

May 30, 1950

N. E. KLEIN

2,509,928

RADIO FREQUENCY SWITCH

Filed Oct. 31, 1945

4 Sheets-Sheet 1

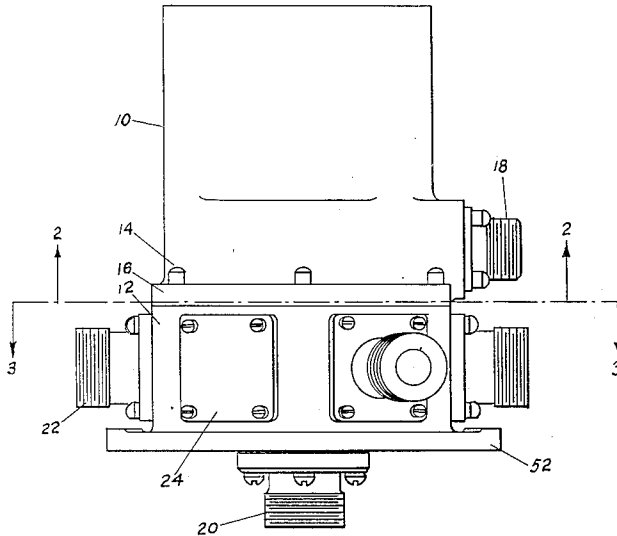


Fig. 1

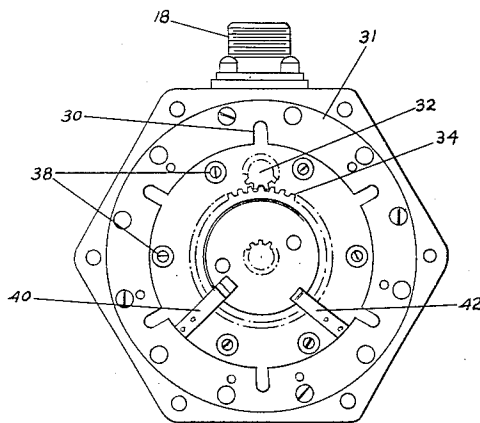


Fig. 2

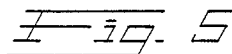
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4 Sheets-Sheet 3

