Nov. 6, 1956 W. R. ELLIOTT 2,769,948

CONTROL CIRCUIT AND ACTUATING MECHANISM FOR A COAXIAL SWITCH

Filed Jan. 27, 1953

2 Sheets-Sheet 1

Fig. 1

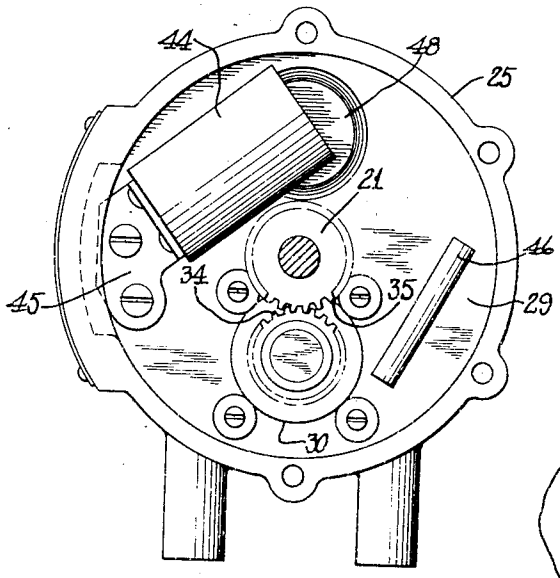


Fig. 3

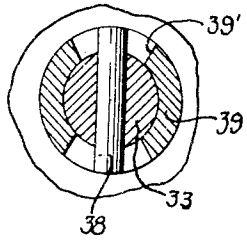
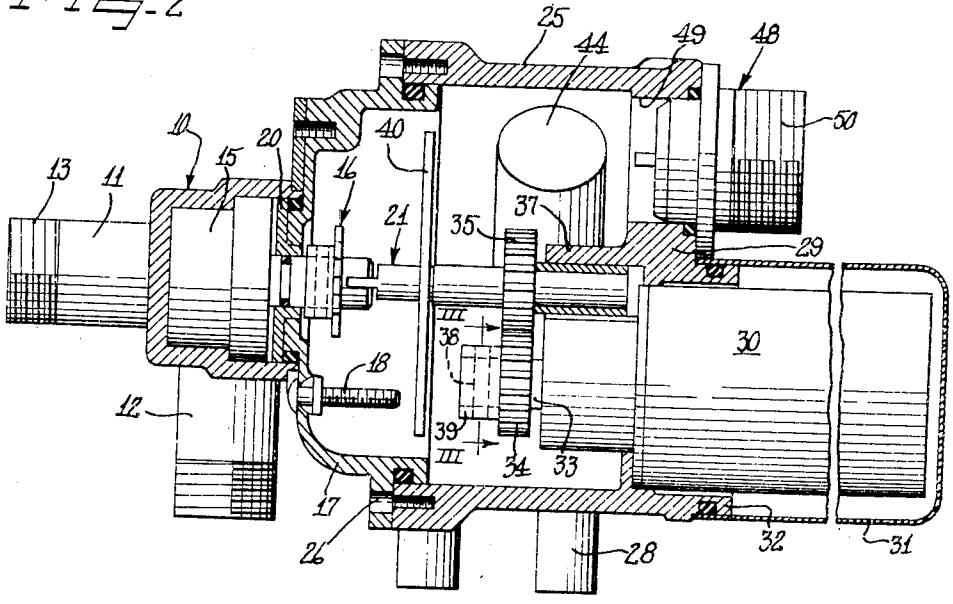


