United States Patent [19]

Vaughan et al.

[11] **3,864,536**

[45] **Feb. 4, 1975**

[54] **COAXIAL TRANSFER SWITCH**

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[21] Appl. No.: **307,193**

[52] **U.S. Cl.** ..... **200/37 A,** 200/153, 333/7

[51] **Int. Cl.** **H01h 43/00**

[58] **Field of Search** ..... 200/153 P, 153 S, 37 A, 200/38 R, 35 R; 335/177, 183, 73; 333/7, 97 S; 318/35, 37, 134

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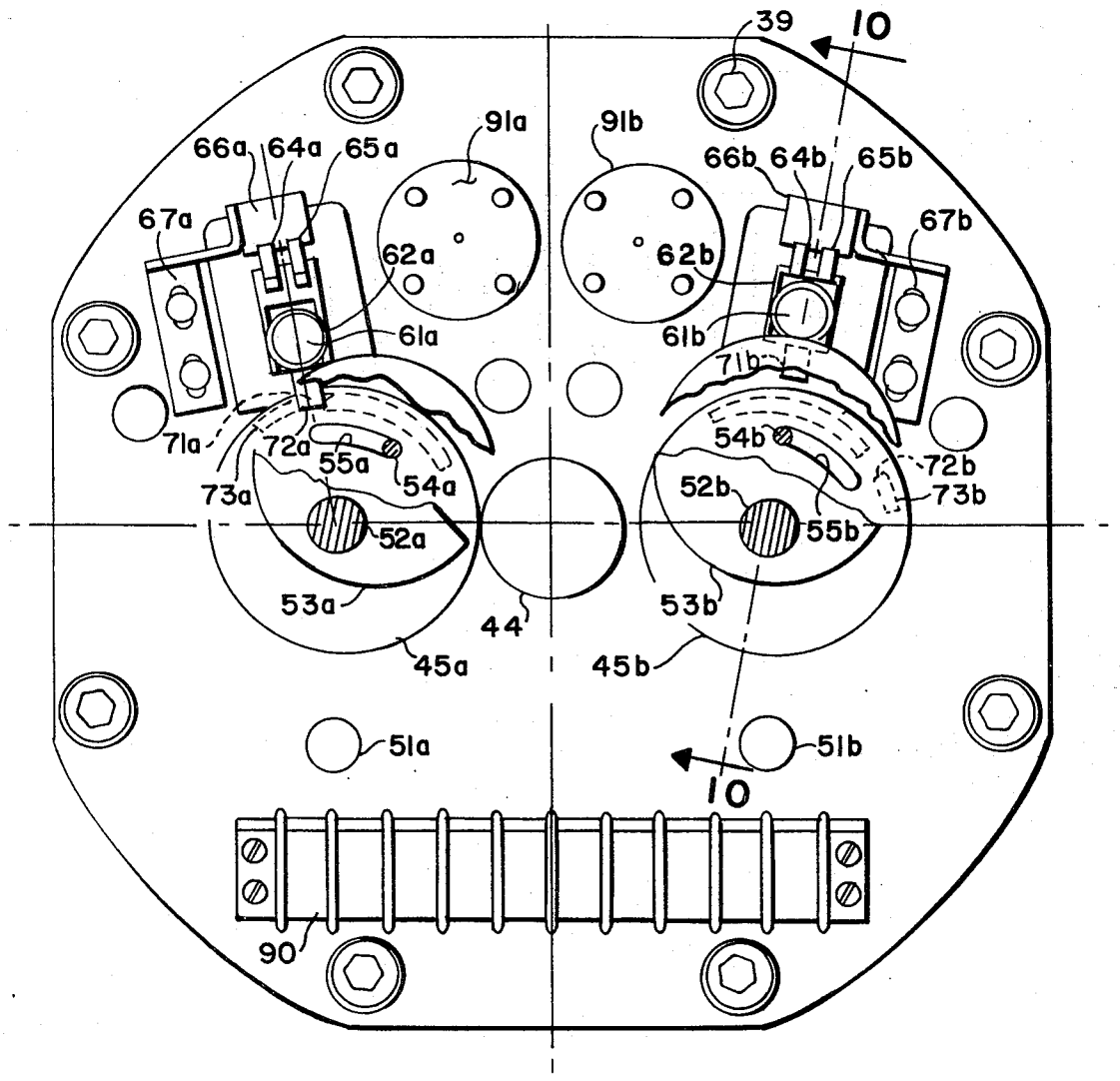
Primary Examiner—Robert K. Schaefer
Assistant Examiner—William J. Smith
Attorney, Agent, or Firm—Robert T. Dunn

[57] **ABSTRACT**

A rotary switch for coupling coaxial transmission lines which are connected to ports of the switch has a rotor for interconnecting any two adjacent ports by connecting the center conductors of the adjacent ports. The rotor is actuated by two electrical drives which drive the rotor in opposite directions, each to a predetermined position when the electrical drive is energized. Each electrical drive actuates a different set of micro-switches, one switch in each set controlling electrical power to the other electrical drive so that the drives are energized at different intervals and another switch in each set providing logic signals for turning transmitters on and off.