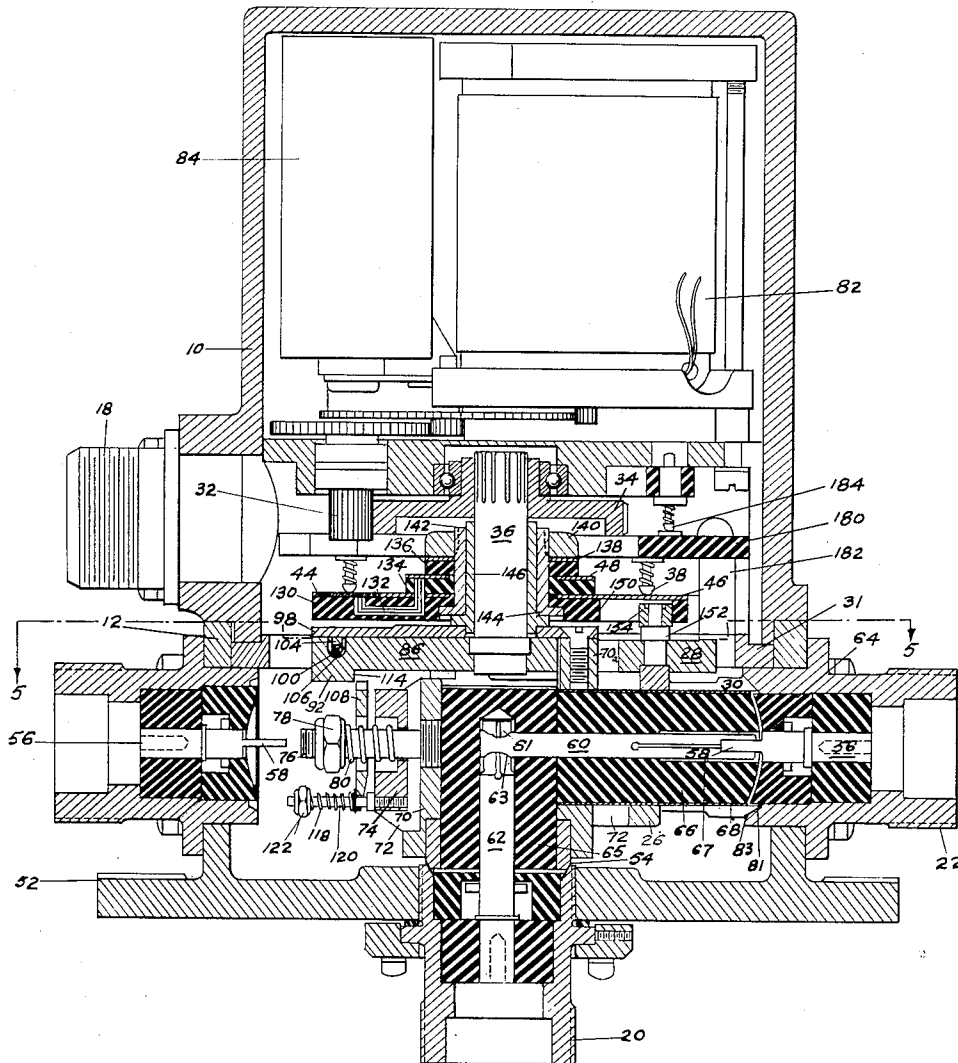


Fig. 4

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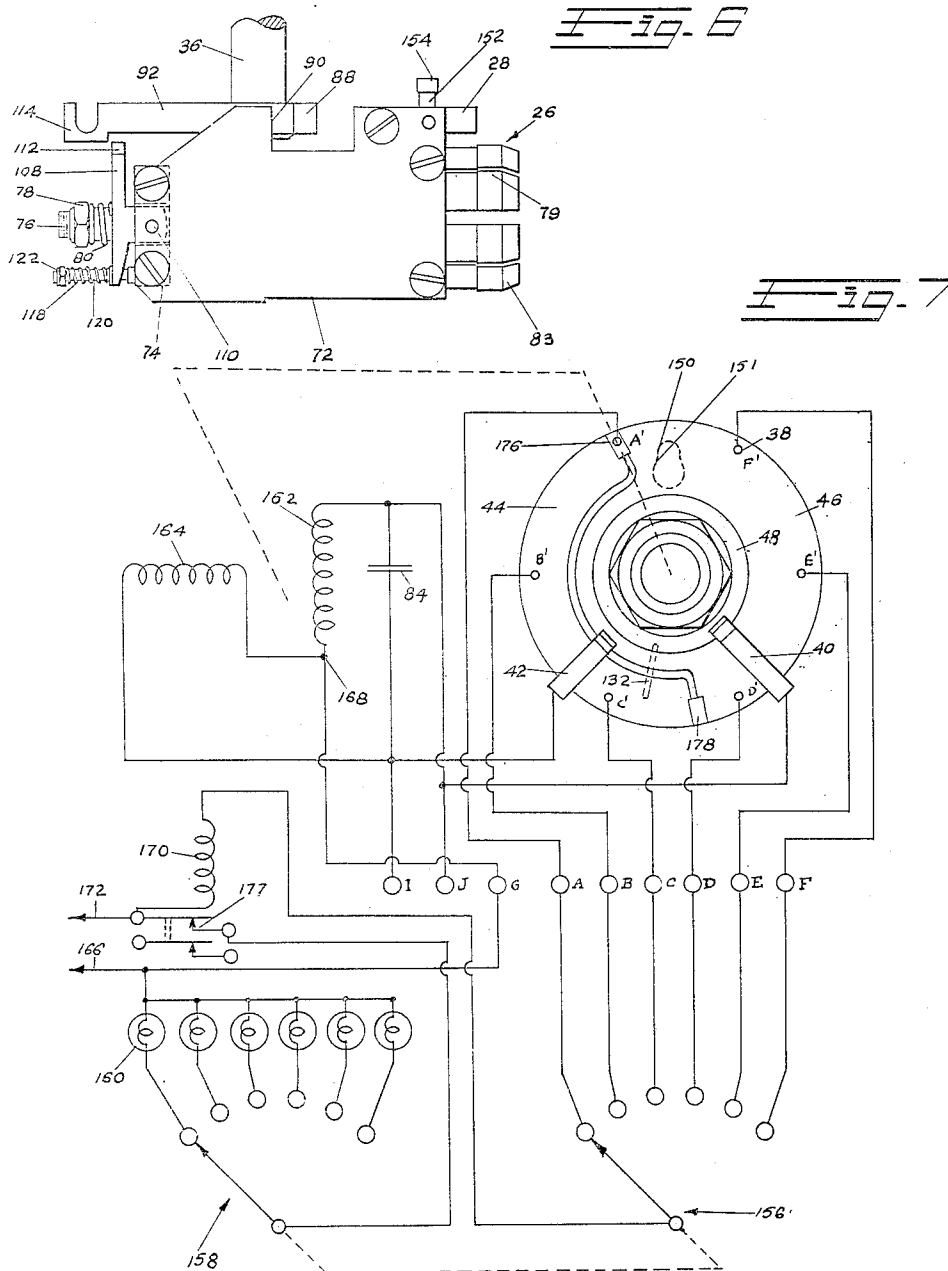
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RADIO FREQUENCY SWITCH