Fig. 2



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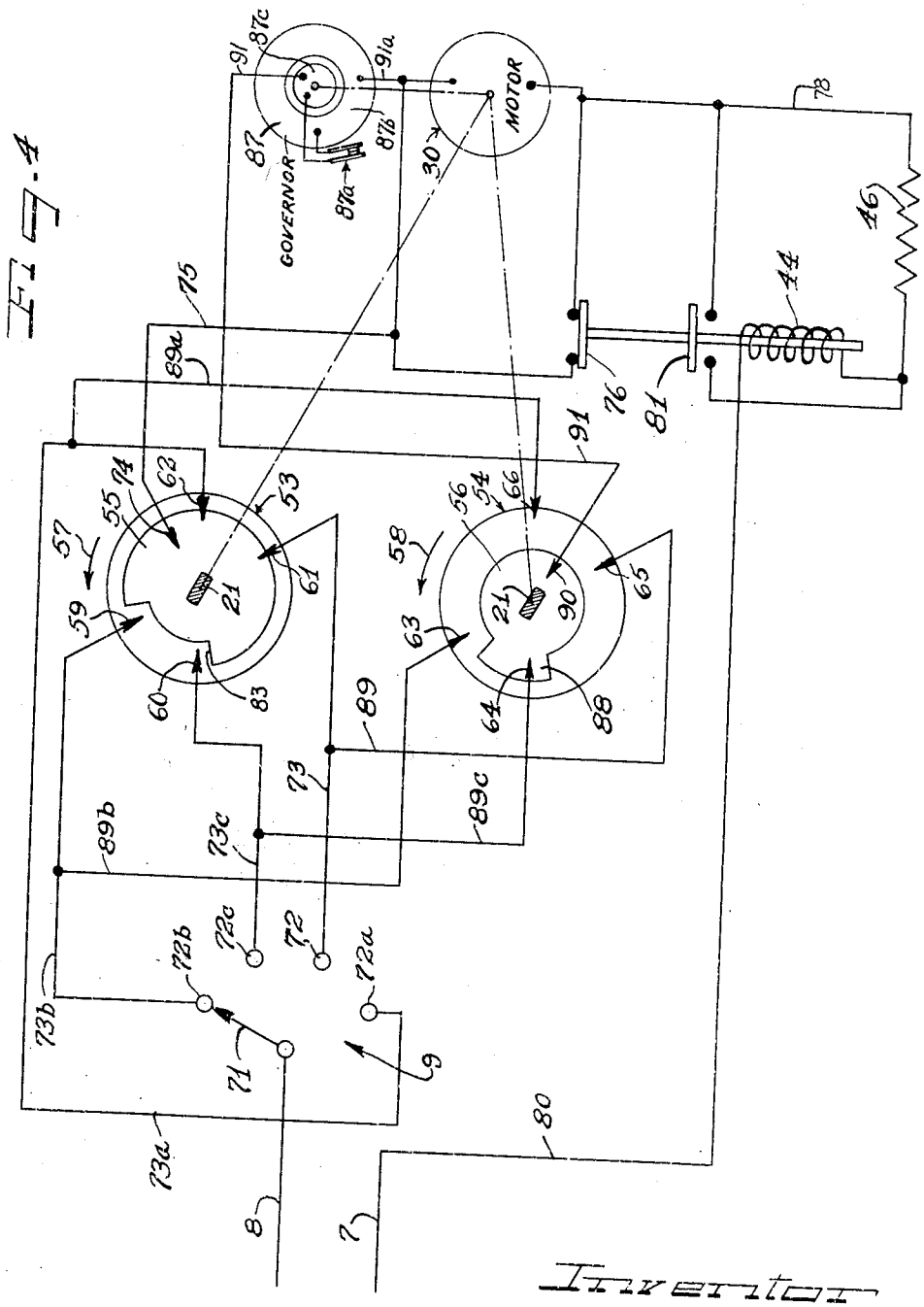
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Filed Jan. 27, 1953

2 Sheets-Sheet 2

Fig. 4



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United States Patent Office

2,769,948

Patented Nov. 6, 1956

2,769,948

CONTROL CIRCUIT AND ACTUATING MECHANISM FOR A COAXIAL SWITCH

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Application January 27, 1953, Serial No. 333,482

15 Claims. (Cl. 318—275)

This invention relates to an actuating mechanism and more particularly to a control circuit and actuating mechanism for a coaxial switch.

