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REMOTELY-CONTROLLED SELECTOR SWITCH MECHANISM

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Fig. 1.

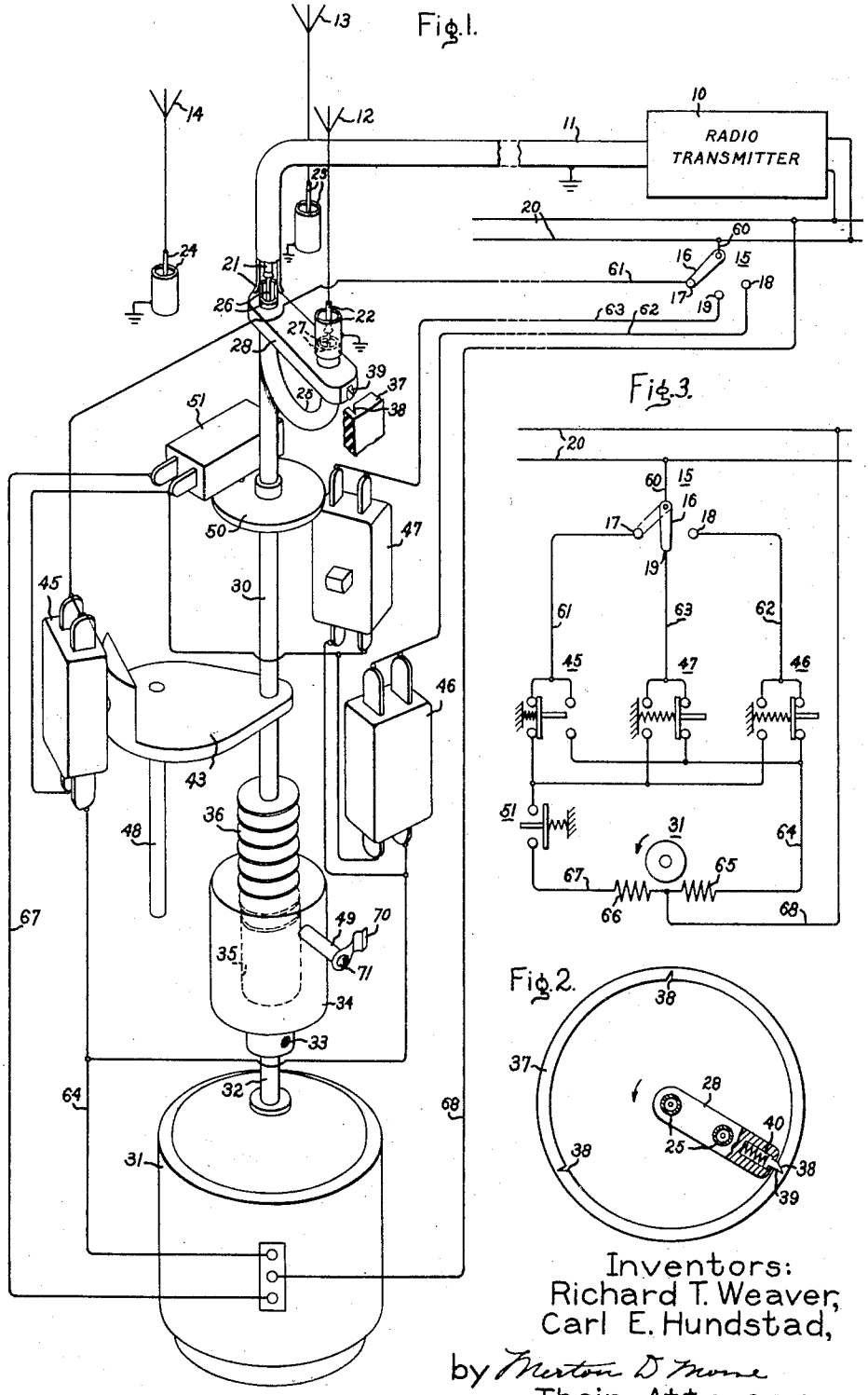


Fig. 3.

Fig. 2.