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4 Sheets-Sheet 4



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RADIO-FREQUENCY SWITCH

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4 Claims. (Cl. 200—4)

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This invention relates to selector switches, and more particularly to radio-frequency switches.

An object of this invention is to provide an indexible selector switch for making improved contact in the selected position.

Another object is to provide an ultra-high-frequency coaxial selector switch.

A further object is to provide an improved remote control mechanism for the improved selector switch.

According to the invention, a cylindrical selector contact is indexed from one contact position to the others, progressively. It is retracted radially preparatory to each indexing motion and in each selected position it is projected radially to establish a firm contact with the selected terminal, and also to grip the conductor along which it slides radially. When used for ultra-high-frequency circuits for which the arrangement is particularly well suited, the cylindrical contact is associated with an inner coaxial conductor. A remote-control mechanism is provided for indexing the switch to any given position and the improved control mechanism forms an integral part of the novel selector switch. The details of the invention, together with further novel features, will be apparent from the following specific disclosure of one embodiment thereof, in which:

Fig. 1 is a lateral external view;

Fig. 2 is an end view in the direction 2—2 of Fig. 1 when the two main casing sections are separated and the assembly is rotated about its longitudinal axis through approximately a right angle;

Fig. 3 is an end view in the direction 3—3 of Fig. 1 when the two main casing sections are separated and the assembly is rotated through substantially a right angle;

Fig. 4 is a lateral section along the axis of the switch in a plane parallel to Fig. 1 with the assembly rotated through approximately 180 degrees;

Fig. 5 is a sectional view along the line 5—5 in Fig. 4, with the parts in a configuration assumed during indexing;

Fig. 6 is a sub-assembly of the radially movable contact, associated with parts of its operating mechanism; and

Fig. 7 is a wiring diagram of the remote control mechanism.

In Fig. 1, a switch casing is shown divided into an upper part or section 10 and a lower, generally hexagonal part or section 12. The upper casing section is secured by means of screws 14 through flange 16 to lower casing section 12.

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Connector 18 on section 10 contains multiple terminals for the remote-control circuit to be described. Casing 12 has an axial terminal 20 which is adapted to be connected to any one of the four radial terminals 22 with which the switch is provided. Cover plates 24 are provided in two of the six possible positions in casing 12 where terminals 22 might be mounted if required. The hexagonal form of casing 12 is purely illustrative, of course, and as many selector positions as desired can be incorporated in a switch made in accordance with the present invention.

Upper casing section 10 encloses the motor-drive mechanism, reduction gearing and part of the remote-control switching system. Lower section 12 carries the R.-F. selector mechanism and more of the remote-control mechanism. Sections 10 and 12 can be separated upon removal of screws 14, and when this is done, the inside views of sections 10 and 12 appear as in Fig. 2 and 3. (Fig. 3 shows two of the four terminals 22 replaced by cover plates 24.) In Fig. 3, radially movable selector contact 26 is shown in engagement with one of the terminals 22. Detent 28, which is rigidly associated with that contact 26, fits somewhat loosely within any of aligning notches 30 (Fig. 2) in ring 31 secured to casing section 10. (In Fig. 2 only four of the twelve screws intended to secure ring 31 to casing 10 are shown.) There is one notch 30 for each selector-switch position 22 or 24. Detent 28 is withdrawn from notch 30 as slotted contact member 26 is radially withdrawn preparatory to each indexing operation.