Many of the actuating mechanisms for rotary coaxial switches which have been developed in the past have been of the solenoid operated, ratchet type, which provided step-by-step movement of the coaxial switch rotor to one or more preselected positions. Many advantages have been found to result from the utilization of an electric motor to drive a rotary coaxial switch, particularly ruggedness and reliability in use.

However, when a continuously rotating drive member, such as the rotor of an electric motor, is utilized to move a coaxial switch rotor to a preselected position, the angular momentum of the rotor of the electric motor, after the motor is de-energized, tends to drive the coaxial switch rotor past the preselected position.

In my copending application entitled "Rotary Coaxial Switch Actuating Mechanism," U. S. Serial No. 259,979, filed December 5, 1951, I have disclosed certain systems for counteracting this angular momentum of the rotary driving member. The present application is directed to a different system for accomplishing this purpose.

It is an important object of the present invention to provide a novel actuating system for a switch rotor wherein a governor is electrically energized to reduce the speed of the motor driving the switch rotor as the switch rotor approaches a selected switching position.

It is a further object of the present invention to provide in conjunction with reduced speed energizing means, means for braking said motor when the switch rotor reaches the vicinity of a selected switching position.

It is a further object of the present invention to provide novel means for braking a rotor positioning means such as an electric motor.

It is another object of the present invention to provide a novel control circuit and actuating mechanism for a coaxial switch.

Other novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization, manner of construction and method of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings, in which:

Figure 1 is an end elevational view of the actuating housing and the components therein detached from the coaxial switch housing;

Figure 2 is a longitudinal sectional view illustrating the actuating housing assembled with the coaxial switch housing;

Figure 3 is a fragmentary transverse sectional view taken substantially along the line III—III of Figure 2 and illustrating the loose coupling between the motor and the rotor shaft; and

Figure 4 is a schematic diagram of the control circuit of the actuating system of the present invention.

The present invention is particularly adapted for use with a rotary coaxial switch having a rotor which is designed to be rotated into one or more preselected positions to complete one or more circuits. Accordingly, the actuating system of the present invention has been illustrated at is would be employed with a coaxial switch, by way of example, and not by way of limitation.

The coaxial switch assembly includes a rotor housing **10** with which are connected a main terminal **11** and a plurality of branch terminals such as **12**. Each of the terminals is threaded as at **13** to receive a coaxial cable, the cable connected to the main terminal **11** being selectively connected to the branch terminals by means of the rotor **15**. The internal structure of the terminals and of the rotor may be similar to that illustrated in my above mentioned copending application. It will thus be understood that the function of the actuating mechanism in the present embodiment is to selectively position the rotor **15** with respect to a selected one of the branch terminals in order to connect the coaxial cable connected with the main terminal **11** with the coaxial cable connected to such selected branch terminal. Since the rotor must be positioned accurately with respect to any selected branch terminal, a detent mechanism is commonly employed such as illustrated in my copending application. In Figure 2, only the detent gear **16** is indicated. Since there are four branch terminals in the present embodiment and these are disposed in pairs 180° apart, the branch terminals of each pair being spaced 60° apart, a twelve tooth detent gear is suitable for the present embodiment. The detent arms such as shown in my copending application are mounted by the closure plate **17** as by means of bolts such as **18** in Figure 2. The central portion of the closure plate **17** nests within the rotor housing **10** and positions a collar **20** within the rotor chamber. The rotor shaft **21** extends through collar **20** and into the actuating housing **25**.