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REMOTELY CONTROLLED SELECTOR SWITCH MECHANISM

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3 Claims. (Cl. 171—97)

1

Our invention relates to a selector switch mechanism which may be controlled from a remote point so as to connect a common power circuit to any one of a plurality of branch circuits.

It is a primary object of our invention to provide an improved motor-driven switching mechanism of this general type in which actuation of a remote control switch causes the mechanism automatically to operate through a complete control sequence. Specifically, it operates to disconnect the common power supply circuit from any previously-connected branch circuit and then to reconnect it to another selected branch circuit.

Another object of our invention is to provide a motor-driven selector switch mechanism capable of handling large amounts of electrical power and providing extremely positive contact-engaging action, but which is nevertheless readily controlled from a remote point through a minimum number of low-power control circuits.

Our invention has particular utility in its application to a radio frequency selector switch for connecting a remote radio transmitter to any one of plurality of antenna circuits in response to actuation of a remote control switch located at or near the transmitter.

For additional objects and advantages, and for a better understanding of the invention, attention is now directed to the following description and accompanying drawings. The features of the invention believed to be novel are particularly pointed out in the appended claims.

In the drawings:

Fig. 1 is a schematic diagram of a radio transmitting system embodying our invention, showing the essential mechanical and electrical elements of our improved switch mechanism in an expanded perspective view;

Fig. 2 is a detail view of a portion of the switch structure of Fig. 1; and

Fig. 3 is a simplified circuit diagram of the motor control circuit which will be referred to for a better understanding of the operation of the system of Fig. 1.

Corresponding elements in the several figures of the drawings have been given corresponding reference numerals.

In Fig. 1, our invention is represented in its application to a radio transmitting system including a radio transmitter 10 which supplies high frequency energy to a coaxial transmission line 11. This transmission line is arranged to be selectively connected to any one of three radio antennas 12, 13 and 14, located some distance from the transmitter, through the switching mechanism embodying our invention. This is accomplished by operating a control selector switch 15 so that its movable contact arm 16 engages one of three corresponding contacts 17, 18 or 19. The selector switch 15 may be positioned in any suitable location. It may, for example, be located at or near the operating console for the remote radio transmitter 10, in which case the control circuits associated with switch 15 may conveniently be energized from the same power supply lines 20 as the transmitter 10.

2

The left-hand end of the coaxial transmission line 11 terminates in a pair of female contacts 21 of a coaxial cable connector, which may be of any suitable type known to the art. Each of the antennas 12, 13 and 14 is also connected through a suitable transmission line to pairs of female contacts 22, 23 and 24 respectively, of similar coaxial connectors. The transmission line 11 is arranged to be selectively connected in circuit with any one of the three antennas through a short, U-shaped section 25 of coaxial line. Line section 25 terminates at one end in a pair of male coaxial contacts 26 adapted to engage contacts 21, and at the other end in a pair of male coaxial contacts 27 adapted to engage any one of the pairs of female contacts 22, 23 and 24.

The line section 25 is braced by a radial bracket 28 and its inner end is secured to a rotatable shaft 30 in any suitable manner, as by welding or brazing. The shaft 30 and connector 21, 26 lie on the same axis, while the contacts 22, 23 and 24 lie on parallel axes equidistant from this axis and equi-angularly spaced around it. Therefore, when the shaft 30 is moved axially downward, line section 25 and associated contacts are disengaged. They may then be rotated to any desired angular position and, when properly indexed, may be reengaged so that line section 25 completes a power circuit from the transmitter 10 to any one of the antennas.

The mechanism to effect the required axial and rotational movement for operating the contact members, as just described, includes a reversible electric motor 31 having a drive shaft 32. Motor 31 may, for example, be a commercial type of gear motor having internal gearing for driving shaft 32 at a relatively low speed. Secured to the shaft 32 in any suitable manner, as by means of set screw 33, is a cylindrical hub 34. The upper end of hub 34 is drilled and

tapped to form an inner threaded cylindrical surface 35 coaxial with the motor shaft 32. A screw member 36, which is integral with shaft 30 or rigidly secured to one end thereof, is threaded into the hollow hub 34.