The radial withdrawing motion and the indexing motion are accomplished by mechanism to be described, driven by the motor and reduction gearing in casing 10. In Fig. 2, pinion 32 is shown in mesh with gear 34 and the latter is connected by splined shaft 36 (Fig. 3) to the mechanism in lower casing 12. Axially resilient contacts 38 are adapted intermittently to make electrical contact with segments 44 and 46, and leafspring contacts 42 and 40 of casing section 10 (Fig. 2) are adapted to maintain continuous electrical contact with contact segment 46 and slip ring 48, respectively, of section 12. These contacts and segments form part of the remote-control mechanism to be described. Casing 12 has a flange 52 by means of which the switch can be attached to any convenient support.

In Fig. 4, axial terminal 20 is shown connected to one of the radial terminals 22 through radial selector contact 26, conical-ended element 54, and other intervening parts to be described.

Each terminal 22 has an inner coaxial conductor 56 for connection to the inner conductor of a coax line. A tongue 58 is suitably formed on each inner conductor 56 and this is wedged within forked inner, coaxial conductor 60 of the selector assembly as the selector rotates into the selected position. At right angles to inner conductor 60 and coaxial with terminal 20 is another inner coaxial conductor 62, formed with a necked-down, split end 61 fitting tightly within hole 63 in inner conductor 60. Each of the inner conductors 56, 60 and 62 are held in place by suitable dielectric material as shown. Dielectric portion 65 surrounds the stationary conductor 62 and is indexed with conductor 60 by which it is penetrated. The dielectric portion 64 in each terminal 22 has a shallow spherical concavity and the dielectric sleeve 66 surrounding conductor 60 is spherical-ended for uniform but close spacing from dielectric portion 64. There is a slot in the end of sleeve 66 to pass elements 58 during rotation and the axial bore of the sleeve is enlarged as at 67 to allow the forked portions of conductor 60 to spread. Metallic cylinder 68 encases sleeve 66 and forms a radial slide-bearing for contact 26.

Cylinder 68 is connected to element 54 by means of a transition piece 70 which is internally cylindrical to accommodate the dielectric 65 surrounding conductor 62, and which is squared externally. In contact with two of the parallel external surfaces of transition piece 70 are plates 72. At one end these plates are spaced apart and secured to plate 74 (Figs. 5 and 6) while at their opposite ends they are equally spaced, and secured to cylindrical contact 26, the base of which is externally squared. Stud 76 extending through a hole in plate 74 is rigidly supported by transition piece 70 and carries adjustable abutment in the form of nut 78 for compression spring 80, the opposite end of which bears against plate 74. It is by this means that selector contact 26 is forced outward radially for contact with the selected terminal 22. The cylindrical portion of contact 26 has axial slots 79 (Figs. 5 and 6) and its end 83 is made conical to fit into a conical seat 81 of each terminal 22. The camming action of the conical portions causes contact 26 to grip cylinder 68 firmly. This camming action also centers the selector assembly accurately, after the relatively rough positioning by coaction of detent 28 with notches 30 in ring 31.

For radially withdrawing contact 26 there is the following mechanism. Reversible split-phase motor 82 (Fig. 4) having capacitor 84 drives suitable reduction gearing including pinion 32, gear 34 and splined shaft 36 as previously mentioned. Other motors, preferably reversible, can similarly be used. Secured to the lower end of shaft 36 is Y-shaped member 86. Its two equal arms 88 (Fig. 5) are adapted to engage an associated shoulder 90 of plates 72. Arms 88 are shown in their normal position in Fig. 6, while in Fig. 5 they are shown in the partly operated position, assumed when detent 28 is almost fully retracted from notch 30. The normal position of Y-shaped member 86 is with its third arm 92 vertical, as in Fig. 5. Member 86 is retained in assembly with transition piece 70 by a plate 98 screwed at three points to extensions 70a of the transition piece (Figs. 4 and 5). Plate 98 supports curved rod 100 by means of studs 102 and a square spacer 104. Helical springs 94 and 96 surround rod 100 and are held in compression between spacer 104 and one of the studs 102.

