June 24, 1958 C. F. SCHUNEMANN ET AL 2,840,786

COAXIAL SWITCH

Filed Jan. 19, 1952

Fig. 1

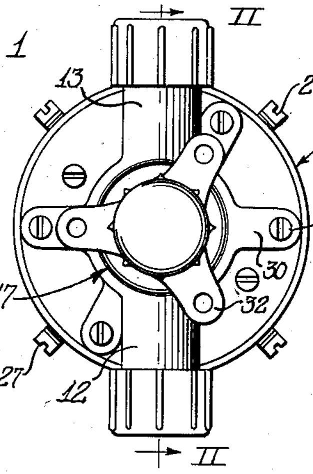


Fig. 4

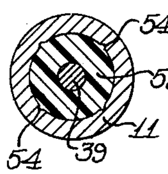


Fig. 5

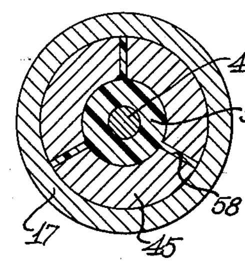


Fig. 2

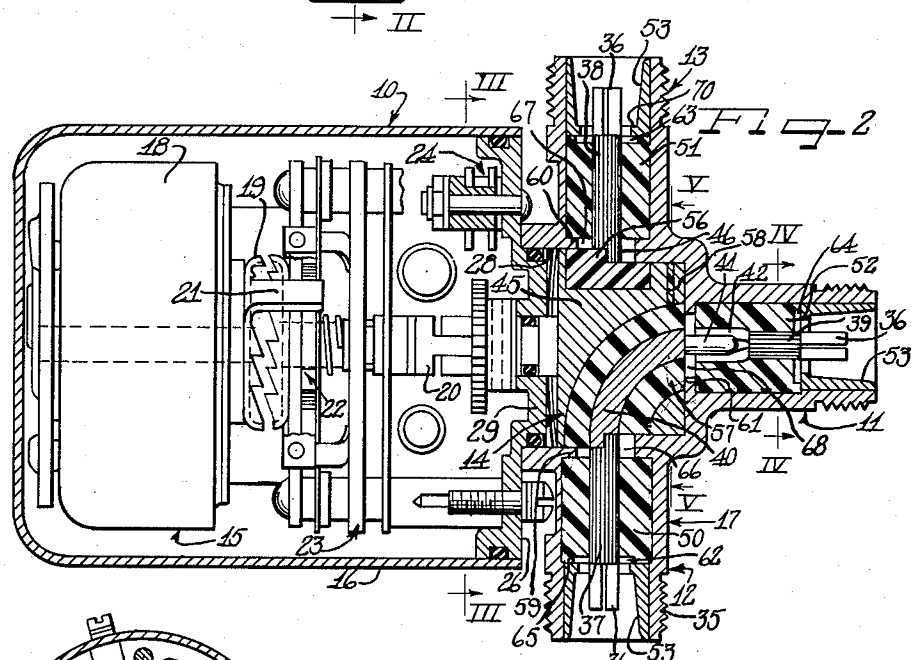
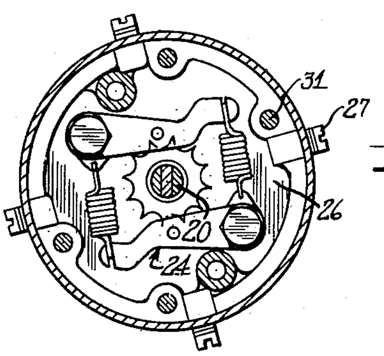


Fig. 3



Inventors
Carl F. Schunemann
Theodore R. Thoren
by Hill, Sherman, Meroni, Gross & Simpson Attys

United States Patent Office

2,840,786

Patented June 24, 1958

1

2,840,786

COAXIAL SWITCH

Carl F. Schunemann, East Cleveland, and Theodore R. Thoren, Russell Township, Geauga County, Ohio, assignors to Thompson Products, Inc., Cleveland, Ohio, a corporation of Ohio

Application January 19, 1952, Serial No. 267,246

2 Claims. (Cl. 333—7)

This invention relates to a coaxial switch, and, more particularly, to the coaxial switch head assembly.

