June 24, 1952 C. W. CREASER, JR 2,601,372

ROTARY COAXIAL SWITCH

Filed Aug. 11, 1948

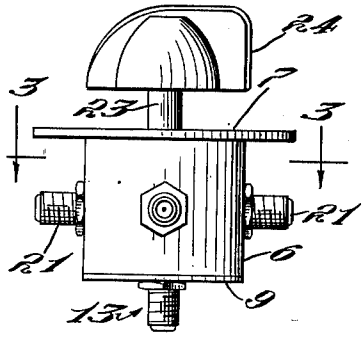


Fig. 1

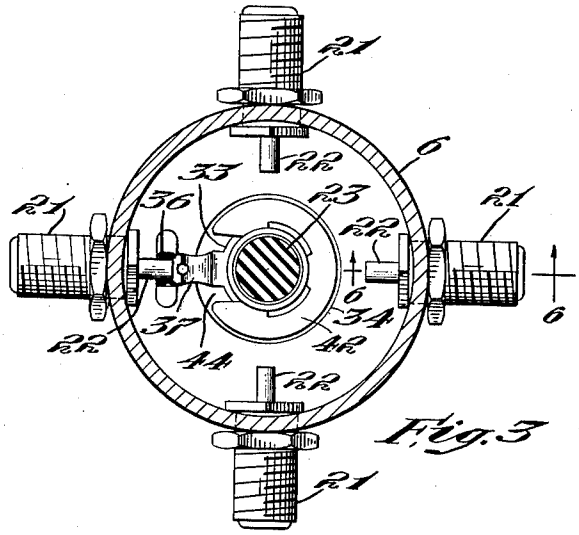


Fig. 3

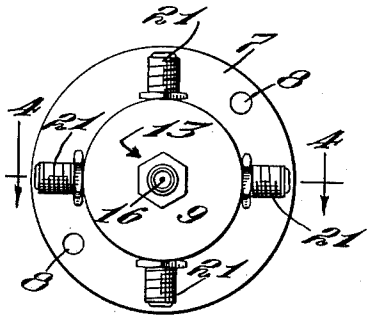


Fig. 2

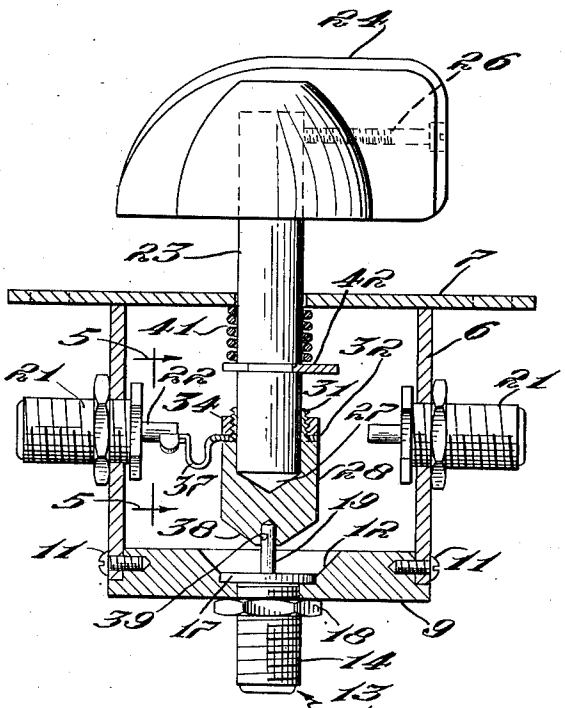


Fig. 4

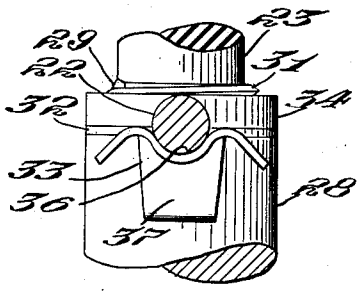


Fig. 5

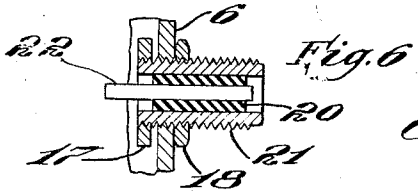


Fig. 6

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ROTARY COAXIAL SWITCH

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8 Claims. (Cl. 200—153)

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In high frequency communication system it is often desirable consecutively to establish connection, through a wave guide channel, between selected components of several groups of circuit elements. For example, because of the difficulty of obtaining consistent signal strength over the entire television frequency band with a single broad band antenna, more satisfactory reception may be obtained by providing a separate high gain antenna for each one of several television senders and by selectively connecting the television receiver to the respective antennas. Conversely, it is often desirable successively to connect the same antenna to several receivers, for example, to allow during experiments or sales demonstrations comparative observations of the quality of reception of the respective receivers under similar operating conditions.