10 Claims, 22 Drawing Figures



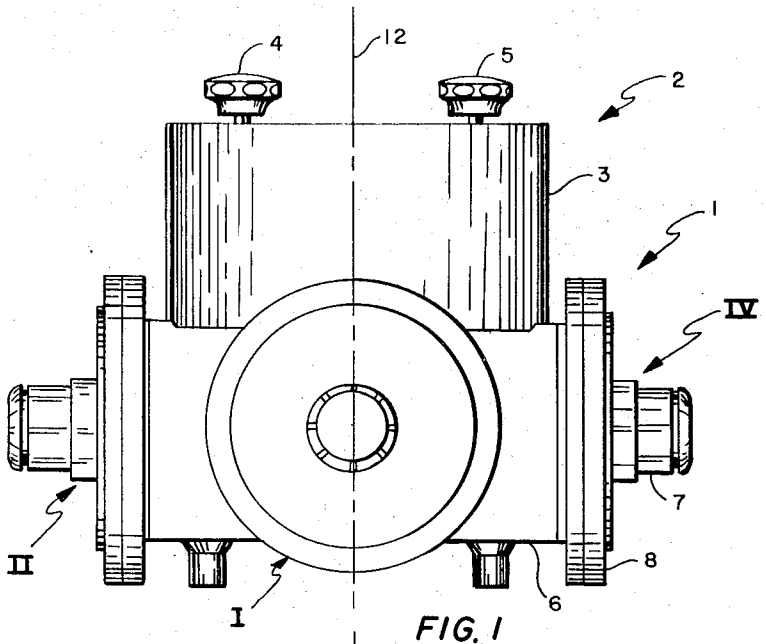


FIG. 1

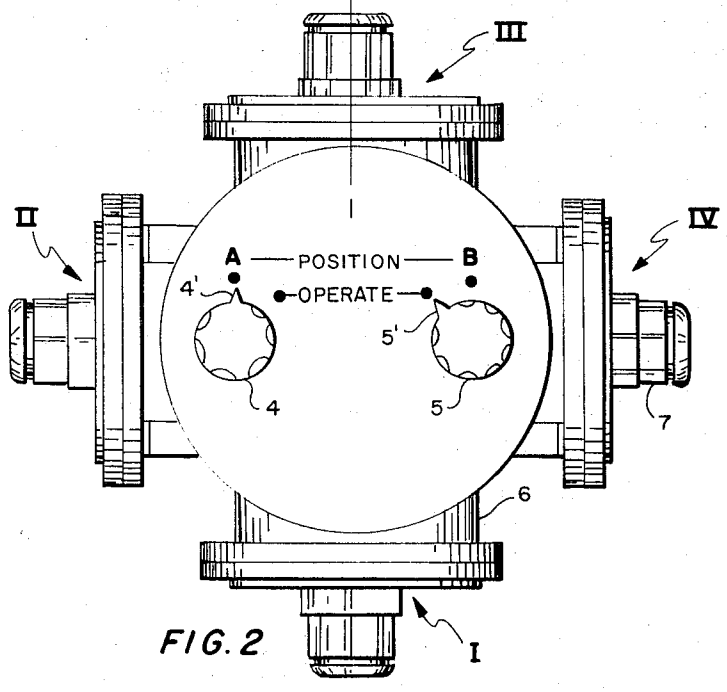


FIG. 2

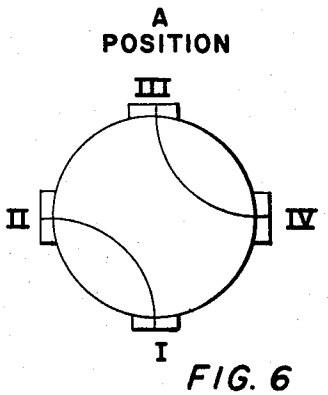


FIG. 6

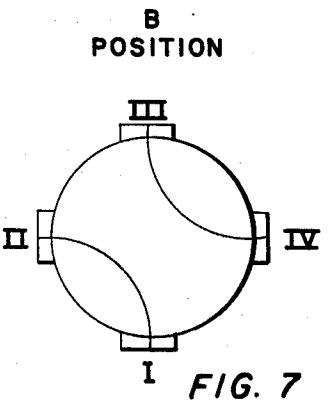


FIG. 7

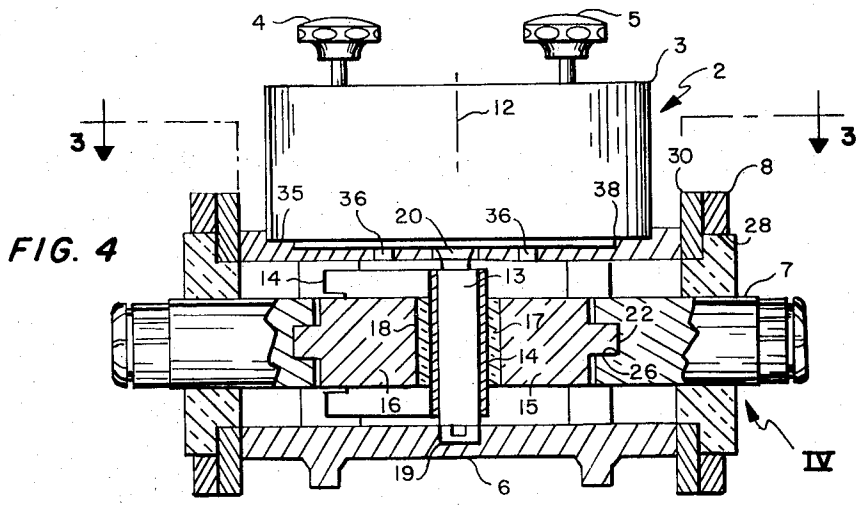


FIG. 4

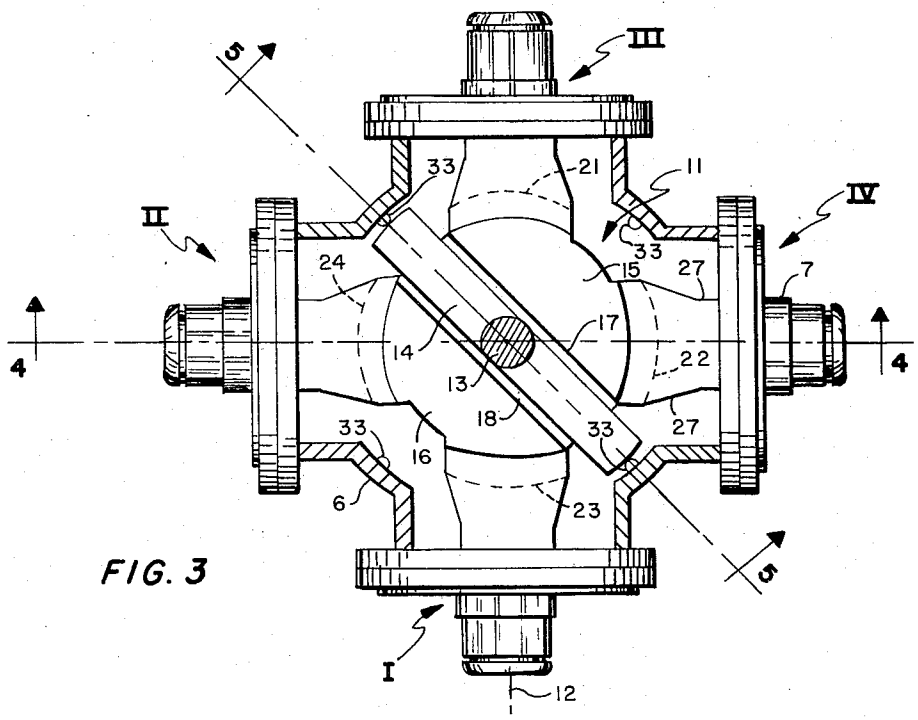


FIG. 3

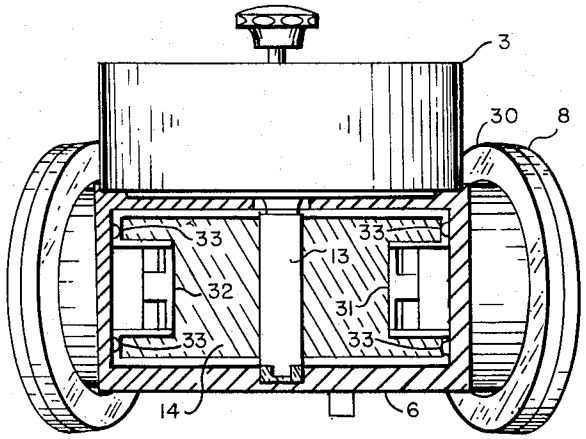