It is an object of this invention to provide a coaxial switch which will exhibit excellent mechanical performance and which, at the same time, will have the required electrical performance as judged on the basis of voltage standing wave ratio, cross talk and insertion loss.

Mechanically, a switch may be required to satisfactorily undergo more than 10,000 actuations and may be required to operate satisfactorily under vibration, shock, low temperatures, high temperatures, sand and dust, humidity and high altitudes.

Another object of the invention is to provide a coaxial switch which will operate satisfactorily under the above enumerated conditions.

Still another object of the present invention is to provide novel means for adjusting the electrical properties of a coaxial switch.

Another and further object of the present invention is to provide means for mounting an inner conductor elbow in a switch rotor.

Still another and further object of the present invention is to provide means for mounting inner conductors in the switch body.

Other and further important objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

On the drawings:

Figure 1 is an end elevational view of a coaxial switch embodying novel features of the present invention;

Figure 2 is a longitudinal sectional view taken substantially along the line II—II of Figure 1;

Figure 3 is a cross-sectional view taken substantially along the line III—III of Figure 2;

Figure 4 is a cross-sectional view taken substantially along the line IV—IV of Figure 2; and

Figure 5 is a cross-sectional view taken substantially along the line V—V of Figure 2.

As shown on the drawings:

In Figures 1 and 2, a coaxial switch **10** is disclosed of the single-pole type, by way of illustration. It will, of course, be understood that the novel principles and teachings of the present invention may also be applied, for example, to a double-pole type switch.

In the particular switch shown, an axial terminal **11** is to be selectively connected to one of a pair of radial terminals **12** and **13** by means of a switch rotor **14** which is mounted for rotation about an axis contiguous with the axis of terminal **11**.

The switch rotor **14** is driven by means of a step-by-step actuating mechanism **15** which is mounted in a cup housing **16** secured to the switch head assembly body or stator **17**. The actuating mechanism, which forms no part of the present invention, includes generally a solenoid motor **18**, driving jaws **19** and a drive shaft **20** connecting with the switch rotor **14**. The arm **21** cooperates with an interrupter mechanism **22** to deenergize the solenoid motor after each step thereof. The switch mechanism **23** controls the movement of the switch rotor to one of its two preselected switching positions.

As best seen in Figure 3, a detent mechanism **24** serves to center the shaft **20** for precise location of the switch rotor **14** in one of the preselected switching positions.

An end plate **26** seals the open end of the cup housing **16** and is retained therewith by means of screws **27** shown in Figure 1. The switch head body **17** has a large diameter cylindrical bore for receiving a central boss **29** of the end plate **26**. Transverse flanges **30** and screws **31**, Figure 1, serve to connect the switch head body **17** to the end plate **26**. The entire switch may be mounted by means of the radiating mounting arms **32** which are best seen in Figure 1.

For purposes of attachment of coaxial cables to the terminals of the switch head, the terminals are externally threaded as indicated at **35**. The split prongs **36** of inner conductors **37**, **38** and **39**, are adapted for receiving the inner conductors of coaxial cables attached to the switch. The switch rotor carries an inner conductor elbow **40** for making circuit between the axial inner conductor **39** and one of the radial inner conductors **37** and **38**. For permitting rotation between the inner conductor elbow **40** and the axial inner conductor **39**, the inner conductor elbow **40** is provided with an axial pin **41** for rotation within the prongs **42** of the axial inner conductor **39**. For greater contact between the radial inner conductors **37** and **38** and the inner conductor elbow **40**, the inner conductors and the elbow have complementary transversely extending semi-circular notches so that the inner conductors and the elbow will overlap when registered. To accommodate rotation of the rotor **14**, the generally cylindrical metallic plug **45** of the rotor **14** has a reduced diameter to correspond to the spacing between the overlapping ends **46** of the radial inner conductors **37** and **38**. The switch body **17** has a reduced bore portion closely receiving the reduced diameter half of the switch rotor **14**.