It will thus be seen that if the shaft 30 is constrained against rotation, it will be moved axially downward upon rotation of the motor shaft in the counter-clock-wise direction, and that it will be moved axially upward in response to motor rotation in the opposite direction. A suitable detent mechanism is provided for resisting rotation of shaft 30 when it is in any one of the three angular positions at which the coaxial connector contacts are properly indexed for movement into or out of engagement. As best shown in the detail view of Fig. 3, this comprises a cylindrical ring member 37, concentric with shaft 30, which has three axial grooves 38 of triangular cross-section in its inner surface. (Only a fragment of ring 37 has been shown in Fig. 1 to clarify the drawing.) The grooves 38 are angularly spaced so that one of them is arranged to be resiliently engaged by a spring-biased latch 39, carried in a socket 40 in the end of bracket 26, whenever the radial transmission line section 25 is properly indexed. It will be observed from Fig. 3 that each groove 38 has a radial face and a sloping face, so as to permit rotation of the movable switch elements only in the counter-clock-wise direction. This rotation is also resiliently resisted at each of the three indexing positions. As seen in Fig. 1, ring 37 is positioned so that its upper face 40 lies below latch 39 when the elements of the coaxial connectors are in engagement. Therefore, latch 39 does not enter a groove 38 until the connector elements have just disengaged. This permits the connector elements to seek their own centers, without any strain due to slight misalignment with respect to the detent mechanism. However, as soon as the connector elements are disengaged, during downward movement of shaft 30, the detect mechanism prevents any rotation throughout the remainder of the downward movement.

A radial cam 43 is also rigidly secured to shaft 30 for movement therewith. Equally spaced around the shaft 30 are three push-button switches 45, 46 and 47. Each of these switches is a two-position switch which is normally biased to a first operating position and which has an operating pin adapted to be engaged by the cam surface formed by an upwardly-extending flange 44 on the cam 43. Each of the switches 45, 46 and 47 is arranged to be actuated to a second operating position when its operating pin is engaged by flange 44, and its angular position is such that this occurs only when the switch mechanism is properly indexed for engagement of a pair of transmission line connectors. Flange 44 is of sufficient axial depth to permit it to remain in engagement with a selected switch throughout the limits of axial movement of shaft 30. Switches 45, 46 and 47 may be any suitable type known to the art. Patent 2,332,911, issued October 26, 1943, to George M. Hausler and assigned to the same assignee as our invention, shows a very satisfactory switch construction for this purpose.

The cam plate 43 also carries a downwardly-extending pin 48. The lower end of pin 48 terminates adjacent the path of travel of a radial pin 49 secured to hub 34. Pin 48 is of such length that it is not engaged by pin 49 when the shaft

30 is in its upper, contact-engaging position. However, as the motor shaft 32 and hub 34 rotate counter-clock-wise, causing the shaft 30 to be drawn downward, after a number of revolutions the pin 48 is struck by the pin 49. This is arranged to occur when the contacts 27 have been completely disengaged from contacts 22, 23 or 24. When this occurs, the shaft 30, line section 25 and cam 43 are caused to rotate counter-clock-wise, since the rotational driving force is arranged to be sufficient to overcome the resistance offered by the latch 41 of the detent mechanism. As will shortly be explained in greater detail, the shaft 30 never makes more than one complete revolution after the pins 48 and 49 engage, but the direction of motor rotation is reversed upon actuation of another selected one of the switches 45, 46 and 47. When the direction of motor rotation is thus reversed, the radial pin 49 is disengaged from pin 48, and the pitch of the threads of member 36 and hub 34 is such that the end of pin 48 moves out of the path of movement of pin 49 before one revolution in the opposite direction is completed. Therefore, continued rotation of the motor shaft causes the shaft 30 only to move axially upward, further rotation being resiliently resisted by the detent mechanism, as previously described.

Also secured rigidly to the shaft 30 is a third cam 50 in the form of a flat circular disc. As the disc 50 moves axially upward with shaft 30 it is arranged to actuate a normally-closed, single-position, limit switch 51 to an open-circuit position just as the selected contact members move into full engagement. This occurs irrespective of the angular position of shaft 30 at the time.