FIG. 5

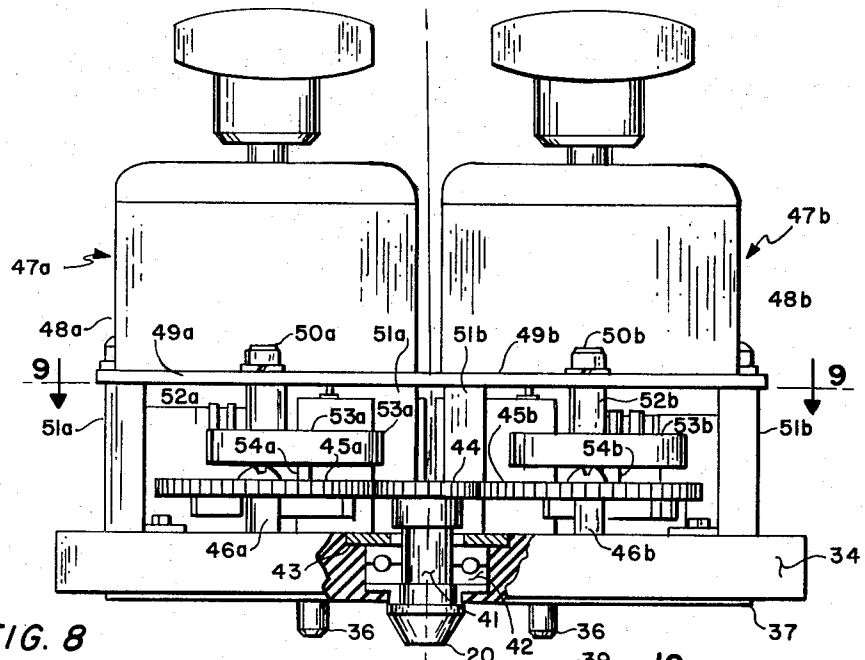

47a
47b
48a
48b
49a
50a
51a
51b
49b
50b
9
9
52a
53a
53a
45b
52b
53b
54a
45a
44
54b
51a
51b
46a
43
46b
34
36
41
36
37
20
42

FIG. 8

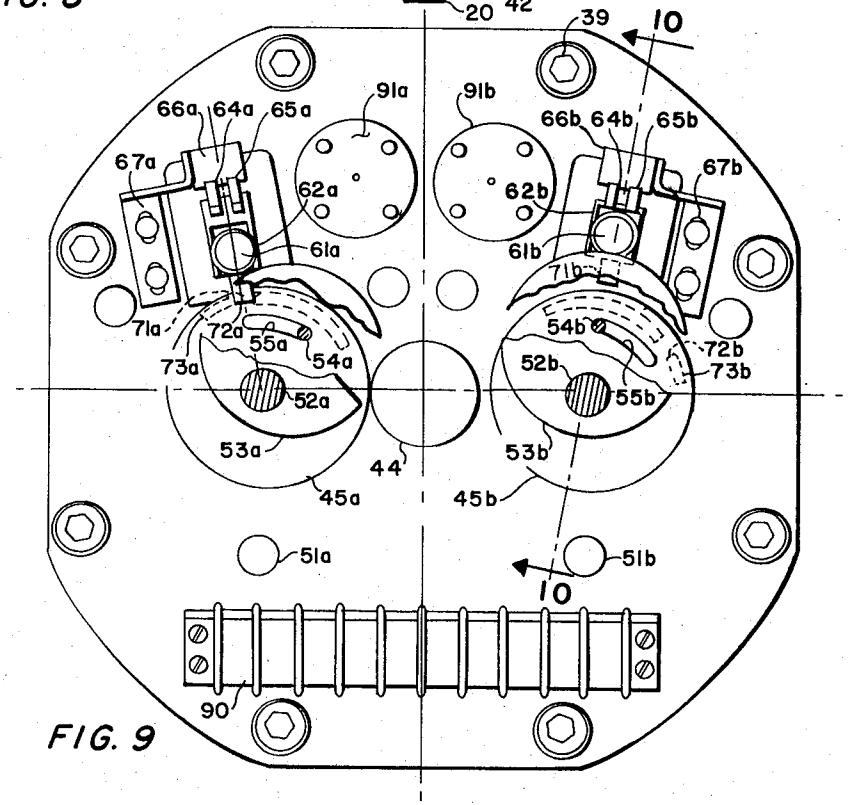

39
10
91a
91b
66a
64a
65a
66b
64b
65b
67a
67b
62a
62b
61a
61b
71a
71b
72a
55a
54a
54b
72b
73a
73b
52b
52a
55b
53a
53b
44
45a
45b
51a
51b
10
90