Heretofore, it has been felt necessary in the coaxial switch art to have the insulating sleeves mounting the inner conductors made of the same material as that mounting the inner conductor elbow. According to the present invention, however, it has been found that the utilization of different dielectric materials improves the mechanical performance of the switch as well as the electrical characteristics of the switch.

Particularly advantageous results have been obtained by the use of Polytetrafluoroethylene resin for the insulating sleeves **50**, **51** and **52** which are used to mount the inner conductors 37, 38 and 39. This material, which is commonly referred to as "Teflon," is satisfactory over the temperature range involved, has a low dielectric constant (approximately 2.2) and has low power loss. Since "Teflon" has a coefficient of thermal expansion of about 10 times that of steel or brass, it can be cooled to a low temperature and dropped into the terminal bores or passages. In order to prevent rotation of the "Teflon" sleeve, axial grooves **54** are formed in the inner walls of the terminals into which the "Teflon" will be extruded upon return to room temperature, as best seen in Figure 4. Thus the sleeves are retained against rotation even when subjected to low temperatures. The adaptor inserts **53** are force fitted into the terminal openings and retain the sleeves against outward displacement axially of the terminal bores. The ends of the sleeves **50**, **51** and **52** have recesses **62**, **63** and **64** therein with annular shoulders **65** abutting the inserts **53**. As shown in Figure 4, the grooves **54** may be four in number. In the particular switch illustrated, the grooves may be from .010 to .014 inch deep and 11/16" in length.

The rotor plug in its peripheral face has a circular recess into which may be molded a disk of insulating material indicated by the reference numeral **56**. The function of this disk **56** is to prevent contact between the inner conductor which is not registered with the arcuate conductor **40** and the plug **45**. The material of this plug may be any suitable insulating material which will prevent cross talk in the switch to the desired degree.

The inner conductor **40** is mounted in the rotor plug **45** by molding the insulating material therearound. The insulating elbow **57** thus formed serves to insulate the conductor **40**.

Since "Teflon" cannot be molded into a metal structure, advantage of its low power loss cannot be taken in the switch rotor. It has been found that advantageous results can be obtained by the use of Polytrifluorochloroethylene resin. This material, which is commonly known as "Kel–F," has the desired temperature characteristis and can be molded. Furthermore, the "Kel–F" section dielectric constant approximately 2.3 is matched with that of "Teflon" by proper selection of relative diameters so as to minimize the discontinuity introduced by the use of different dielectric materials in the stator and rotor.

It has been discovered that the insulating elbow **57** may be advantageously retained in place by drilling a number of holes radially into the rotor plug as indicated in Figures 2 and 5 by the reference numeral **58**. When the insulating material is molded in the rotor, it extrudes into these holes to firmly hold the insulating elbow **57** in place. It has further been discovered that by the proper selection of the location of these holes **58**, the electrical characteristics of the switch can be improved, as will hereinafter be explained.

It is believed that improved electrical characteristics are obtained by the proper selection of the location of the holes **58** in the rotor plug **45**. It has been previously established that certain discontinuities in the conductors of a coaxial cable may be considered as capacitance shunting a transmission line or principle-wave equivalent circuit at the discontinuity. Such discontinuities occur between the outer conductor of the stator and the outer part of the rotor if mechanical clearance is provided. Such capacitance effect is also obtained where there is a discontinuity in dielectric material. Further, where there are changes in the diameter of one of the conductors, an effect occurs equivalent to that of a capacity shunting the line. Thus, in the present switch there would be an effective capacitance shunting the line at each end of the shoulders **59**, **60** and **61** representing changes in the diameter of the outer conductor and further capacitance between the stator and the rotor portions of the outer conducotrs representing the mechanical clearance therebetween. It has been found that the holes **58** in the rotor plug likewise act as capacitances across the line. If, however, this capacitance effect produced by holes **58** is located an odd multiple of quarter wave lengths from the other capacitance effects, the capacitance introduced by these holes will tend to subtract from the capacitance introduced by the shoulders **59**, **60** and **61** and the capacitance produced by the mechanical clearances between the stator and rotor; and this would tend to reduce deflection along the line and thus reduce the standing wave ratio. For example, if at a particular frequency the rotor path is about one wave length, and if the holes **58** are located at one-quarter of a wave length from one end, a beneficial effect would be obtained.