Arm 92 has a U-shaped notch 106 closely embracing rod 100. Normally the arm is centered about spacer 104 by springs 94 and 96, arm 92 and spacer 104 being equal in length along rod 100. When arm 92 is displaced from its normal position, it compresses one of the springs 94 or 96, while the other remains confined between spacer 104 and its stud 102. Spring 80 is also compressed through coaction of an arm 88 with the radially retractable contact assembly, as described above. After detent 28 is sufficiently retracted from notch 30 as shown in Fig. 5, spring 94 acting on its stud 102 snaps plate 98, transition piece 70, contact 26 in its retracted position, coax elements 60, 66 and 68, dielectric portion 65 and rigidly associated spacer 104 through an angle of approximately 20° in the embodiment shown, during which springs 94 and 96 realign spacer 104 opposite arm 92. From that point until detent 28 reaches the next notch 30, the selector assembly is maintained in the retracted configuration by ring 31 against which detent 28 bears. After spring 94 (or 96) has snapped the selector assembly through the small arc described, the motor and drive gearing continues the indexing motion until detent 28 is forced by spring 80 into the succeeding notch 30. If the motor remains energized, the radially slidable assembly must again be withdrawn compressing springs 94 (or 96) and 80. The effect of overtravel of the motor, when de-energized after the selector assembly has reached the desired position, is merely to compress spring 94 or 96 without affecting the selector assembly, since arms 88 are normally spaced from shoulders 90 by 7° to 10° expressly for this purpose. Y-shaped member 86 is then centered by spring 94 or 96.

Following the preliminary 20° sweep, it is desirable that there should be a positive drive of the selector assembly in completing the indexing operation, to overcome any possible binding action of the mechanism, rather than to rely on the yielding motor drive through arm 92 and one of the springs 94, 96. For this purpose there is provided a plate 108 (Figs. 4 and 6) supported on plate 74 by means of pivot 110 (Fig. 6). At its upper end, plate 108 has a pair of cam surfaces 112 (Fig. 5) which are adapted to coact with a depending portion 114 of Y-shaped member 86. After the contact assembly has been withdrawn and during the last 20° travel affected by spring 94 or 96, depending portion 114 acts on cam 112 to tip plate 108 clockwise. When arm 92 is again centered by springs 94 and 96 opposite spacer 104, a notch 116 (Fig. 5) in the top of plate 108 between cams 112 is vertically aligned with portion 114. Spring 118 surrounding stud 120 on plate 74 and confined by nut 122 tips plate 108 so that portion 114 is embraced within notch 116. From this point on, so long as the selector assembly remains retracted, the motor drive through splined shaft 36 and Y-shaped member 86 acts positively to complete the indexing motion of the selector assembly. When detent 28 is forced into the next notch 30 by spring 80, plate 108 is carried away from portion 114 of Y-shaped member 86. The latter is thereby freed for the next indexing operation.

Remote control mechanism

Certain portions of the remote-control system have previously been described. These include axially resilient contacts 38, one allocated to each radial terminal, leaf spring brush contacts

40 and 42, commutator segments 44 and 46 and slip ring 48. These parts are shown not merely in Figs. 2 and 3, as previously mentioned, but also in Figs. 4 and 7. In Fig. 4, contact segments 44 and 46 are secured (as by rivets) to insulating disc 130. Insulating disc 134 spaces elements 46 and 48 from each other and an insulating washer 136 insulates ring 48 from washer 138 and nut 140. At one point disc 130 is recessed, and commutator segment 46 and disc 134 are apertured for lead 132 connecting segment 44 and ring 48. Nut 140 is threaded to sleeve 142, which extends through discs 130, 134 and 136 and is flanged at 144, to constitute a unitary assembly of contact commutator segments 44 and 46 and ring 48. This contact segment assembly is rotatable about bushing 146 which is fixed to plate 98, the bushing in turn being rotatable relative to shaft 36. A double-acting cam, here in the form of keyhole slot 150, is formed in disc 130 (Figs. 4 and 7) and upstanding pin 152 carried by the selector contact assembly (Fig. 6) works in this keyhole slot. The transition 151 between the large and small keyhole portions is advantageously at an angle of 30° to the radius. The working portion of the pin is an anti-friction roller 154 the diameter of which equals the narrow portion of the keyhole slot.

