May 1, 1951 G. G. GREENE 2,550,921

SLIDING COAXIAL SWITCH

Filed Aug. 11, 1948

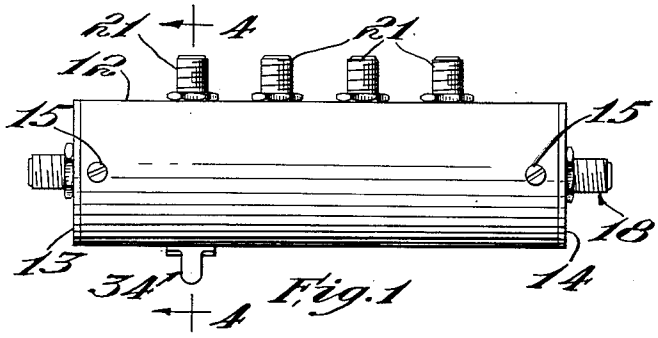


Fig. 1

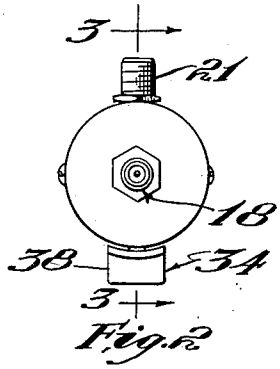


Fig. 2

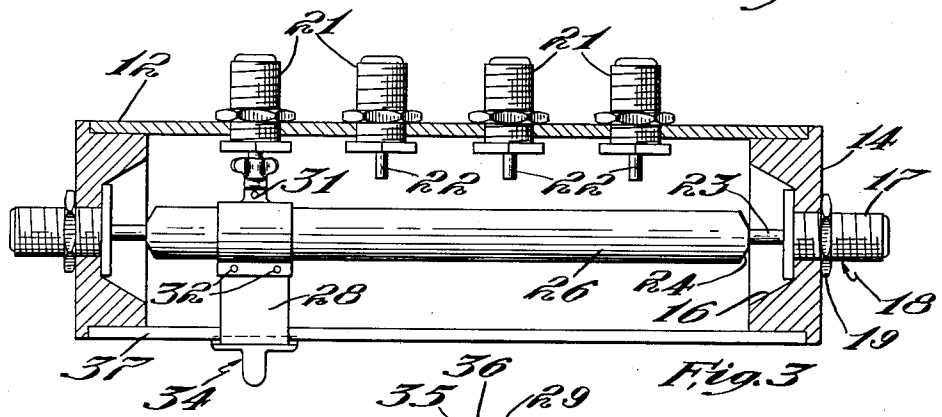


Fig. 3

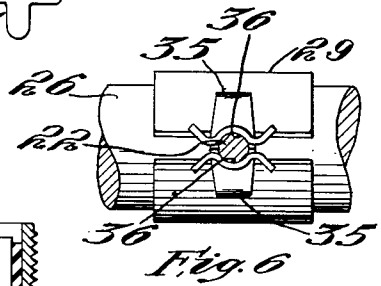


Fig. 6

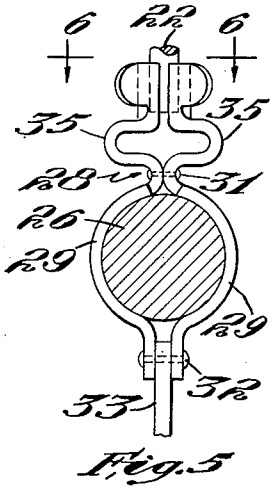


Fig. 5

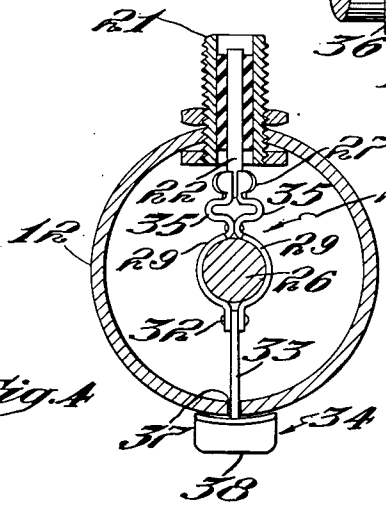


Fig. 4

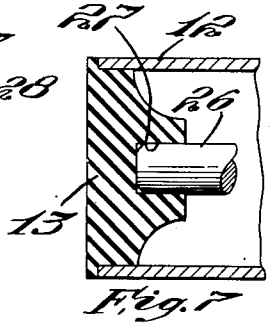


Fig. 7

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SLIDING COAXIAL SWITCH

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1

In high frequency communication systems it is often desirable consecutively to establish connection, through a wave guide channel, between selected components of several groups of circuit elements. Such elements are for example those of the antenna on the one hand and receiver or transmitter of television and frequency modulation systems on the other hand. To eliminate reflected waves, it is a common practice to couple the antenna and receiver by means of a coaxial cable having a characteristic impedance which is substantially the same as that of the connected antenna. The matching of the characteristic impedance of the receiving elements introduces difficulties when, for example for sales demonstration purposes, several receivers are to be successively connected to the same antenna, or conversely when, to improve signal strength, a receiver is selectively connected to one of a plurality of receiving antennas.

Objects of this invention are to provide a switch which will selectively connect one of a plurality of coaxial cables with any one of the remaining cables, which has the same characteristic impedance as the connected cables, which can be connected at the end or in an intermediate position in the connected cable, which can be used in conjunction with conventional high frequency elements, which is simple to operate, which is small and compact, which will accommodate any number of lines, which is economical to construct, 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, a plurality of coaxial lines leading into the body 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 with its ends closed by end plates and supporting a plurality of coaxial connectors each having a projecting contact extending within the body used to couple the switch to the respective coaxial lines. A connector is centrically located in one or each of the end plates, the remaining connectors being positioned in the wall of the body. A movable assembly is supported within the body and electrically connected to the projecting contact of the end plate connector. This assembly includes an operating means and a movable arm for selectively making contact with the respective projecting contacts of the wall connectors. The configurations of the body and movable assembly are dimensioned relatively to each other so that the characteristic impedance of the switch is of substantially the same magnitude as that of the connected lines.

2