The electrical control circuits for the switching mechanism just described, and the operation thereof, will be better understood by reference to the simplified circuit diagram of Fig. 3 in which elements corresponding to those of Fig. 1 have been given the same reference numerals. The movable contact arm 16 of the remote selector switch 15 is connected to one side of the power supply lines 20 through a conductor 60. Each of the three stationary contacts 17, 18 and 19 is connected to an upper pair of contacts on one of the two-position push-button switches 45, 46 and 47 through conductors 61, 62 and 63 respectively. Each of the push-button switches 45, 46 and 47 has its movable contact member normally spring-biased toward the right, as viewed in Fig. 3. However, the switch 45 is represented as being in its left-hand, or depressed position, corresponding to its position shown in Fig. 1, where it is engaged by the flange 44.

All of the lower right-hand contacts of switches 45, 46 and 47 are connected through a common conductor 64 to a first motor winding 65 in the motor 31. The motor 31 also has a reversing winding 66 which is connected to all of the lower-hand contacts of these same switches through conductor 67 and the limit switch 51. The limit switch 51 is normally spring-biased toward the left, as viewed in Fig. 3, and is represented in its open-circuit, or depressed, position, corresponding to the position shown in Fig. 1. The junction between the two motor windings is connected to the other side of the power supply lines 20 through a conductor 68.

In analyzing the operation of the system, assume first that the remote selector switch 15 is in the position shown in Fig. 1. Both motor circuits are deenergized, since the right-hand contacts of switch 45 are open, and the circuit

through the left-hand contacts of switch 45 to motor winding 66 is interrupted by the open limit switch 51. Next assume that contact arm 16 is moved into engagement with contact 19, as shown in Fig. 2. A power circuit for the right-hand motor winding 65 is now completed. This may be traced from the power supply through conductor 60, contact arm 16, contact 19, conductor 63, the right-hand contacts of push-button switch 47, conductor 64, motor winding 65, and conductor 68 to the other side of the power supply.

Motor shaft 32 now commences to rotate in counter-clock-wise direction and, as previously described, the shaft 30 and pairs of coaxial contacts 26 and 27 are now moved axially downward out of engagement to disengage the stationary pairs of contacts 21 and 22. When the contacts are completely disengaged, the radial pin 49 strikes the end of pin 48, causing the whole shaft assembly to rotate counter-clock-wise. This continues only through a fraction of a revolution until the switch 47 is actuated to its second position. This causes the previous circuit through motor winding 65 to be interrupted and closes a circuit through the reversing winding 66. This new circuit may be traced from the power supply 20 through conductor 60, contact arm 16, contact 19, conductor 63, the left-hand contacts of switch 47, the limit switch 51 (which is now released to its closed position), conductor 67, motor winding 66 and conductor 68 to the other side of power supply 20. The motor 31, which is preferably of a low-inertia type, now begins to rotate in the opposite direction almost instantaneously. Any slight misalignment of the coaxial contacts 27 with the contacts 24 is corrected by the action of the spring-biased latch 39 in being forced into engagement with the proper groove in ring 37. The shaft 30 is also resiliently held against further rotation, and the reverse rotation of motor shaft 32 causes the shaft 30 to be moved axially upward, engaging the coaxial contact members in the new position so as to connect the transmitter 10 with antenna 14. When the coaxial contact members have moved into full engagement, the cam disc 50 opens the limit switch 51, as previously described, and the control circuits for the motor remain completely deenergized until the next actuation of selector switch 15 to a different position.

It will thus be seen that we have provided a simple and effective selector switch mechanism which provides axial disengagement of the radio frequency contacts, rotation to a new switch position, and reengagement of a new set of radio frequency contacts, all in response to the single movement of a simple selector switch at a remote point.