FIG. 9

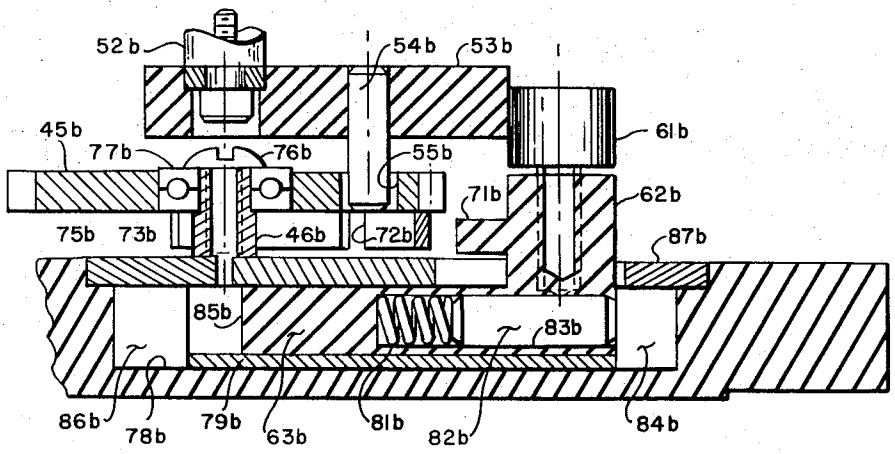


FIG. 10

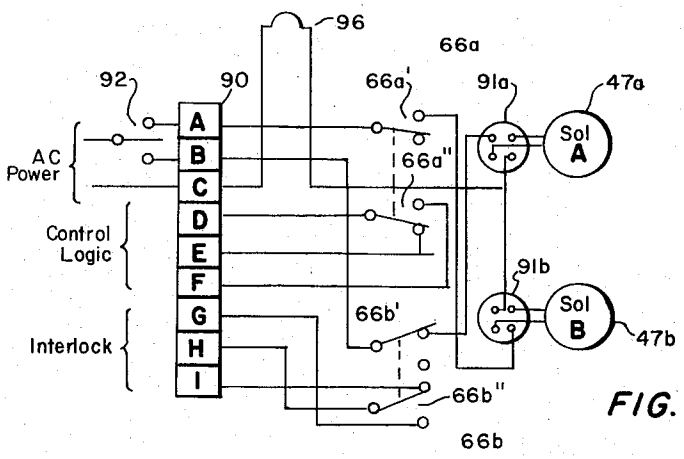


FIG. 12

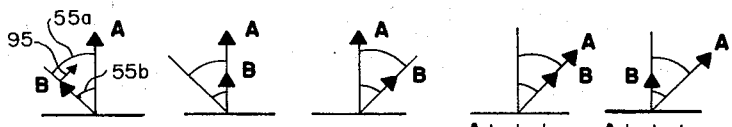


FIG. IIa FIG. IIb FIG. IIc FIG. IId FIG. IIe

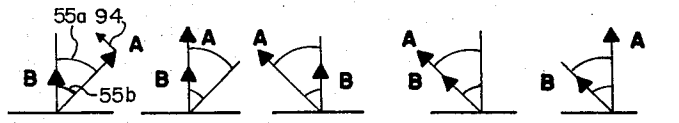


FIG. IIf FIG. IIg FIG. IIh FIG. IIi FIG. IIj

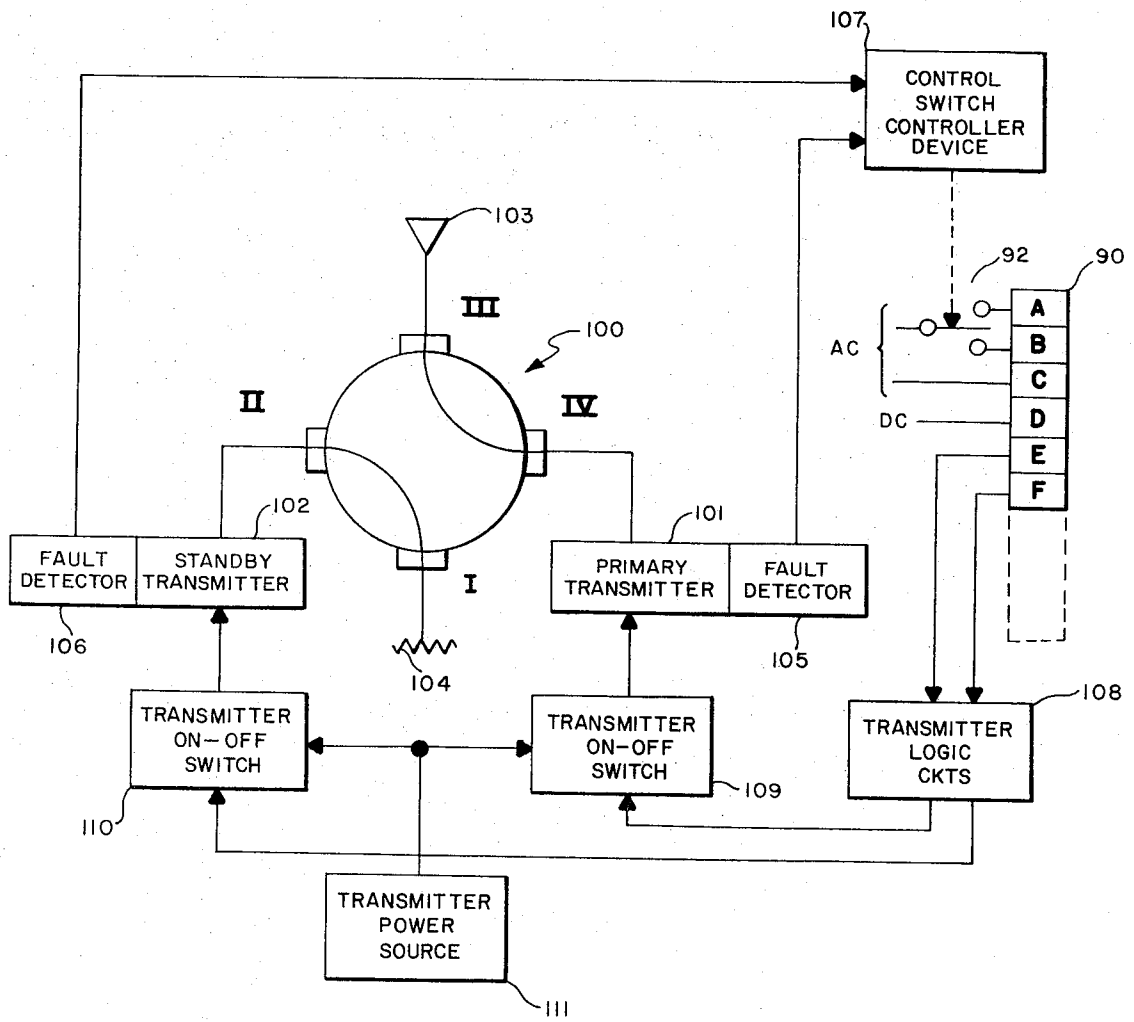

107
CONTROL SWITCH CONTROLLER DEVICE
103
III
100
II
IV
92
90
A
B
C
D
E
F
AC
DC
102
101
FAULT DETECTOR
STANDBY TRANSMITTER
PRIMARY TRANSMITTER
FAULT DETECTOR
I
106
104
105
TRANSMITTER ON-OFF SWITCH
TRANSMITTER ON-OFF SWITCH
TRANSMITTER LOGIC CKTS
108
109
110
TRANSMITTER POWER SOURCE
111

FIG. 13

COAXIAL TRANSFER SWITCH

This invention relates to rotary switches for use in transmission lines and more particularly for fast switching action between coaxial transmission lines to transfer radio frequency (rf) signals between transmission lines connected to alternate ports of the switch.

In radio frequency transmission systems it is sometimes required to transfer high power radio frequency signals between transmission lines. For this purpose, a four port transfer switch is provided with different transmission lines connected to the ports of the switch. A rotor inside the switch includes separate insulated electrical conductors which connect the center conductors of adjacent ports of the switch. For example, if the ports are numbered I to IV, at one position of the switch, the center conductors of ports I and II are connected and the center conductors of ports III and IV are connected and at another position of the switch, the center conductors of ports I and IV are connected while the center conductors of ports II and III are connected. In this configuration, the switch functions as a double pole, double throw switch. By leaving one port unconnected, the switch can also function as a single pole double throw switch.

It is sometimes required that a four port transfer switch whether functioning as a single pole double throw switch or as a double pole single throw switch, accomplish the switching action in an extremely short cycle time, typically around 180 milliseconds, and that the switching cycle be synchronized with the energization of a transmitter that feeds a transmission line connected to one of the ports of the switch. For example, in broadcast applications where high average power and fast switching time are required, it is sometimes desirable to switch off the transmitter and switch on a stand-by transmitter without any substantial loss or change in the broadcast signals. To accomplish this, switching time must be within a few hundred milliseconds, within which time the switch rotor must commence and complete its travel coming to a rest position without overshoot or misalignment. Furthermore, where the switching is electrically energized to operate automatically, it is required that accidental switching be impossible with loss of the energizing power to the switch. Furthermore, it is desirable to provide a manual override so that the switch can be actuated even when the switch electrical power is lost.

It is one object of the present invention to provide a relatively fast acting electrically energized drive for a multi port switch.

It is another object to provide the switch and switch drive for broadcast applications where relatively high average power and fast switching time are required.

It is another object to provide an electrically energized four port transfer switch for transferring high power rf signals between alternate ports of the switch.