The operation of this contact structure will be understood after a study of the wiring diagram in Fig. 7. A two-gang manual selector switch 156, 158 may be provided for controlling the six-position coaxial selector switch heretofore described and a position indicator. Switch 158 has six positions with an indicator lamp 160 at each. Switch 156 also has six tap positions (A, B, . . . F) for connecting through a cable to connector 18 and to the respective axially resilient contacts 38. As illustrated in Fig. 7, the contacts 38 are identified by letters A', B', C', D', E', and F' corresponding to the tap positions of the switch 156. Two windings 162 and 164 of motor 82 are arranged for split-phase operation by means of capacitor 84.

When selector contact 26 is in any given position, as adjacent contact 38 (A'), the motor will not be energized provided that the selector arm of switch 156 is in the corresponding position (A). If it is desired to cause an indexing operation to position B, for example, selector switches 156 and 158 are moved to that position. The motor is then energized. From terminal 166 of the power line to terminal G of connector 18 and junction 168 of windings 162 and 164, one branch circuit extends through winding 164, capacitor 84, contact 40, slip ring 48, lead 132, segment 44, contact 38 (B'), selector 156 and through a relay 170 to line terminal 172. A separate branch of the circuit is established from line terminal 166 and junction 168 through motor winding 162 and contact 40, etc., to line terminal 172.

Relay 170 is energized concurrently with the motor circuit. The relay is provided with a pair of normally closed contacts 177 in series with the lamp circuit. So long as the motor is energized no lamp will light since contacts 177 remain open.

The motor causes indexing not only of selector contact 26, as previously described, but also causes indexing of the commutator segment unit 44, 46, etc. When selector contact 26 is radially projected at terminal 22 (B), an insulating element 176 or 178 will be opposite contact 38 (B) and the motor will be de-energized. These insu-

lating elements are provided to fill the gaps in track 50 between segments 44 and 46.

The motor is de-energized at the end of each indexing operation in an abrupt manner to prevent pitting of contacts 38 and of segments 44 and 46 at their edges. This is accomplished in the following manner. The initial action of the drive mechanism is to withdraw contact 26 inwardly, thereby carrying roller 154 toward the large diameter portion of keyhole 150 and disc 130. When contact 26 is indexed, in a snap-action initially, the selector assembly 44, 46, etc. lags by a short distance. This indexing travel, in which the lag is caused by the friction of contacts 38 on segments 44 and 46, forces roller 154 against the forward surface of the enlarged portion of keyhole 150. When detent 28 is just about to enter notch 30 (B), contact 38 (B') is still fully engaged with segment 44. Then because of the outward travel of roller 154 in keyhole 150, the contact assembly 44, 46, etc. is sharply indexed to bring insulating element 176 in line with contact 38 (B).

It might be desired to select terminal 22 (C) rather than 22 (B) starting from the (A) position. In that event the motor is not de-energized when the selector assembly moves into position (B). After engaging terminal 22 (B) contact 26 is again retracted and indexed until insulating element 176 is opposite contact 38 (C).

The remote-control system embodies a known arrangement for limiting the number of indexing operations to a minimum from any given starting position to any required destination. The motor circuit described above is for indexing the selector contact 26 and contact assembly 44, 46, etc. clockwise. The motor, however, operates in the reverse direction in indexing from A to F (or D or E). In that event, a different motor circuit is established, which is as follows. Starting with line terminal 166 and junction 168, winding 164 is energized not through capacitor 84 but through contact 42, segment 46, contact 38 (F), selector switch 156, relay 170 and line 172. Winding 162 is energized from terminal 166 and junction 168 through capacitor 84 and contact 142, etc. to terminal 172. With this circuit connection, the motor drive is the reverse of that for indexing the appropriate insulator 174 or 176 from position (A) to (B) or (C).

All of the illustrative circuit conditions described have started with the (A) position, but the principles of operation are the same starting from any of the other positions.