In one specific aspect the switch according to the invention comprises a hollow body having a cylindrical wall, the ends of which are closed respectively by two end plates and a plurality of connectors for coupling the switch with the respective coaxial lines. A connector is positioned in a tapered aperture centrically located in the inner surface of each of the respective end plates. The remaining connectors are positioned in the body wall in a plane passing through the axis thereof. A cylindrical member is supported coaxially within the body wall. Each end of the member is conically shaped with a hole in the apex thereof for engaging a contact pin projecting into the interior of the body from the respective connectors located in the end plates. A slidable assembly is supported within the body upon the cylindrical member so that a recess in one end of a movable contact arm selectively makes with the respective contact pins projecting within the body from the wall connectors. The other end of the contact arm is fastened to an operating handle which projects out through a slot in the body wall located diametrically opposite the wall connectors. A spring loop is interposed between the ends of the contact arm to insure adequate electrical contact pressure.

In another specific aspect of the invention, one end of the cylindrical wall is closed by an end plate having a tapered aperture wherein is centrically located a connector. An insulating cover plate, having a recess wherein is supported one end of the cylindrical member, closes the opposite end of the wall. The other end of the member is conically shaped with a hole in the apex thereof for engaging the contact pin of the end plate connector. A slidable assembly is supported within the body upon the cylindrical member so

that a recess in one end of a movable contact arm selectively makes with the respective contact pins projecting from the wall connectors. The other end of the contact arm is fastened to an operating handle which projects out through a slot located in the body wall diametrically opposite the wall connectors. A spring loop is interposed between the ends of the contact to insure adequate electrical contact pressure.

In all these embodiments the relative diameters of the wall and the cylindrical member and the relative tapers of the end plate and the end of the cylindrical member are proportioned so that the characteristic impedance of the switch is of substantially the same magnitude as that of the connected coaxial lines.

These and other objects and aspects of the invention will be apparent from the typical embodiment thereof illustrated in the accompanying drawing in which:

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

Fig. 2 is an end elevation view of the same embodiment;

Fig. 3 is a cross sectional view on line 3—3 of Fig. 2;

Fig. 4 is a cross sectional view on line 4—4 of Fig. 1;

Fig. 5 is an enlarged fragmentary cross sectional view of the slidable assembly;

Fig. 6 is a cross sectional view on the line 6—6 of Fig. 5; and

Fig. 7 is a fragmentary cross sectional view of another embodiment of the invention.