It is another object to provide a mechanism for driving the rotor of a four port switch which mechanically locks the rotor at each position and produces electrical signals representative of the switch position.

It is another object to provide a mechanism for driving a four port coaxial transfer switch for high power broadcast application which mechanically locks the switch rotor at each position and produces electrical signals indicative of the switch rotor position.

It is a further object to provide such a switch drive mechanism by which a switching cycle is accomplished within a few hundred milliseconds.

It is a further object to provide such a switch drive and four port transfer switch for switching power from two rf transmitters between two loads, the produced electrical signals being used to turn the transmitters on and off.

In accordance with features of a specific embodiment of the present invention described herein, a multi port coaxial transfer switch suitable for transferring relatively high average broadcast rf power between ports of the switch is provided with a drive mechanism for driving the switch rotor to accomplish switching in a few hundred milliseconds. The rotor is driven in one direction to a first switch position by one solenoid and is driven in the opposite direction to a second switch position by another solenoid. At each switch position, a mechanical lock is engaged to prevent overshoot and to secure the switch at the position. One position lock is unlocked by the rotation of one solenoid and the other is unlocked by the rotation of the other solenoid and so the switch is always mechanically locked except when a solenoid rotates sufficiently to unlock the switch as when the solenoid is electrically energized or mechanically manipulated, and each solenoid is energized from an electrical source via a switch actuated by rotation of the other solenoid. Both solenoids have spring returns and so tend to return when not energized to positions which initiates locking of the switch rotor. The switches which feed energizing power to the solenoids have logic and interlock switches ganged thereto which provide electrical signals for synchronizing the energization of, for example, primary and stand-by transmitters which transmit through the transfer switch.

The embodiment of the invention described herein with reference to the drawings represents the best known use of the invention.

In the drawings:

FIG. **1** is an external side view of the four port coaxial transfer switch with drive mechanism taken directly toward one of the ports;

FIG. **2** is a top view of the transfer switch and drive mechanism showing the manual control knobs and positions on the drive mechanism;

FIG. **3** is a top view of the transfer switch with the top thereof broken away to reveal the rotor configuration and knife switches whereby the rotor blades engage the center conductors at the ports of the switch;

FIG. **4** is a cross section view through ports II and IV of the switch parallel to the rotor axis showing the rotor knife blade connection to the center conductor of the port;

FIG. **5** is a cross section view through the ground bar at the center of the rotor parallel to the rotor axis;

FIGS. **6** and **7** are schematic drawings illustrating the port connections at the two positions A and B of the switch;

FIG. **8** is a front view of the drive mechanism with cover removed taken perpendicular to the rotor axis;

FIG. **9** is a view of the drive mechanism along the rotor axis taken as shown in FIG. **8**;

FIG. **10** is a section view taken parallel to the axis of solenoid A showing details of the mechanical locking mechanism and switch which controls energization of solenoid B;

FIGS. 11*a* to 11*j* are diagrams showing the relative positions of the transfer switch, the solenoids, the switch rotor locks and the energization switches which control energization of the solenoids by which to gain an understanding of the operation of the transfer switch and drive mechanism;

FIG. 12 is an electrical schematic showing the wiring between the switches and solenoids and a source of energization of the solenoids; and

FIG. 13 is an electrical block diagram showing a use of the rotary switch and control logic signals for switching power from two transmitters between typical loads.

A four port coaxial transfer switch for a broadcast application is illustrated in FIGS. 1 and 2. The switch 1 is equipped with a drive mechanism 2 enclosed by a housing 3 and having two manual control knobs 4 and 5 at the top of the housing. The switch 1 includes a body or housing 6 and four coaxial ports denoted I, II, III, and IV. Each of these ports such as port IV includes a center conductor 7 and outer conductor flange 8 for connection to a coaxial transmission line of the same size. For broadcast application, the size of these ports is usually ⅞ to 6 ⅛ inches in diameter. For the smaller size, the weight of the switch may be in the range of 10 pounds and for the larger size the weight may be in the range of 60 pounds.

Heretofore, the switching time for a switch of this size using conventional switch drive mechanisms has been on the order of 1 to 2 seconds and weight up to 120 pounds. The same transfer switch when equipped with the drive mechanism disclosed herein and shown in the figures is capable of switching within less than half a second and switching is accomplished automatically with positive drive to the switch rotor and a mechanical lock on the drive at each position of the switch rotor.

Within the transfer switch housing 6 is the transfer switch rotor 11. This rotor is rotatable about the axis 12 of the switch on an axel 13. The axel connects rigidly to the ground plate 14 of the rotor 11. This plate separates the two isolated conductive parts 15 and 16 of the rotor and is separated from them by dielectric strips 17 and 18, respectively. The axel, ground plate, isolated conductive parts of the rotor and dielectric strips form a rigid assembly referred to herein as the rotor 11. The axel is carried at the bottom end by a bearing 19 axially located on the inside of the housing 6 of the switch. The other end of the axel 13 attaches to a spline 20 extending from a central idler gear in the transfer switch drive mechanism 2.

Within the drive mechanisms are two solenoids denoted herein solenoid A and solenoid B. Solenoid A drives the transfer switch to the B position of the switch and solenoid B drives to the A position of the transfer switch. These two positions A and B are indicated on the top of the drive mechanism housing 3 as shown in FIG. 2. Position A is indicated by pointer 4′ on knob 4 that extends from the shaft of the solenoid A and position B is indicated by pointer 5′ on knob 5 which extends from the shaft of solenoid B.

Within the housing 3, a drive from each solenoid to the transfer switch rotor 11 has a locking mechanism. When the switch is in the A position, the locking mechanism from solenoid A to the rotor locks and when in the B position, the locking mechanism from solenoid B to the rotor locks. Each of the solenoids has a spring return which returns the solenoid to the position denoted operate on the top of the housing 3 and shown in FIG. 2 except when the drive from that solenoid to the transfer switch rotor is locked. When either solenoid is in the operate position, the drive from that solenoid closes an associated micro-switch which controls electrical energization of the other solenoid and also produces output logic or interlock signals. Thus, the position indicated by the knob as shown in FIG. 2, is that the transfer switch is in the A position, the drive from solenoid A to the rotor is locked and the energizing switch for solenoid A which is actuated by the drive from solenoid B, is closed.