The actuating housing **25** is secured to the outer portion of the closure plate **17** as by means of screws **26** and has four mounting bosses **28** depending therefrom. In the lower central portion of the end wall **29** of the housing **25** is disposed the motor **30** for driving the rotor shaft **21**. The motor is provided with a casing **31** which telescopes over a boss **32** provided by the end wall **29** of the housing. The drive connection between the motor **30** and the rotor shaft **21** includes motor shaft **33**, gears **34** and **35**, the rotor shaft **21** being journalled in a bearing portion **37** of the housing end wall. As shown in Figures 2 and 3, a loose coupling is provided between motor shaft **33** and gear **34**. This coupling includes a pin **38** carried by shaft **33** and engaging the hub portion **39** which carries gear **34**. Arcuate slots **39'** in hub portion **39** afford a certain amount of relative movement to the rotor shaft **21** even after braking of shaft **33** to allow the detent means to perform the final precise positioning of the rotor at a preselected position. A wafer switch **40** is operatively associated with the rotor shaft **21** and has its stator portion secured to the housing end wall by means of mounting bolts and spacer sleeves (not shown) extending from the end wall **29**. The function of the wafer switch **40** as well as the control relay **44** which is mounted on the end wall by means of a bracket **45**, Figure 1, and the resistor **46** will be hereinafter described. Electrical connection with the electrical components within the actuating housing is made by means of a fitting **48** which is sealed in an opening **49** of the end wall and is externally threaded as at **50** to receive an electrical cable.

In Figure 4 is illustrated the electrical control circuit for the actuation of the motor **30** which angularly positions the coaxial switch and also moves the rotors **55** and **56** of the switch components **53** and **54** of wafer switch **40**. The actuating circuit includes a control re-

lay 44 and a current limiting resistor 46. The rotor portions 55 and 56 of the switch components 53 and 54 rotate with the rotor shaft 21 in the direction indicated by the arrows 57 and 58. The contacts 59, 60, 61 and 62 of switch component 53 and contacts 63, 64, 65 and 66 of switch component 54 correspond to the relative locations of the four coaxial switch branch terminals 12, one of which is shown in Figure 2.

The motor 30 is arranged to be energized from a pair of power supply conductors 7 and 8 through the selector switch 9. This selector switch 9 includes a movable contact element 71, and a plurality of stationary contacts 72, 72*a*, 72*b*, 72*c*. The stationary contacts 72*b*, 72*c*, 72 and 72*a* are connected to contacts 59, 60, 61 and 62, respectively, of the switch component 53 through conductors 73*b*, 73*c*, 73 and 73*a*. The contacts 72*b*, 72*c*, 72 and 72*a* are also connected to contacts 63, 64, 65 and 66, respectively, of the switch component 54 through conductors 89*b*, 89*c*, 89 and 89*a*, respectively. The rotating conductor 55 of the switch component 53 is connected through a conductor 75 to one side of the motor 30. The other side of the motor 30 is connected through a conductor 78, a resistor 46, a relay 44 and conductor 80 to the power supply conductor 7.

The movable contact segment 88 of the switch rotor 56 of the switch component 54 is connected through a contact 90 to one side of a motor governor 87. A governor suitable for use with the present embodiment is illustrated in the Lee Patent No. 1,767,146. As indicated in said Lee patent, the governor 87 would then comprise a centrifugal switch 87*a* mounted to rotate with collector rings 87*b* and 87*c* and driven by motor 30, the switch 87*a* having its contact in series between leads 91 and 91*a* to open the circuit from lead 91 to the motor 30 whenever the motor 30 exceeds a predetermined speed. For further details of the circuit and operation of such a governor, reference is made to said Lee patent. The other side of the governor 87 is connected to the motor 30 on the same side of the motor 30 that is connected through conductor 75 of the rotor part 55 of the switch component 53. A series relay 44 in the motor circuit is provided with a normally closed bridging contact 76 and a normally opened bridging contact 81. The bridging contact 76 is connected across the motor 30 while the bridging contact 81 is connected in parallel relation with the resistor 46. Thus, when the relay 44 is energized by the flow of current in the motor circuit, the switch element 81 closes and the switch element 76 opens. Because of the arrangement of the contact element 76, it will be apparent that this element closes when the relay 44 is deenergized and thereby short circuits the motor and applies dynamic braking.

From a careful examination of the wiring diagram shown in Figure 4 of the drawing, it will be apparent that when the motor 30 is energized to move the coaxial switch to a position several stations removed from its then position, the motor is directly energized through the wafer switch 53, but when it arrives at a position shortly in advance of the selected position, the motor 30 is energized through the wafer switch 54 and switch 87*a* of the governor 87.