Operating tests have also shown that the switching cycle may be completed quite rapidly, even through the radio frequency switch elements are of heavy, high-power construction. If the motor shaft speed is too high, however, the inertia of the rotating switch parts may tend to cause the contacts 27 to overshoot after they are rotated to the proper indexing position. We have found that this tendency can be greatly reduced by securing a flat leaf spring 70 to radial pin 49, as shown in Fig. 1. The spring 70 is secured to the end of pin 49 in any suitable manner, as by means of a machine screw 71, so as to hook over the outside edge of the pin 48 when the two pins come into engagement. This spring, therefore, resiliently forces the two pins into

engagement, and the friction between spring 70 and pin 48 may readily be adjusted so that it exerts a certain amount of pull on the pin 48 just as the motor shaft reverses after the indexing operation. It may, therefore, be arranged to pull the pin 48 backward slightly into proper indexing position, in case it has overshot the position in which detent mechanism 37, 39 is engaged. Cam surface 44 is wide enough so that the selected switch 45, 46 or 47 remains actuated during any such small amount of overshoot. The detent mechanism thereafter positively holds shaft 30 against further rotation in the reverse direction, while the spring 70 is pulled out of frictional engagement with pin 48.

It will be apparent that various modifications may be made in our improved switching mechanism without departing from the principles of our invention. For example, while we have shown only three switch positions, it is obvious that a larger number of positions may readily be accommodated. Also, while we have shown our invention as particularly applied to switching between coaxial transmission lines, it will be evident that the exact arrangement of the electrical circuits and contacts is immaterial, and that other types of electrical switch structures may be employed. We, therefore, wish it to be understood that the appended claims are intended to cover any such modifications within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A remotely-controlled switching mechanism comprising a driven shaft, a movable switch contact supported by said shaft at one side thereof, a plurality of fixed contacts each arranged to be selectively engaged in response to axial movement of said shaft after a rotational indexing movement, a remote selector switch having a corresponding plurality of circuit-controlling positions, a reversible electric motor having a drive shaft, means responsive to movement of said remote selector switch to any selected position for energizing said motor to rotate in one direction, mechanical coupling means between said shafts for first moving said driven shaft axially to disengage said contacts and then rotating it in response to motor rotation in said one direction, means for reversing said motor in response to rotation of said driven shaft to an indexing position corresponding to said selector switch position, and means controlled by the resultant reverse axial movement of said driven shaft into contact-engaging position for interrupting said reversing circuit.

2. A remotely-controlled switching mechanism comprising a driven shaft with a radial arm, a movable switch contact carried by said arm, a plurality of fixed contacts angularly spaced around said shaft and each arranged to be selectively engaged in response to axial movement of said shaft after a rotational indexing movement, a corresponding plurality of two-position switches angularly arranged around said shaft and spring-biased to a first position, cam means operated by rotation of said shaft for actuating each of said switches to its second position whenever said shaft is correctly indexed to a corresponding contact position, a reversible electric motor having a drive shaft, means comprising a remote selector switch for completing a circuit through said motor and through any selected one of said switches in its first position, said circuit energizing said motor for rotation in one direc-

tion, mechanical coupling means between said shafts for first moving said driven shaft axially to disengage said contacts and then rotating it in response to motor rotation in said one direction, means for completing a reversing circuit through said motor in response to actuation of each said selected switch to its second position, and means comprising a limit switch actuated by the resultant reverse axial movement of said driven shaft into the contact-engaging position for interrupting said reversing circuit.

3. A remotely-controlled switching mechanism comprising a driven shaft with a radial arm, a movable switch contact carried by said arm, a plurality of fixed contacts angularly spaced around said shaft and each arranged to be selectively engaged in response to axial movement of said shaft after a rotational indexing movement, a corresponding plurality of two-position switches angularly arranged around said shaft and spring-biased to a first position, means comprising a cam driven by said shaft for actuating each of said switches to its second position whenever said shaft is correctly indexed to a corresponding contact position, a plurality of detents for resisting rotation of said shaft from each of said contact positions, a reversible electric motor having a drive shaft, means comprising a remote selector switch having a corresponding plurality of circuit-controlling positions for completing a circuit through said motor and through any selected one of said switches in its first position, said circuit energizing said motor to rotate in one direction, said drive shaft having a coaxial threaded engagement with one end of said driven shaft and being arranged to move said driven shaft axially without rotation so as to disengage said movable contact in response to said rotation, means comprising a one-way clutch between said shafts for positively rotating said driven shaft against the resistance of said detents after a predetermined axial movement, means for completing a reversing circuit through said motor in response to cam actuation of each said selected switch to its second position, and means comprising a limit switch actuated by subsequent reverse axial movement of said driven shaft into the contact-engaging position for interrupting said reversing circuit.

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