Objects of this invention are to provide a switch which will selectively make coaxial conductor connections between a high frequency line and any one of a plurality of similar lines, which has a characteristic impedance matched to that of the connected lines, which is simple and positive in operation, which is small and attractive in appearance, which is economical to construct and maintain, and which advances the art of switch manufacture generally.

In a broad aspect the invention contemplates a multi-position switch comprising a hollow conductive body having an opening which is closed by a plate leading into the body, a plurality of coaxial lines having their outer tubular conductors conductively connected to the body and a coaxial line having its outer tubular conductor mounted on the plate with the ends of the inner conductors extending into the body, an assembly movable within the body having a conductive connecting portion frictionally engaging the inner conductor which is mounted on the plate and a contact portion conductingly joined to the connecting portion and resiliently fitting the end of each one of the inner conductors which extend into the body, and an actuator for switching the contact portion between adjacent inner conductors while the connecting portion remains in engagement with its inner conductor.

In another aspect, the hollow body of a switch of the above-indicated type has a cylindrical wall whereon are mounted a plurality of coaxial connectors for coupling the switch to respective coaxial lines. An additional connector is centrically located in a plate which closes one end of the body; each of the connectors has a projecting contact extending from the inner conductor

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within the body, whereas the inner conductor of the end plate connector is electrically connected to a rotatable assembly which is supported within the body. This rotatable assembly includes an operating means such as a dial knob and a movable arm for selectively making contact with the respective projecting inner conductors of the wall connectors. The configurations of the body and rotatable assembly are dimensioned relatively to each other so that the characteristic impedance of the switch is of substantially constant magnitude.

In a specific aspect the switch comprises a cylindrical wall whose open ends are closed by a cover plate and an end plate with a tapered aperture centrically located in its inner surface. A plurality of connectors are located in the wall in a plane normal to the wall axis and an additional connector is positioned in the tapered aperture of the end plate. Each of the connectors has a contact pin extending within the body from the inner conductor. Supported within the body is a rotatable assembly including an operating shaft with one end extending through an opening in the cover plate, the opposite end of the shaft being fastened to the end of a cylindrical member. The other end of the cylindrical member is conically shaped with a hole in the apex thereof for engaging the contact pin of the connector in the end plate. One end of a movable contact arm is fastened to the cylindrical member whereas the other end of the movable contact arm has a recess therein for engaging as a detent the respective contact pins of the wall connectors. A spring loop is interposed between the ends of the movable contact arm to insure adequate contact pressure. A collar is positioned circumjacent the shaft, the portion of the shaft between the collar and contacts being of insulating material. A spring is compressed between the collar and the cover plate to maintain the hole in the cylindrical member in engagement with the contact pin projecting from the end plate connector.

These and other objects and aspects of the invention will be apparent from the following detailed description of a typical embodiment thereof illustrated in the drawings in which:

Fig. 1 is a side elevation view of an embodiment of the invention;

Fig. 2 is a bottom view of the same embodiment;

Fig. 3 is a sectional view on line 3—3 of Fig. 1;

Fig. 4 is a sectional view on line 4—4 of Fig. 2;

Fig. 5 is a fragmentary cross sectional view on line 5—5 of Fig. 4; and

Fig. 6 is a fragmentary cross sectional view on lines 6—6 of Fig. 3.

As is shown in Fig. 1, a multiposition switch according to the invention has a hollow body with a cylindrical wall 6 and a cover plate 7 fastened to one end thereof by brazing or any other conventional means. Two holes 8 may be provided in the flange of the cover plate 7 as a means of mounting the switch. The opposite end of the wall 6 is closed by an end plate 9 which is fastened in position by the screws 11, each of which projects through a respective hole in the wall 6 to engage a threaded hole tapped radially in the end piece 9.