The body of the switch shown in Fig. 1 comprises a cylindrical wall 12 each end of which is closed by a respective end plate 14 secured by the screws 15. Located in a tapered aperture 16 centrically positioned in each of the respective end plates 14 is a flanged nipple 17 of a conventional coaxial connector 18. A check nut 19 secures each of the connectors 18 in their respective aperture 16. The taper of the side walls of each of the apertures 16 is proportioned in a manner to be described in detail hereinafter.

A plurality of similar connectors 21 are secured in the wall 12 in a plane passing through the wall axis. These connectors 21 are secured by check nuts in a manner analogous to that by which the connectors 18 are secured in the end plates 14. Although four connectors 21 are shown in Figs. 1 and 3, it will be understood that one of the principal advantages of this type of switch is that by suitably increasing the length of the wall 12, any desired number of connectors 21 can be secured therein.

A plurality of contact pins 22, each of which is electrically connected to the central conductor of the respective connector 21, projects within the interior of the switch body. A similar contact pin 23 projects from each of the respective end plate connectors 18 to support a cylindrical conducting member 26. The pins 23 can be formed as an integral extension of the tapered ends 24 of the cylindrical member 26; or can project into a hole in each apex thereof and be attached by any conventional means, for example soldering or brazing.

A slidable assembly 28 (shown in detail in Figs. 4, 5 and 6) is movably supported upon the cylindrical member 26 so that its contact arm 27 selectively makes with the respective pins 22 which project from the wall connectors 21. The arm 27 comprises two identical strip pieces 29 of berryllium bronze or other material having similar characteristics, maintained in juxtaposed relationship by means of the rivets 31 and 32. The rivets 32 also pass through the end of the extension 33 of a nonconducting operating handle assembly 34. The portion of each piece 29 between the rivets 32 and 31 is formed in the shape of a semicircle so that surface to surface contact is made with the cylindrical member 26. As is best shown in Fig. 6, the ends of each piece 29 abutting the contact pin 22 are in the shape of a double ogee, the recess 36 formed thereby cooperating with the similar recess of the juxtaposed piece to provide a detent. The portion of each piece 29 located between the ogee-shaped end and the rivet 31 is of reduced width and is bent to form a spring loop 35, thereby insuring both the proper locking action of the detent and providing adequate electrical contact pressure.

The handle extension 33 projects through a slot 37 cut in the cylindrical wall 12 diametrically opposite the wall connectors 21. Molded integrally with the extension 33 is a knob 38 curved generally to conform with the outer contour of the wall 12 and having a projection which can be grasped by the fingers of an operator to move the slidable assembly 28.

To match the characteristic impedance Zo of the connecting lines the dimensions of the switch must be proportioned so that

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

where L and C are the distributed inductance and capacitance per unit length respectively.

As the dielectric constant of air is unity; the relation of the diameters of the cylindrical member 26 and the wall 12 are given by the formula

$$Z_0=138\ \log_{10}D/d$$

where D is the inner diameter of the outer conductor; and d is the outer diameter of the inner conductor.

The surface 16 of each of the end pieces 14 is tapered relatively to the taper of the correlated conical end 24 of the cylindrical member 26 so that any point on one of the tapered surfaces 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 other tapered surface closest to the point on the first tapered surface whereby the ratio of diameters when substituted in the above formula results in the desired characteristic impedance.

It is also within the scope of this invention to provide a switch with a connector 18 in one end only. With such an arrangement, the opposite end of the wall 12 is closed as is shown in Fig. 7 by an insulating cover plate 13. In this embodiment the end of the cylindrical member 26 engages a recess 27 in the cover plate 13 so that the member 26 is supported coaxially with respect to the inner surface of the wall 12. The construction of the remainder of the switch is identical with that of the first embodiment, the location of the wall connectors 21 and the details of the end plate 14 being the same as the analogous parts described in connection with the switch shown in Fig. 1.

The switch is installed by connecting the branch lines having the same characteristic impedance as the switch to the respective wall connectors 21 by means of conventional mating

couplings. Whenever the leads are selectively to be connected to an intermediate point in the main feeding lead, a switch such as is shown in Fig. 1 is installed by cutting the main lead and connecting the two resulting ends to the respective end connectors 18 by means of couplings similar to those mentioned above. Whenever the branch leads are selectively to be connected to the end of a main lead, the end connector 18 of a switch such as shown in Fig. 6 is connected to the end of the main line.