By way of example, if the apparatus is in the position as diagrammatically illustrated in Figure 4 and it is desired to index the coaxial switch to the position represented by terminal 72 of selector switch 9, the movable contact element 71 of the selector switch 9 is shifted to engage the terminal 72. This causes energization of the relay 44 through conductor 73, switch component 53, conductor 75 from power supply conductor 8 and through conductor 80, resistor 46 and conductor 78 from power supply conductor 7. The relay 44 is thus energized through the resistor 46, which limits the relay current. The relay then opens contacts 76 which bridge the armature, and closes contacts 81 shorting out the resistor 46. Power is then applied to the motor armature 30 through the relay coil 44 and the motor begins to turn. The governor 87 is not, at this time, energized for the segmental contact portion 88 of the switch component 54 is not, at this time, in engagement with the stationary contact 65 of switch component 54. The shaft 21 of the wafer switch is now driven at its normal speed by the motor 30 in a counterclockwise direction, as illustrated in the drawing. When the cut-out portion 83 reaches the contact 61, the motor 30 is no longer energized through conductor 75. Just before that instant of time, however, the segment 88 of the switch component 54 engages its associated stationary contact 65. Energization of the motor is now obtained as a result thereof from the power supply conductor 8 through selector switch 9, conductors 73 and 89, switch component 54, conductor 91, and governor 87. The other side of the motor circuit is the same as before. This effects a speed reduction of the motor 30 as soon as cut-out portion 83 reaches the contact 61 so that as the coaxial switch moves into its selected position, the motor is running at a substantially reduced speed. By way of example, and not by way of limitation, the motor 30 may be selected as to have a normal speed of about 120 R. P. M. and a governor controlled speed of about 50 R. P. M.

It has been found in the practice that dynamic braking of the motor by itself is not sufficiently reliable to stop the motor fast enough. By reducing the speed of the motor just before reaching the selected position, however, it has been found that the dynamic braking is sufficient so that the coaxial switch mechanism will not override its selected position. The switching network is such that when the governor is in the circuit and the motor is rotating faster than the cut-out speed of the governor, it opens the circuit and dynamic braking is applied to the motor. Thus the motor slows down faster than if the governor were in the circuit alone. The governor 87 has been diagrammatically illustrated, for any well known electric type governor may be employed to reduce the speed of the motor 30.

It will be observed that the energization of the motor 30 through the governor 87 continues until the trailing edge of the segment 88 rides off the stationary contact 65. This occurs at a time before the cut-out portion of rotor element 55 has completely passed the stationary contact 61. In this position, neither the stationary contact 61 nor the stationary contact 65 is in engagement with the rotating switch elements 55 or 56. The motor 30 is, therefore, deenergized, as is also the relay 44. The bridging contact 76 of the relay 44 thus closes to short the motor 30 and have the motor thus apply dynamic braking. At the same time, the bridging contact 81 opens to reinsert the resistance in the motor circuit, preparing for another actuation.

It will, of course, be apparent from the above that the width of the segmental portion 88 must be less than the gap 83 of the rotor portions 56 and 55, respectively, of the switch components 54 and 53.

The manner of indexing the switch to the other selected positions, 72*a*, 72*b* and 72*c*, are similar to the operation just described of moving the switch to the selected position 72. Corresponding structures have been given corresponding numerals, suffixed by the letters *a*, *b* or *c*, respectively.

While I have shown a particular embodiment of my invention, it will, of course, be understood that I do not wish to be limited thereto, since many modifications may be made, and I, therefore, contemplate by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

I claim as my invention:

1. In the rotary switch art, a rotary indexing mechanism for selectively positioning a movable rotary element at a selected one of a plurality of angularly positioned stations, comprising an electric motor in rotary driving

engagement with said rotary element, means for energizing said motor until said rotary element reaches a preselected position, and means for automatically reducing the speed of said motor a predetermined distance in advance of when said rotary element reaches said preselected position.