The end plate 9 is of sufficient depth to accommodate a centrically positioned aperture 12 having sides tapered in the manner described in detail hereinafter. Located at the center of the aperture 12 is a connector 13 for coupling the switch to a coaxial cable.

The connector 13 is of conventional construction, as shown in Fig. 6, for one of the side connections, having a threaded nipple 14 which acts as an outer conductor wherein a central conductor 16 (Fig. 2) is coaxially maintained in spaced relationship by a sleeve 20 of insulating material. One end of the nipple 14 has a flange 17 which cooperates with a check nut 18 to secure the connector 13 in the aperture 12. A contact pin 19 electrically connected to the central conductor 16 projects upwardly into the body to support a rotatable assembly which is described in detail below. Four similar connectors 21 (Fig. 6) each having a contact pin 22 projecting into the body are equally spaced in the wall 6 in a plane normal to the axis thereof.

The rotatable assembly comprises an operating shaft 23 of insulating material, one end of which projects through an opening in the cover plate 7 to engage an indicating knob 24. A set screw 26 holds the knob 24 on the shaft and prevents relative motion therebetween. The opposite end of the shaft 23 is secured in an aperture 27 in the upper end of the cylindrical member 28 by staking as at 29 (Fig. 5). The upper end of the cylindrical member 28 has a threaded portion 31 of reduced diameter which forms a supporting shoulder for an eye 32 at one end of a movable contact arm 33. The eye 32 is secured against the shoulder by a circular nut 34. The opposite end of the movable contact arm 33 is double ogee-shaped, the recess 36 formed thereby acting as a detent for maintaining the contact arm 33 in engagement with any selected one of the respective contact pins 22 of the wall connectors 21. To provide adequate detent force and to insure an electrical connection, a portion of the contact arm 33 between the ends thereof is bent into an open spring loop 37.

The lower end of the cylindrical member 28 is conically shaped as is 38 with a hole 39 in the apex thereof for engaging the projecting contact pin 19. To maintain adequate electrical contact and mechanical engagement of the pin 19 in the hole 39, a spring 41 is compressed between the inner surface of the cover plate 7 and a spring collar 42 which is clipped in an annular groove in the shaft 23.

By proper dimensioning of the above-described switch its characteristic impedance can be matched to the impedance of the connecting lines substantially to eliminate reflected waves.

Such characteristic impedance Zo for two conductors may be expressed generally by:

$$Zo=\sqrt{L/C}$$

where L and C are the inductance and capacitance, respectively, per unit length. For coaxially positioned conductors the characteristic impedance is expressed as follows:

$$Zo=(138/\sqrt{e})\log^{10}D/d$$

where

e=the dielectric constant of the insulating material;

D=the inside diameter of the outer conductor; and

d=the outside diameter of the inner conductor.

As the cylindrical wall 6 acts as one conductor located coaxially with respect to the conducting rotatable assembly, the approximate principal dimensions thereof for any desired characteristic impedance may be determined from the above formula. When the medium between the conductors is air, e=1.

When determining the distance between the collar 42 and the threaded top portion 31 of the cylindrical member 38 the dielectric constant of the insulating material of the shaft 23 must be taken into consideration.

The tapered portion 38 of the cylindrical member 28 and the adjacent taper of the wall of the aperture 12 in the end plate 9 provides a gradual electrical transition from the connector 13 to the rotatable assembly of the switch. These tapers are proportioned relatively to each other whereby any point on one tapered surface lies in the circumference of a circle in a plane normal to the axis of the cone formed by such surface and having a diameter proportioned with respect to the diameter of a circle concentric and coplanar with the first circle and passing through the point on the second tapered surface closest to the point on the first tapered surface so that the ratio of diameters when substituted in the above formula results in the desired characteristic impedance.

Because of the irregularities and multiplicity of dielectric paths present of necessity in any practical switch, laboratory checks may indicate that the mechanical dimensions of the switch must be modified somewhat to obtain electrical dimensions whereby the switch will have the required characteristic impedance.