The transfer switch rotor 11 is generally disc-shaped. The isolated conductive parts 15 and 16 make connection to the center conductors of adjacent parts of the switch. Extending from the ends of each of these conductive parts are knife edges which engage widened slots at the ends of the center conductors of the four ports of the switch. Blades 21 and 22 extend at right angles from the ends of conductive part 15 and blades 23 and 24 extend at right angles from the ends of conductive part 16. At the position of the transfer switch rotor shown in FIG. 3, which is the A position, knife edges 23 and 24 engage the center conductors of ports I and II, respectively, and the knife edges 21 and 22 engage the center conductors of ports III and IV, respectively. A sectional view through the rotor along the axis 12 of the switch taken as shown in FIG. 3 is illustrated in FIG. 4. This shows the engagement of the knife edge 22 extending from conductive part 18 of the rotor into a slot 26 in the center conductor 7 of port IV. This slot is preferably arched as is the knife edge 22 and the slot may be equipped with fingers or springs which are compressed as the knife edge moves into the slot to insure substantial electrical contact between the knife edge and the center conductor of the port. The center conductor is preferably widened somewhat where it engages the knife edge and tapers smaller at 27, to the diameter of the center conductor 7 projecting outward from the port. This taper serves electrically as a transformer and is shaped in consideration of that performance. The center conductor 7 is held in place by dielectric plug 28 in the port flange 8, attached to the housing flange 30, all at port IV. The other ports and their center conductors are constructed substantially as port IV with center conductor 7.

The ground plate 14 at the center of the switch rotor 11 is slotted at each end to clear the widened ends 27 of the port center conductors 7 where the rotor is rotated from one position to another. The slots 31 and 32 in the plate define two legs at each end of the plate which engage spring contacts such as 33 attached to the inside wall of the housing. This plate and contacts insure a common grounded wall adjacent each of the isolated conductive parts 15 and 16 of the switch. Thus, an rf wave is conducted from port II to port I (where the switch is positioned as shown in FIG. 3) by a coaxial transmission line section formed by part 16, housing 6 and plate 14.

The two positions of the transfer switch are indicated by FIGS. 6 and 7. Position A is represented in FIG. 6 where ports III and IV are electrically connected and ports I and II are electrically connected. In the B position shown in FIG. 7, ports IV and I are connected and ports II and III are connected. From the description given above, it may be clear that switching from position A to position B is accomplished by energizing sole-

noid A via the micro-switch actuated by the drive from solenoid B. Likewise, switching from position B to position A is accomplished by energizing solenoid B via a micro-switch actuated by the drive from solenoid A.

Turning next to FIGS. **8** and **9** there is shown a front and top views of the drive mechanism with the cover **3** removed and at twice the scale of FIGS. **1** to **5**. The drive mechanism is carried on plate **34** which attaches to an accommodating surface **35** on the top of the transfer switch housing **6** as shown in FIG. **4**. Barrier stop pins **36** extending from the bottom of the plate **34** serve to stop the motion of rotation and align the plate with the housing as they are inserted into corresponding holes in the top of the housing and insure that the rotor drive shaft spline **20** projecting below the plate rigidly connects to the switch rotor axel **13**. The slight projection **37** from the bottom of plate **34** engages a matching recess **38** in the top of the switch housing and the plate is secured to the housing by bolts such as bolt **39**.

The drive shaft spline **20** extends from the drive shaft **41** carried by bearing **42** axially located in the plate **31** and contained therein by captive washer **43**. At the other end of the drive shaft is the idler gear **44** which engages the A cam gear **45***a* and the B cam gear **45***b* which are carried on axels **46***a* and **46***b*, respectively, attached to the top of plate **34**. Concentric with the gears **45***a* and **45***b* and located above these gears are the solenoids A and B, respectively, denoted **47***a* and **47***b*, respectively. Each solenoid is contained within a solenoid cover denoted **48***a* and **48***b* which attach to solenoid plate **49***a* and **49***b* by cover screws **50***a* and **50***b* and so contain the solenoids A and B, respectively. The cover plates **49***a* and **49***b* are spaced above the plate **34** by spacer posts **51***a* and **51***b*, respectively. Through an opening at the center of each cover plate extends the solenoid drive shaft, these are solenoid drive shafts **52***a* and **52***b* for the solenoids A and B, respectively. Cam A, denoted **53***a* is fixedly attached to the end of shaft **52***a* and Cam B, denoted **53***b* is fixedly attached to the end of shaft **52***b*. Each juts above the corresponding cam gear. The cams engage the gears by pins which are fixed to the cams and extend into slots in the gear discs. Pin **54***a* fixed to cam **53***a* extends into slot **55***a* in gear **45***a*. Likewise, **54***b* fixed to cam **53***b* extends into a slot **55***b* in the disc of gear **45***b*. Thus, a drive imparted by the solenoid shaft to the solenoid cam will initiate a rotation of the gear depending upon the position of the pin in the slot in the gear. This will be described more fully below.

The action of each of the cams is to open and close an associated micro-switch and lock and unlock the associated cam gear. For these purposes, cam A, **53***a*, plays against roller **61***a* mounted on boss **62***a* which extends from the sliding detent arm **63***a* carried by the drive mechanism plate **31**. This structure is shown more fully in FIG. **10** which is a cross section view of the structure taken as shown in FIG. **9** and twice the scale of FIGS. **8** and **9**. Similarly, cam B, denoted **53***b*, plays against roller **61***b* carried on boss **62***b* extending from detent arm **63***b* also carried by the plate **31**. When the detent arm which is spring loaded towards the axis of the associated solenoid is moved away from that axis by the action of the cam, the boss contacts two springs which actuate associated micro-switches mounted to the plate **31**. The boss **62***a* moves against the springs **64***a* and **65***a* which actuate micro-switches **66***a* mounted to the plate **31** by a switch mounting bracket **67** *a*. Similarly, micro-switches **66***b* are actuated by movement of the roller **61***b* which plays against cam **53***b*, depending upon the rotational position of solenoid B.

Extending from each boss of each detent arm in an axial direction with respect to the solenoid axis is a locking pin which engages a slot attached to the bottom of the cam gear to lock the gear when the position of the associated cam permits the roller to move towards the position closest to the solenoid axis, such as the position of roller **61***a* when cam A is at the position shown in FIG. **9**. Here the locking pin **71**a engages the slot **72***a* defined by a ridge **73***a* which may be an integral part of the disc of cam gear **45***a*. When thus engaged, the gear **45***a* is locked in position and so the transfer switch rotor **11** is locked in position. A similar pin **71***b* which is part of the detent **63***b* positioned by roller **61***b* engages a slot **72***b* in a ridge **73***b* at the bottom of cam gear **45***b*. Cam gear **45***b* is locked when the slot **72***b* aligns with pin **71***b*. In FIG. **9**, the position of solenoid B is such that the associated switches **66***b* are closed and the gear is unlocked.

FIG. **10** shows details of one of the detents which locks a gear and other details of the associated cam gear, and pin drive. Since both solenoids and the drive and switches associated therewith are constructed substantially the same, details are illustrated for only one of the solenoids. FIG. **10** shows the drive from solenoid B and is taken as illustrated in FIG. **9** showing the position of the detent for solenoid B at the position shown in FIG. **9**. The cam gear axel **46***b* includes for example, the axel **46***b* attached to the gear support plate **75***b* by axel screw **76***b* and carrying bearing **77***b* to which cam gear **45***b* is attached. A cavity **78***b* in plate **31** which is disposed radially with respect to the axel contains detent bearing **79***b* upon which slides the detent arm **63***b*. Within the arm is the detent pin spring **81***b* and detent pin **82***b* carried in an accommodating bore **83***b*. This pin is urged by the spring against detent stop spacer **84***b* at one end of the bearing. The end **85***b* of detent arm abuts spacer **86***b* at the other end of the bearing. The spacer **84***b* is retained by plate **87***b*. The locking pin detent associated with solenoid A is constructed identically and parts thereof are referred to by the same reference numbers but with the letter designation a rather than *b*.