2. In the rotary switch art, a rotary indexing mechanism for selectively positioning a movable rotary element at a selected one of a plurality of angularly positioned stations, comprising an electric motor in rotary driving engagement with said rotary element, means for energizing said motor until said rotary element reaches a preselected position, means for automatically reducing the speed of said motor a predetermined distance in advance of when said rotary element reaches said preselected position, and means for causing said motor to act as a dynamic brake when said rotary element substantially reaches said preselected position.

3. In the rotary switch art, a rotary indexing mechanism for selectively positioning a movable rotary element at a selected one of a plurality of angularly positioned stations, comprising an electric motor in rotary driving engagement with said rotary element, a motor speed reducing governor, means for directly energizing said motor for a predetermined portion of the travel of said rotary element, means for energizing said motor through said governor for an additional portion of the travel of said rotary element, and means for deenergizing said motor when said rotary element has reached its preselected position.

4. In the rotary switch art, an actuating system for selectively positioning a switch rotor with respect to a plurality of surrounding stations, comprising a motor, an energizing circuit for said motor, a governor operatively associated with said motor, means for connecting said governor in circuit with said motor at a preselected position of said rotor in advance of a selected station, and means for applying a dynamic brake to said motor when said rotor has moved into proximity to said selected station.

5. An actuating system for a coaxial switch including a switch rotor shaft for movement to a preselected switching position, comprising a motor, a driving connection between said motor and said switch rotor shaft, means for energizing said motor to drive said rotor shaft toward said preselected switching position through said driving connection, a governor operatively associated with said motor, and means for applying said governor to said motor when said switch rotor shaft has moved to a preselected relative position in advance of said preselected switching position to retard the speed of said rotor shaft.

6. An actuating system for a coaxial switch including a switch rotor shaft for movement to a preselected switching position, comprising a motor, a driving connection between said motor and said switch rotor shaft, means for energizing said motor to drive said rotor shaft toward said preselected switching position through said driving connection, a governor operatively associated with said motor, means for connecting said governor in circuit with said motor when said switch rotor shaft has moved to a preselected relative position in advance of said preselected switching position to retard the speed of said rotor, a dynamic braking circuit for said motor, and means for closing said braking circuit to stop said motor as said switch rotor shaft approaches said preselected switching position at the retarded speed.

7. In the rotary switch art, an actuating system for selectively positioning a rotor with respect to a plurality of surrounding stations, comprising a motor, an energizing circuit for said motor, means for opening said motor energizing circuit when said rotor is within a preselected angular range in advance of a selected station, a reduced speed energizing circuit for said motor, and means for closing said reduced speed energizing circuit when said first-mentioned motor energizing circuit is opened to run said motor at reduced speed, relay means in said reduced speed energizing circuit for actuation upon opening of said reduced speed energizing circuit, a dynamic braking circuit connected across said motor and controlled by said relay means, and means for opening said reduced speed energizing circuit when said rotor is in proximity to said selected station to actuate said relay means and thus close said dynamic braking circuit to stop the motor.

8. In the rotary switch art, an actuating system for selectively positioning a rotor with respect to a plurality of surrounding stations, comprising a motor, an energizing circuit for said motor, means for opening said motor energizing circuit when said rotor is within a preselected angular range in advance of a selected station, a reduced speed energizing circuit for said motor, and means for closing said reduced speed energizing circuit when said first-mentioned motor energizing circuit is opened to run said motor at reduced speed, relay means in said reduced speed energizing circuit for actuation upon opening of said reduced speed energizing circuit, a dynamic braking circuit connected across said motor and controlled by said relay means, means for opening said reduced speed energizing circuit when said rotor is in proximity to said selected station to actuate said relay means and thus close said dynamic braking circuit to stop the motor, a resistor in said first-mentioned motor energizing circuit, and short circuit conductor means shunting said resistor, said relay means controlling said short circuit conductor means and being actuated by closure of said first-mentioned motor energizing circuit to close said short circuit conductor means.