A switch having the following pertinent dimensions has been found to match satisfactorily coaxial lines having a characteristic impedance of 70 ohms:

Internal diameter of wall 6	inches	1⅛
Internal length of body between plates 7 and 9	inches	1 1/16
Distance from contact pins 22 to cover plate 7	inch	½
Diameter of cylindrical member 28	do	⅜
Length of cylindrical member 28	do	½
Length of taper on cylindrical member 28	inch	9/32
Taper angle of cylindrical member 28	degrees	45
Greatest diameter of tapered aperture 12	inch	9/16
Angle of taper of wall 12	degrees	45
Lenth of portion of shaft 23 between washer 42 and cylindrical member 28	inch	5/32
Shaft dielectric constant		3.6–5.5

When a plurality of antennas are to be selectively connected to a single receiver, the an-

tenna lead-in cables are coupled to the wall connectors **21** by use of conventional mating couplings. The cable to the receiver input terminals is connected in an analogous manner to the connector **13** in the end plate **9**. These connections are reversed when a single antenna is to be selectively connected to a plurality of receivers. After installation the desired connection is made by turning the knob **24** to connect the movable contact arm **33** with the pin **22** of the connector **21** coupled with the cable from the selected antenna, or receiver, or other circuit element, as the case may be. By proper correlation of the indicia mark on the knob **24** with the movable contact **22**, it is possible to indicate to which of the coupled lines a connection is being made.

If the switch is to be remotely actuated, the knob **24** is removed and the shaft **23** rotated by a mechanical linkage, a stepping relay, a servo mechanism or any other similar means now conventional for this purpose.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A multiposition switch for selectively connecting a plurality of coaxial lines comprising a hollow body having an end plate with a tapered aperture centrically located in the inner surface thereof and a cylindrical wall with an end closed by the plate, a plurality of coaxial connectors for coupling said switch to the respective lines, each of said connectors having a projecting contact extending within said body, one of said connectors being located in the tapered aperture of the end plate, the remaining connectors being positioned in said wall in a plane normal to the wall axis, and a rotatable assembly supported within said body including operating means extending through the body end opposite said plate, a cylindrical member having a conically shaped end abutting the projecting contact of the end connector, and a movable contact arm positioned adjacent the opposite end of the cylindrical member for selectively making contact with the respective projecting contacts of the wall connectors, the taper of said aperture and said cylindrical member being proportioned relatively to each other so that the characteristic impedance of the switch is substantially of constant magnitude.

2. A multiposition switch for selectively connecting a plurality of coaxial lines comprising a hollow body having an end plate and a cylindrical wall with an end closed by the plate, a plurality of coaxial connectors for coupling said switch to the respective lines, each of said connectors having a projecting contact extending within said body, one of said connectors being centrically located in the end plate with its outer conductor electrically connected to the plate, the remaining connectors being positioned in said wall in a plane normal to the wall axis with their outer conductors electrically connected to the body, and a rotatable assembly supported within said body by the projecting contact of the end plate connector and including an operating shaft extending through the body end opposite said plate, a movable contact arm carried by the shaft for selectively making contact with the respective projecting contacts of the wall connectors, and a collar positioned circumjacent said shaft and electrically linked with said body, the portion of the shaft between said collar and said arm being of insulating material, the length of the shaft portion being proportioned with respect to the dielectric constant of the insulating material so that the characteristic impedance of the switch is of substantially constant magnitude.

3. A multiposition switch for selectively connecting a plurality of coaxial lines comprising a hollow body having an end plate, a cover plate and a cylindrical wall the ends of which are closed by the respective plates, a plurality of coaxial connectors for coupling said switch to the respective lines, each of said connectors having a projecting contact extending within said body, one of said connectors being centrically located in the end plate, the remaining connectors being positioned in said wall in a plane normal to the wall axis, and a rotatable assembly including a conducting member one end of which is pivotally mounted upon the projecting contact of the end plate connector to support the member within the body without coming into contact therewith, insulating means journaled in the cover plate and a movable contact arm electrically connected to said member for selectively making contact with the respective projecting contacts of the wall connectors, the distances from the moving contact arm to the respective plates being proportioned so that the characteristic impedance of the switch is substantially of constant magnitude.

4. A multiposition switch for selectively connecting a plurality of coaxial lines comprising a hollow body having an end plate and a cylindrical wall with an end closed by the plate, a plurality of coaxial connectors for coupling said switch to the respective lines, each of said connectors having a projecting contact extending within said body, one of said connectors being centrically located in the end plate, the remaining connectors being positioned in said wall in a plane normal to the wall axis, and a rotatable assembly supported within said body including operating means extending through the body end opposite said plate, a cylindrical member of conducting material having a conically shaped end abutting the projecting contact of the end connector to support the member within the body without coming into contact therewith, and a movable contact arm electrically connected to said member for selectively making contact with the respective projecting contacts of the wall connectors, the end of each projecting contact being spaced from the cylindrical member so that the characteristic impedance of the switch is substantially of constant magnitude.