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 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 through the wall axis, a supporting member mounted within said body by the projecting contact of the end plate connector, and a slidable assembly carried by said supporting member and including operating means and a movable contact arm for selectively making with the respective projecting contacts of the wall connectors, the dimensions of the wall and the supporting member being proportioned relatively to each other so that the characteristic impedance of the switch is of substantially the same magnitude as that of the connected lines.

2. 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 through the wall axis, a cylindrical member having a conically shaped end abutting the projecting contact of the end connector, and a slidable assembly supported within said body and including operating means extending through the body wall, and a movable contact arm positioned circumjacent the cylindrical member for selectively making 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 of substantially the same magnitude as that of the connected lines.

3. 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 through the wall axis, a cylindrical member having a conically shaped end abutting the projecting contact of the end connector, and a slidable assembly supported within said body and including operating means extending through the body wall and a movable contact arm for selectively making with the respective projecting contacts of the wall connectors, the end of each projecting contact of the respective wall connectors being spaced from the cylindrical member so that the characteristic impedance of the switch is of substantially the same magnitude as that of the connected lines.

4. A multiposition switch for selectively connecting a plurality of coaxial lines comprising a hollow body having two end plates, and a cylindrical wall with a longitudinal slot therein, the ends of said wall being 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 each of the respective end plates, the remaining connectors being positioned in said wall in a plane passing through both the wall slot and the wall axis; a cylindrical member having conically shaped ends, each with a hole in the apex thereof for engaging the contact pin of the respective end plate connectors; and a slidable assembly supported within said body including an operating handle with one end extending through the wall slot, and a movable contact arm fastened to the opposite handle end and slidably engaging said cylindrical member for selectively making with the respective projecting contacts of the wall connectors.

5. A multiposition switch for selectively connecting a plurality of coaxial lines comprising a hollow body having an end plate, a cover plate of insulating material having a recess therein and a cylindrical wall having a longitudinal slot therein, the ends of said wall being 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 passing through both the wall slot and the wall axis; a cylindrical member with one end engaging the cover plate recess, 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 connector; and a slidable assembly supported within said body including an operating handle with one end extending through the wall slot, and a movable contact arm fastened to the opposite handle end and slidably engaging said cylindrical member for selectively making with the respective projecting contacts of the wall connectors.

6. A multiposition switch for selectively connecting a plurality of coaxial lines comprising a hollow body having a cylindrical wall with a longitudinal slot therein, and an end plate closing one end of said wall, 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 passing through both the wall slot and the wall axis, a cylindrical member coaxially located within said body, and

a slidable assembly supported within said body upon said cylindrical member and including an operating handle with one end extending through the wall slot and a movable contact arm for selectively making with the respective projecting contact pins of the wall connectors, one end of said contact arm being fastened to the opposite end of said handle, the other arm end having a recess therein for engaging selectively the respective wall connector contact 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 two end plates, each with a tapered aperture centrically located in the inner surface thereof, and a cylindrical wall having a longitudinal slot therein and ends closed by the respective end 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 each of the respective end plates, the remaining connectors being positioned in said wall in a plane passing through both the wall slot and the wall axis, a cylindrical member having conically shaped ends, each with a hole in the apex thereof for engaging the contact pin of the respective end plate connectors, and a slidable assembly supported within said body by the cylindrical members, said assembly including an operating handle with one end extending through the wall slot, a movable contact arm for selectively making with the respective projecting contact pins of the wall connectors, one end of said contact arms being fastened to the opposite end of said handle, the other arm end having a recess therein for engaging the wall connector contact pins as a detent and a spring loop interposed between said arm ends to insure adequate contact pressure.

8. 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, an insulating cover plate having a recess therein, and a cylindrical wall having a longitudinal slot therein and ends 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 passing through both the wall slot and the wall axis; a cylindrical member with one end engaging the cover plate recess, 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 connector; and a slidable assembly supported within said body by the cylindrical member, said assembly including an operating handle with one end extending through the wall slot, a movable contact arm for selectively making with the respective projecting contact pins of the wall connectors, one end of said contact arms being fastened to the opposite end of said handle, the other arm end having a recess therein for engaging the wall connector contact pins as a detent and a spring loop interposed between said arm ends to insure adequate contact pressure.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,018,356	Hastings	Feb. 20, 1912
1,443,098	Smith	Jan. 23, 1923
1,997,158	Thomas	Apr. 9, 1935
2,426,186	Dow	Aug. 26, 1947