **34E–48E** is connected by a lead **58** to an individual output circuit **60**. (For ready identification the leads **58** 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 lead 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 **80** between the transistor collector and the resistor **76** 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 operative signal 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 **98** and resistors **100** and **102** to a negative potential point **104**, the input **94** to the control unit **88** being 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 **34C**, 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 a conductive portion B of its associated track a signal will be sent through the 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 nonconductive 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 engaged, 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. By this time all of the brushes F, even if somewhat misaligned or distorted in shape, will have moved off conductive track sections C. Slight differences in alignment between the individual tracks **34–49** or between the brushes F or the brushes G will have no effect on this silmultaneous shifting of brush energization, and as a result, for any given position of the drum **4**, there will be a definite, predetermined and nonambiguous electrical output from all of the output circuits **60** considered as a group.

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 1½ inches can readily be made capable of counting from zero to 99 by providing on track **34** one hundred bits 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 on the support relative to the drum, dimensionally accurate only to plus or minus .012 inch, a dimensional accuracy which is readily attainable.

For counting up to a higher number, such as 1000, on a single drum a marked increase in drum diameter would be entailed. In order to keep such a unit within reasonable size, and also to minimize the problems involved in properly relating the various tracks to one another, a second drum **6** is employed which, as has been indicated above, is rotated at a speed which is one-tenth that of the drum **4**. The second drum **6** is provided with tracks **51**, **53**, **55** and **57** which are similar to the tracks **34–40** and to the tracks **42–48** respectively. Thus they comprise continuously conductive sections A electrically connected to sections B formed of alternating conductive portions C and nonconductive portions D, the configuration of the portions B and C being designed to produce the desired output, such as that required by a binary coded decimal system. Each of these tracks **51–57** is provided with brush E which engages the continuously conductive track section A, and with spaced brushes F and G which slide over the track section B. Each of the brushes **51E–57E** is connected by a lead **58** to its own output circuit **60** which may be similar to the output circuits **60** associated with the output tracks **34–48** on drum **4**. Each of the brushes F is connected by rectifier **108′** and lead **84′** to a signal source **90′** on control unit **88′**. Each of the brushes G is connected by rectifier **110′** and lead **86′** to the signal source **92′** on control unit **88′**. The source **88′** has a control input **94′** which is connected to point **106′**, a resistor **102′** being connected between point **106′** and the negative potential point **104**. Point **106′** is also connected by lead **112** to an output circuit **114** associated with an additional track **116** on drum **4**, that track **116** having a continuously conductive section **116A** electrically connected to an alternately conductive and nonconductive section **116B** in which the conductive portion **116C** extends half-way around the drum **4**, the nonconductive portion **116D** extending around the other half thereof. The track **116** is provided with brush **116E** which engages the track section **116A** with brushes **116F** and **116G** which are spaced from one another as are the other F and G brushes, which engage the track section **116B**, and which are connected respectively by rectifiers **108″** and **110″** and leads **84″** and **86″** to all of the other F and G brushes respectively. The brush **116E** is connected by lead **58–116** and resistor **118** to the base of transistor **120** in the output circuit **114**. The emitter of that transistor is connected by lead **74″** to ground, and the collector of that transistor **120** is connected by resistor **76″** to the positive potential line **78**.

The track **116** may be termed a "transfer" track, because it transfers the position of drum **4** to the control unit **88′** associated with the tracks **51–57**. The control unit **88′** controls which of the brushes F or G of the tracks **51–57** on the second drum **6** is operative at any given time, thereby producing non-ambiguity in the output circuits **60** associated with the second drum **6**. The control track **34** on the first drum **4** determines which of the brushes **116F** or **116G** is operative at any given time, thus providing non-ambiguity in the transfer operation. Hence at all times, and for any position of the drum **4**, and consequently of the drum **6** which is connected thereto, there will be only one non-ambiguous output from each of the output circuits **60**, and this despite the existence, within limits, of mechanical or design inaccuracies—e.g. backlash in the gears **16**, **18**, **26**, **28**, slight dimensional variations in the precise positioning of the tracks on the drums, and misadjustment or distortion of the brushes.

As a result of the structural and electrical arrangement here disclosed, the size of the switch arrangement may be greatly minimized. A switch assembly 4″ in length and utilizing drums having a diameter of 1½″ can produce a nonambiguous switch assembly capable of providing 1000 separate output conditions and having the advantages outlined above.

While but a single preferred embodiment of the present invention has been here specifically disclosed, it will be apparent that many variations may be made therein, with regard both to mechanical and electrical details, and with regard to the particular shaping of the conductive tracks to produce virtually any desired input-output relationship, without departing from the spirit of the invention.

I claim:

1. A nonambiguous switch system comprising a plurality of output tracks each having a first section which is alternately conductive and nonconductive and a second section which is continuously conductive along the length of said track, conductive portions of said first section being electrically connected to said second section; first, second and third brushes for each of said output tracks, said first and second brushes engaging 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 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, 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.

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 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, said first and second brushes of said output tracks being respectively rotatively aligned and the brush engageable with said first section of said control track being located rotatively 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 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, 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 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 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.

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 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.

8. 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, 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 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.

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 simultaneous 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 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.

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, said first and second brushes of said output tracks being respectively rotatively aligned and the brush engageable with said first section of said control track being located rotatively 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.

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 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 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.

15. 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 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 connections between said first and second brushes of said second member and to 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.

16. The combination of claim **1**, 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.

17. 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 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, 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 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.

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 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 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 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 second member having an outer insulating surface, a plurality of conductive tracks on said outer surface of said second member and extending therearound, a second 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.

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 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 second 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.

References Cited

UNITED STATES PATENTS

2,880,410	3/1959	Postman	340—357
3,049,706	8/1962	Freedman	340—206

THOMAS B. HABECKER, *Primary Examiner.*

U.S. Cl. X.R.

340—176, 354