9. An actuating system for selectively positioning a rotor with respect to a plurality of surrounding stations, comprising an electric motor for driving said rotor, a governor operatively associated with said motor, a first energizing circuit for energizing said motor independently of said governor, a second energizing circuit for energizing said motor under the control of said governor for driving said motor at a reduced speed, wafer switch means having a first rotor portion driven by said motor and controlling said first energizing circuit and having a second rotor portion driven by said motor and controlling said second energizing circuit, said wafer switch means including a first stationary contact cooperating with said first rotor portion to control said first energizing circuit and including a second stationary contact cooperating with said second rotor portion to control said second energizing circuit, said first rotor portion having insulating means movable therewith for isolating said first contact from said first rotor portion at a predetermined angular position of said first rotor portion to open said first energizing circuit, and said second rotor portion having conducting means movable therewith for engagement with said second contact at a predetermined angular position of said second rotor portion to close said second energizing circuit, the insulating means of the first rotor portion and the conducting means of the second rotor portion being co-ordinated with respect to said first and second contacts to open said first energizing circuit and to close said second energizing circuit in advance of the rotor reaching a selected station, whereby said motor moves said rotor at reduced speed as the rotor approaches the selected station.

10. In the rotary switch art wherein a switch rotor is movable between a plurality of angular switching positions, an actuating system for positioning the rotor with respect to a selected switching position comprising an electric motor for driving said rotor, a governor operatively associated with said motor, a first energizing circuit for energizing said motor independently of said governor, a second energizing circuit for energizing said motor under the control of said governor for driving said motor at a reduced speed, wafer switch means having a first rotor portion driven by said motor and having a first contact cooperation with said first rotor portion to control

said first energizing circuit and having a second rotor portion driven by said motor and having a second contact cooperating with said second rotor portion to control said second energizing circuit, said first rotor portion having insulating means movable therewith for isolating said first contact from said first rotor portion at a pre-determined angular position of said rotor portion to open said first energizing circuit, said second rotor portion having conducting means movable therewith for engagement with said second contact at a predetermined angular position of said second rotor portion to close said second energizing circuit, the insulating means of said first rotor portion and the conducting means of said second rotor portion being coordinated with respect to said first and second contacts to open said first energizing circuit and to close said second energizing circuit in advance of the switch rotor reaching the selected switching position, and said conducting means associated with said second rotor portion being dimensioned to move out of engagement with said second contact to deenergize said motor when said switch rotor reaches the selected switching position.

11. In the rotary switch art wherein a switch rotor is movable between a plurality of angular switching positions, an actuating system for positioning the rotor with respect to a selected switching position comprising an electric motor for driving said rotor, a governor operatively associated with said motor, a first energizing circuit for energizing said motor independently of said governor, a second energizing circuit for energizing said motor under the control of said governor for driving said motor at a reduced speed, wafer switch means having a first rotor portion driven by said motor and having a first contact cooperation with said first rotor portion to control said first energizing circuit and having a second rotor portion driven by said motor and having a second contact cooperating with said second rotor portion to control said second energizing circuit, said first rotor portion having insulating means movable therewith for isolating said first contact from said first rotor portion at a predetermined angular position of said rotor portion to open said first energizing circuit, said second rotor portion having conducting means movable therewith for engagement with said second contact at a predetermined angular position of said second rotor portion to close said second energizing circuit, the insulating means of said first rotor portion and the conducting means of said second rotor portion being co-ordinated with respect to said first and second contacts to open said first energizing circuit and to close said second energizing circuit in advance of the switch rotor reaching the selected switching position, and said conducting means associated with said second rotor portion being dimensioned to move out of engagement with said second contact to de-energize said motor when said switch rotor reaches the selected switching position, a dynamic braking circuit for said motor, and relay means controlled by said first and second motor energizing circuits and having contacts controlling said dynamic braking circuit to close said dynamic braking circuit upon opening of both said first and second motor energizing circuits to stop said motor with said switch rotor in the selected switching position.