5. A multiposition switch for selectively connecting a plurality of coaxial lines comprising a hollow body having an end plate, a cover plate having an opening therein and a cylindrical wall the ends of which are closed by the respective plates; a plurality of coaxial connectors for coupling said switch to the respective lines, each of said connectors having a projecting contact pin extending within said body, one of said connectors being centrically located in the end plate, the remaining connectors being positioned in said wall in a plane normal to the wall axis; and a rotatable assembly supported within said body including an operating shaft with one end extending through the cover plate opening, a cylindrical member with one end fastened to the opposite end of the shaft, the other end of the cylindrical member being conically shaped with a hole in the apex thereof for engaging the contact pin of the end connector, a movable contact arm for

selectively making contact with the respective projecting contacts of the wall connectors, a collar positioned circumjacent said shaft, and a spring compressed between said collar and said cover plate to maintain the engagement of said end connector contact pin in said apex hole.

6. A multiposition switch for selectively connecting a plurality of coaxial lines comprising a hollow body having an end plate and a cylindrical wall with an end closed by the plate, a plurality of coaxial connectors for coupling said switch to the respective lines, each of said connectors having a projecting contact pin extending within said body, one of said connectors being centrically located in the end plate, the remaining connectors being positioned in said wall in a plane normal to the wall axis, and a rotatable assembly including a conducting member one end of which is pivotally mounted upon the projecting contact of the end plate connector to support the member within the body without coming into contact therewith, an operating shaft of insulating material attached to the other end of the member, a movable contact arm electrically connected to said member for selectively making contact with the respective projecting contact pins of the wall connectors, one end of said contact arm being fastened to said shaft, the other arm end having a recess therein for engaging the wall connector pins as a detent, and a spring loop interposed between said arm ends to insure adequate contact pressure.

7. A multiposition switch for selectively connecting a plurality of coaxial lines comprising a hollow body having an end plate with a tapered aperture centrically located in the inner surface thereof, a cover plate having an opening thereon and a cylindrical wall the ends of which are closed by the respective plates, a plurality of coaxial connectors for coupling said switch to the respective lines, each of said connectors having a projecting contact pin extending within said body, one of said connectors being centrically located in the tapered aperture of the end plate, the remaining connectors being positioned in said wall in a plane normal to the wall axis, and a rotatable assembly supported within said body including an operating shaft with one end extending through the cover plate opening, a cylindrical member with one end fastened to the opposite end of the shaft, the other end of the cylindrical member being conically shaped with a hole in the apex thereof for engaging the contact pin of the end plate, a movable contact for selectively

making contact with the respective projecting contact pins of the wall connectors, one end of said contact being fastened to the cylindrical member shaft end, the other end having a recess therein for engaging the respective wall connector contact pins as a detent and a spring loop interposed between said ends to insure contact pressure, and a collar positioned circumjacent said shaft with a radial slot in alignment with said movable contact, the shaft portion between said collar and said contact being of insulating material, and a spring compressed between said collar and said cover plate.

8. A multiposition switch for selectively connecting a plurality of coaxial lines comprising an essentially cylindrical hollow conductive body, the openings of which are closed by conductive plates, a plurality of coaxial lines one of which has its outer tubular conductor conductively connected to one of said plates, the outer tubular conductors of the other coaxial lines being conductively connected to the body; insulators for mounting the inner conductors of said coaxial lines within said outer conductors on said body and said plate respectively with the ends of the inner conductors extending into the body; a rotatable assembly including a conductive connecting portion one end of which is pivotally mounted upon the inner conductor on said plate to support the portion within the body without coming into contact therewith and an insulating bearing portion attached to the other end of the conductive connecting portion and journaled in the other plate, said conductive connecting portion having a contact conductingly joined thereto which selectively makes a resilient connection with the ends of the inner conductors which are mounted on said body; and an actuator attached to the insulated bearing position for transferring said contact portion from one to another of the inner conductors while the connecting portion remains in engagement with its inner conductor.

CHARLES W. CREASER, JR.

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