Spring contacts 38 are mounted on an insulating horseshoe-shaped member 180 which is in turn supported by stud spacers 182 on ring 31. Member 180 would ordinarily be an annulus, but is relieved opposite connector 18 to accommodate the wiring. When the casing sections are separated, spring contacts 38 no longer bear on segments 44 and 46 and that segment assembly may in that event be readily removed. With the casing sections assembled, however, the combined spring pressure of contacts 38 is transmitted through assembly 44, 46, etc., to plate 98, transition piece 70 and conical element 54. This assures firm contact between this conical element and its seat in terminal 20.

Insulation is not ordinarily provided between the casing and any of the terminals 20 and 22, but it may be added if required by the circuit conditions. Spring contact 184 (Fig. 4) is for the motor and capacitor sub-assembly and is provided for convenience in completing the circuits

when assembling the motor and reduction gearing and the wiring to connector 13.

Summary

The described coax selector switch which incorporates a radially movable outer conductor in the selector assembly has been found to be notably effective at ultra-high-frequencies, having a commendably low standing-wave-ratio. While a manual knob on shaft 36 may in some cases replace the motor driven, the remote-control feature as added forms an intimate part of the selector switch. The follow-up contact arrangement is improved by association with pin 152 of the radially movable selector contact. The radial motion of the selector-contact mechanism will be found desirable in switches of other than coax construction, and can even be advantageous for power frequencies and for direct-current circuits.

Among the many novel features of this useful switch are: the radially movable indexible contact, especially one that grips its slide bearing as it seats in the selected terminal, and that is associated with an inner, coaxial conductor; the resilient load on the motor during the start of indexing followed by the positive indexing drive whereby the motor is not subjected to a heavy starting load; and the interaction between the radially movable selector and the remote-control follow-up contact assembly for prevention of arcing at the follow-up contacts.

It is to be understood that various modifications and changes can be made in this invention without departing from the spirit and scope thereof as set forth in the appended claims.

What is claimed is:

1. A radio-frequency selector switch comprising a casing having a plurality of coaxial contact terminals radially disposed thereon, a central coaxial contact member axially disposed within said casing, and a radially disposed selector contact member associated with said central contact member and including a bearing member, a yieldably retractable outer conductor slidably mounted on said bearing member, and an inner coaxial conductor, said selector contact member being indexible to any selected one of said coaxial contact terminals, and said outer conductor being radially retractable preparatory to said indexing and radially projectable when said selector contact member is in the selected position, thereby to establish a firm contact with the selected contact terminal.

2. In combination in a selector switch, a plurality of coaxial terminals each having an inner conductor and an outer coaxial member insulated therefrom, said outer coaxial members having an inner end formed to define a frusto-conical seat, a selector assembly adapted to be indexed

to any of said contact terminals and having an inner conductor, an outer coaxial bearing member insulated from said inner conductor, and a slidable coaxial member embracing said bearing member and having a slotted frusto-conical end adapted to be wedged within the frusto-conical seat of the outer coaxial member of said contact terminals thereby to grip said bearing member and to form a firm union between said selector assembly and the selected contact terminal, and means for yieldably urging said slidable coaxial member into seated relation with said contact terminal when said selector assembly is in a selected position.

3. In a selector switch for use with ultra-high-frequency electromagnetic energy, the combination comprising a plurality of contact terminals, each said terminal having respective coaxial inner and outer conductors; a selector member adapted to be indexed to a selected one of said contact terminals and having a slidable outer coaxial member adapted to be seated within the outer coaxial member of said selected contact terminal and a rotatable inner conductor member adapted to engage the inner conductor of said selected contact terminal, means for yieldably urging said slidable member into seated relation, and control means for retracting said slidable member and for indexing said selector member to another of said contact terminals.

4. In a selector switch, the combination of a rotatively indexible selector element having a radially movable member, and a control system including driving means, resilient means connecting said driving means to said selector element, means connected to said driving means for radially retracting said movable member, and for simultaneously compressing said resilient means, said resilient means being operative upon retraction of said movable member to initiate indexing of said selector element, and means positively engaging said driving means and said selector element after said initiating action, whereby to complete said indexing operation.

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