12. In the rotary switch art wherein a switch rotor is angularly movable between a plurality of switching positions, an actuating mechanism comprising a housing, a switch rotor drive shaft journaled in said housing, an electric motor carried by said housing and having drive means in driving connection with said drive shaft, a loose coupling between said drive means and said drive shaft affording limited relative rotation therebetween, detent means disposed within said housing and operatively connected to said drive shaft to determine a plurality of precise angular positions of said drive shaft corresponding to the switching positions of said switch rotor, a governor operatively associated with said motor, a first energizing circuit for energizing said motor independently of said governor, a second energizing circuit for energizing said motor under the control of said governor for driving said motor at a reduced speed, wafer switch means disposed within said housing and having a first rotor portion on said drive shaft and a first stationary contact cooperating with said first rotor portion to control said first energizing circuit and having a second rotor portion on said drive shaft and a second stationary contact cooperating with said second rotor portion to control said second energizing circuit, said first rotor portion having insulating means movable therewith for isolating said first contact from said first rotor portion at a predetermined angular position of said drive shaft to open said first energizing circuit, said second rotor portion having conducting means movable therewith for engagement with said second contact at a predetermined angular position of said drive shaft to close said second energizing circuit, and the insulating means of said first rotor portion and the conducting means of the second rotor portion being co-ordinated with respect to said first and second contacts to open said first energizing circuit and to close said second energizing circuit in advance of said drive shaft reaching a selected angular position, and said conducting means being dimensioned to move out of engagement with said second contact to open said second energizing circuit with said drive shaft in proximity to the selected position, and means for braking said motor drive means when said motor is de-energized, said detent means being operative to precisely position said drive shaft in the selected angular position upon de-energization of said motor with said loose coupling accommodating movement of said drive shaft to its precise position independent of said braking means.

13. In a compact rotary switch unit wherein a housing carries a driving motor and a switch rotor as a unitary compact assembly and a rotary indexing mechanism is carried in the housing for selectively positioning the switch rotor at a selected one of a plurality of angularly positioned stations, the improvement characterized by said rotary indexing mechanism having means providing a normal speed energizing circuit for the motor and having further means providing a reduced speed energizing circuit for the motor, and said indexing mechanism comprising means for connecting said normal speed energizing circuit with said motor for a predetermined portion of the travel of said switch rotor, means for automatically connecting said reduced speed energizing circuit with said motor for an additional portion of the travel of said switch rotor, and means for de-energizing said motor when said switch rotor has reached the selected station.

14. In the rotary switch art, a drive shaft for movement to each of a plurality of switching positions all lying within 360° of rotation of said drive shaft from each other to determine a plurality of switch positions of a switch rotor in driving connection with said drive shaft, a motor in driving connection with said drive shaft, a normal speed energizing circuit for said motor, a reduced speed energizing circuit for driving said motor at reduced speed, and switch means carried by said drive shaft and operative to disconnect said normal speed energizing circuit from said motor and to connect said reduced speed energizing circuit with said motor when said drive shaft moves to a predetermined angular position in advance of a selected switching position.

15. In the rotary switch art, a rotary indexing mechanism comprising a switch rotor drive shaft, and means for positioning said shaft in each of a plurality of switching positions all lying within 360° rotation of said drive shaft from each other, said positioning means comprising power supply conductors, an electric motor, a governor operatively associated with said motor, a first group of normal speed motor energizing circuits for energizing said motor independently of said governor and each corresponding to one switching position of said drive shaft, a second group of reduced speed motor energizing circuits for energizing said motor under the control of said governor and each corresponding to one switching position

of said drive shaft, selector means for energizing a selected energizing circuit of said first group and a selected energizing circuit of said second group in accordance with the switching position to which said shaft is to be moved, first switch means controlled by the angular position of said drive shaft and controlling connection of the selected normal speed energizing circuit with said motor and operative to disconnect the selected normal speed energizing circuit from said motor in advance of the shaft reaching the selected switching position, second switch means controlled by the angular position of said drive shaft and controlling connection of the reduced speed energizing circuit with said motor and operative to connect the selected reduced speed energizing circuit to the motor under the control of the governor in advance of the shaft reaching

the selected switching position, and said second switch means being operative to disconnect said reduced speed motor energizing circuit from the motor when the shaft reaches the selected switching position.

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