FIG. **12** illustrates an electrical schematic from the block terminal **90** to the switches **66***a* and **66***b* which energize the solenoids **47***a* and **47***b* via rectifiers **91***a* and **91***b*. An input control switch **92** energizes either terminals A or B of the block terminal with 110 volt ac power for energizing either solenoid A or solenoid B. Terminal C of the block terminal is a common or ground for this ac power. Terminal D, E, F, and G, H, I provide logic and interlock output signals derived from the switches **66***a* and **66***b*. Some of the uses of these interlock signals will be described herein below.

In operation commencing with the transfer switch rotor in the A position illustrated by FIGS. **2**, **3**, and **9**, the drive from solenoid A to the switch rotor is locked and switch **66***b* is closed. This is the switch that control energization of solenoid A. This position is illustrated by FIG. **11***f* which shows a short vector A and a long vector B at angular positions representing the positions of the A and B solenoids, respectively. The positions of these vectors A and B also represent the positions of

the cams **54***a* and **54***b*, respectively. In FIG. **11***f*, the arcs extending from each of the vectors A and B and denoted **55***a* and **55***b* represent the slot **55***a* and **55***b* in gears **45***a* and **45***b*, respectively, shown in FIGS. **8** and **9** and which limit the relative position of each of the cams with respect to its associated drive gear. When neither solenoid is energized at the electrical condition illustrated in FIG. **12**, the slots **55***a* and **55***b* are at the positions shown in FIGS. **8** and **9** and **11***f*. These slots limit the positions of the associated cams and solenoids. For example, each solenoid has a spring return which rotates the solenoid in the opposite direction to the direction the solenoid rotates when it is electrically energized. Since solenoid A drives counterclockwise and solenoid B drives clockwise as viewed from the top, the spring returns in these solenoids urge solenoid A clockwise and solenoid B counterclockwise. Hence, when the slots **55***a* and **55***b* in the gears are positioned as shown in FIG. **9** and illustrated schematically in FIG. **11***f*, and neither solenoid is energized, the solenoid cams will be at positions relative to their associated slots as represented in FIG. **11***f*.

When the input control switch **92** is switched to the B terminal of the block terminal **90**, solenoid A is energized and drives its cam **53***a* in the counterclockwise direction as represented by arrow **94** in FIG. **11***f*. The first 45° of the solenoid motion is used to retract the locking pin **71***a*. This is done as cam **53***a* rotates counterclockwise from the position shown in FIG. **9** and represented in FIG. **11***f* to the position represented in FIG. **11***g*. The radial motion of the locking pin **71***a* closes micro-switches **66***a*, one of which controls energization cf solenoid B and so at this point all of switches **66***a* and **66***b* are closed. The second 45° of rotation of solenoid A rotates the transfer switch rotor 90° in the clockwise direction as viewed in FIG. **3**. This occurs because the gear ratio from either of the gears **45***a* or **45***b* to the idler gear **44** is **2** to **1** and so 45° of rotation of the solenoid produces a 90° rotation of the transfer switch rotor. Furthermore, counterclockwise rotation of solenoid A produces a clockwise rotation of the switch rotor. At the end of the second 45° of rotation of solenoid A, the transfer switch will be in the B position and the slots **55***a* and *b* will be at the positions indicated by FIGS. **11***h*, *i*, and *j*. In FIG. **11***h*, vector A represents the completed drive position of solenoid A and vector B represents the position of solenoid B at the beginning of the drive and before that solenoid has been returned by its spring return in a counter-clockwise direction to the end of its travel as limited by slot **55***b*. FIG. **11**i shows the position of solenoid B urged by the spring return. The positions represented by FIGS. **11***h* and *i* actually occur simultaneously, because solenoid B follows solenoid A as solenoid A is driven from the position shown in FIG. **11***g* to the position in FIG. **11***h* and so both solenoids arrive substantially simultaneously at the position shown in FIG. **11***i*. At this position, solenoid B locks as the locking pin **71***b* is aligned radially with slot **72***b* in the bottom of gear **45***b*. As this locking occurs, urged by spring **81***b*, the solenoid switch **66***b'* opens, deenergizing solenoid A which returns by spring return to the position shown in FIG. **11***j* to complete the switching cycle. At the completion of this cycle, solenoid B is locked and the energizing switch **66***b'* controlled by solenoid B is open. Also solenoid B urged by its spring return to the position shown in FIG. **11***j* closes switch **66***a'* which controls energization of solenoid B.

The next cycle of operation, switching from the B position to the A position is represented by the sequence illustrated in FIGS. **11***a* to **11***e*. Here, solenoid B is energized and the control switch **92** is switched to terminal A of the terminal block **90** causing solenoid B and its cam to rotate clockwise as viewed from above in the direction of arrow **95** in FIG. **11***a*. Thereafter, the switching cycle is carried out in the same fashion to arrive again at the A position illustrated by FIG. **11***e* or **11***f* and shown in FIG. **9**.

Each of the micro-switches **66***a* and **66***b* includes two switches. In **66***a* these are **66***a'* and **66***a''*. The first of these as already described controls energization of solenoid B. The other produces a voltage signal at terminal E or terminal F which is referred to herein as a logic signal. These logic signals may be used to control energization of transmitters which feed through the transfer switch in such a manner that the transmitter is turned on only when the switch is properly positioned to feed power from that transmitter to a load. This is one use of the logic signals. Clearly, other uses can be made depending upon the application and functioning of the transfer switch in the system in which it is employed.

The switch **66***b'*, as already described, controls energization of solenoid A. The switch **66***b''* ganged to this, produces an interlock signal at terminal H or I depending upon its position. The interlock signals may be used, for example, to remove voltages from each of the solenoids once they have reached the end of their travel so that further voltage cannot be applied to either solenoid until the transfer switch is fully driven into the opposite position. This makes accidental switching due to loss of ac power impossible.

The manual override enabled by the knobs **4** and **5** at the top of the drive mechanism enable manually rotating the switch during loss of ac power. Clearly, two knobs are provided, however, only one is necessary to operate the switch from its present position to the opposite position. The position of the knobs indicates the position of the switch and also which of the two knobs is to be rotated to actuated the switch.

It is preferred that a circuit breaker be included in the common path of the ac side of the energizing power for the solenoids, which is terminal C of the block terminal **90**. This may be either a manual reset or a thermal automatic reset relay such as relay **96**. With either type, the circuit breaker will open if a solenoid draws current for more than two or three seconds. The thermal automatic reset type of relay, **96**, will reclose the circuit after approximately 10 seconds.

A particularly advantageous use of the coaxial transfer switch is in a broadcast system including two transmitters and two loads. One transmitter, the primary transmitter, feeds rf power through the switch to a broadcast antenna while the other transmitter, the standby transmitter, feeds through the switch at a low power level into a dummy load. Upon demand, or upon the happening of a detectable event, such as a failure in the primary transmitter, the transfer switch is energized automatically by a controller on control switch **92** which positions switch **92** to the A or B terminal of terminal block **90**. If, for example, the transfer switch is in the A position with the primary transmitter feeding through the switch to a broadcast antenna and the standby transmitter coupling through the switch to a

dummy load, and a failure occurs in the primary transmitter, control switch **92** is automatically switched to terminal B of block **90.** This energizes solenoid A and the sequence shown by FIGS. **11**f to **11** j commences.

At the beginning of this sequence, micro-switches **66***a* are open (at the position shown in FIG. **12**) and so logic terminal E of the terminal block **90** is energized with a dc signal level from terminal D and logic terminal F is not so energized. Thereafter, in the sequence represented by FIGS. **11***f* to **11***j*, switches **66***a* (referred to in these FIGS. as S*w a*), close at the beginning of the second 45° of rotation of solenoid A (when rotation of the transfer switch rotor commences), and switches **66***a* open again at the end of the second 45° of rotation of solenoid A (when rotation of the transfer switch rotor is completed). This momentary closing and opening of switch **66***a''* produces a pulse at logic terminal F and a complementary pulse at logic terminal E that turns off both transmitters at the beginning of the pulse, then turns on the standby transmitter only at the end of the pulse. Thus, while the transfer switch rotor is moving from one position to the other, both transmitters are off and the standby transmitter does not come on with full rf power until switching is completed. This avoids rf arcing as the switch rotor blades disengage and engage the center conductors of the switch ports.

A broadcast system incorporating a coaxial transfer switch functioning as described above is represented by the diagram in FIG. **13.** The primary and standby transmitters **101** and **102** feed rf power through the rotary transfer switch **100** to a broadcast antenna **103** and dummy load **104,** respectively. The transfer switch is shown in FIG. **13** in the A position.

Faults detected in the primary and standby transmitters by detectors **105** and **106,** respectively feed signals to the control switch controller **107** which positions control switch **92** at the A or B terminal of block **90.** When a failure in the primary transmitter occurs and is detected by detector **105,** controller **107** switches switch **92** from its center position (no ac energizing power), to terminal B and the sequence described above ensues. In that sequence, the dc pulses at logic terminals E and F are decoded by transmitter logic circuits **108** producing signals to the On-Off switches **109** and **110** which control power from source **111** to the primary and standby transmitters.

In this sequence, following detection of a failure or fault in the primary transmitter, the logic circuits turn off both transmitters during the interval that the rotor of the transfer switch **100** is moving from the A position to the B position (see FIGS. **6** and **7**). Upon reaching the B position, the primary transmitter remains off and the standby is turned on.

Thereafter, should a fault or failure be detected in the standby transmitter, the reverse sequence occurs and both transmitters are turned off while the transfer switch rotor moves from the B position to the A position. Then transmitter **101** is turned on and transmitter **102** remains off.

The embodiment of the invention described herein and the uses of that embodiment represents the preferred structure and use. It is to be understood that this is illustrative of the structure and use and variations, modifications, and improvements may be made by those experienced in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a multi-port coaxial power switch having a rotor for interconnecting ports, means for actuating the rotor comprising,

a first electrical drive for driving the coaxial switch from a second position to a first position,

first drive means from the first electrical drive to the rotor,

said first drive means including a first cam and a first gear directly driving the rotor and first means interconnecting the first cam and first gear,

a second electrical drive for driving the coaxial switch rotor in the opposite direction from the first position to the second position,

second drive means from the second electrical drive to the rotor,

switching means for coupling electrical power from a source to the first and second electrical drives,

whereby the first and second electrical drives are energized at different first and second intervals to position the switch at the first and second positions, respectively.

2. In a multi-port coaxial power switch, means for actuating the rotor as in claim **1** further comprising,

means for locking the first drive means at the second position of the rotor, and

the first cam being driven by the first electrical drive to unlock the first drive means,

whereby the switch rotor locks at the second position and is unlocked when the first electrical drive is energized and following energization of the first electrical drive, the first cam moves and unlocks the first drive means before the first gear moves to position the rotor.

3. In a multi-port coaxial power switch, means for actuating the rotor as in claim **2** further comprising,

means for locking the second drive means at the first position of the rotor, and

second means driven by the second electrical drive for unlocking the second drive means,

whereby the switch rotor locks at the first position and is unlocked when the second electrical drive is energized.

4. In a multi-port coaxial power switch, means for actuating the rotor as in claim **2** wherein,

following energization of the first electrical drive, the first drive means is unlocked before driving the rotor to the first position.

5. In a multi-port coaxial power switch, means for actuating the rotor as in claim **3** wherein,

following energization of the second electrical drive, the second drive means is unlocked before driving the rotor to the second position.

6. In a multi-port coaxial power switch, means for actuating the rotor as in claim **1** wherein,

said switching means includes a first switch actuated by said first cam for coupling electric power from the source to the second electrical drive.

7. In a multi-port coaxial power switch, means for actuating the rotor as in claim **1** wherein,

said switching means includes a second switch actuated by said second drive means for coupling electric power from the source to the first electrical drive.

8. In a multi-port coaxial poer switch, means for actuating the rotor as in claim **3** wherein,

the second drive means includes a second cam and second gear directly driving the rotor and second

means interconnecting the second cam and second gear,

whereby, following energization of the second electrical drive, the second cam moves and unlocks the second drive means before the second gear moves to position the rotor.

9. In a multi-port coaxial power switch, means for actuating the rotor as in claim **1** and further including,

means for locking the first drive means at the second position of the rotor, and

first means driven by the first cam for unlocking the first drive means,

whereby the switch rotor locks at the second position and is unlocked when the first electrical drive is energized

means for locking the second drive means at the first position of the rotor, and

second means driven by the second electrical drive for unlocking the second drive means,

whereby the switch rotor locks at the first position and is unlocked when the second electrical drive is energized,

said switching means includes a first switch actuated by said first cam for coupling electric power from the source to the second electrical drive, and

said switching means includes a second switch actuated by said second drive means for coupling electric power from the source of the first electrical drive,

whereby, following energization of the first electrical drive, the first cam moves and unlocks the first drive means before the first gear moves to position the rotor.

10. In a multi-port coaxial power switch having a rotor for interconnecting ports, means for actuating the rotor comprising,

a first electrical drive for driving the coaxial switch from a second position to a first position,

first drive means from the first electrical drive to the rotor,

said first drive means including a first pin driven along an arc by the first electrical drive and first means including a first slot engaged by the first pin, and driven by the first pin for driving the rotor from the second position to the first position,

a second electrical drive for driving the coaxial switch rotor in the opposite direction from the first position to the second position,

second drive means from the second electrical drive to the rotor,

switching means for coupling electric power from a source to the first and second electrical drives,

whereby the first and second electrical drives are energized at different first and second intervals to position the switch at the first and second positions, respectively.

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