A further important discovery has been made, namely, that advantageous mechanical and electrical results are obtained by spacing the inner conductor sleeves **50**, **51** and **52** from the insulating elbow **57** by means of annular shoulders **59**, **60** and **61**. These shoulders not only limit the axially inward expansion of the sleeves **50**, **51** and **52**, which might occur due to temperature changes, and provide the necessary clearance spaces **66**, **67** and **68** between the rotor and the sleeves **50**, **51** and **52**, but the shoulders have also been found to improve the electrical performance of the switch when the dimensions of the shoulders are properly selected. In particular, it is believed that the spaces **66**, **67** and **68** comprise air match sections for minimizing undesired electrical effects such as reflection due to the change in dielectric and due to the necessary clearance between the stator insulating sleeves **50**, **51** and **52** and the rotor insulation sleeve **57**. In the embodiment disclosed, the air match is achieved by dimensioning the air sections provided by the shoulders **59**, **60** and **61** to have characteristic impedances closely approximating those of the adjacent matched dielectric filled sections of the switch.

There is thus provided according to the present invention a rotary coaxial switch in which the superior electrical characteristics of "Teflon" are utilized as the stator insulation while the slightly different, but moldable, "Kel–F" is used in the rotor.

It will, of course, be understood that various details of construction may be varied through a wide range, depending upon the conditions, without departing from the principles of this invention, and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

We claim as our invention:

1. In a coaxial switch having a stator including an outer conductor and a generally solid plug-type rotor having a passage therein whose wall provides an outer conductor and wherein the clearance between said stator outer conductor and said rotor outer conductor introduces a capacitance effect at a given frequency, the improvement which comprises said rotor having a hole opening into said rotor passage approximately an odd multiple of quarter wave lengths from the clearance between said stator outer conductor and rotor outer conductor to provide a capacitance effect opposing the capacitance effect introduced at the clearance.

2. A coaxial switch for operation with signals of a predetermined wave length comprising a stator having a rotor mounted therein, a plurality of coaxial lines extending into said stator and terminating in proximity to said rotor, said rotor having an interior surface defining an outer conductor passage extending between exterior surface portion of said rotor, an inner conductor extending within said outer conductor passage of said rotor, and a body of dielectric material supporting said inner conductor within said outer conductor passage, said interior surface having a cylindrical bore communicating with said outer conductor passage intermediate the ends of said passage and extending to an exterior surface portion of said rotor, and dielectric material integral with said body of dielectric material and extending within said cylindrical bore, said cylindrical bore intersecting said outer conductor passage substantially an odd multiple of a quarter wave length from one end of said outer conductor passage to provide a capacitance effect opposing the capacitance effect introduced at the discontinuity between said one end of said outer conductor passage and the outer conductors in said stator cooperating therewith.

(References on following page)

References Cited in the file of this patent

UNITED STATES PATENTS

2,066,802	Rowntree et al.	Jan. 5, 1937
2,358,499	Fiedler	Sept. 19, 1944
2,401,863	Espley	June 11, 1946
2,427,940	Ayers	Sept. 23, 1947
2,488,419	Lindenblad	Nov. 15, 1949
2,546,976	Clark et al.	Apr. 3, 1951
2,565,643	Baddour	Aug. 28, 1951

OTHER REFERENCES

"Plastics Bulletin," vol. 12, No. 46, 1950, page 185, published at Wilmington, Delaware by the Polychemicals Dept., E. I. du Pont de Nemours & Co., 174/110.6.

"Product Engineering Bulletin," No. 52, 1954, page 2, published at Wilmington, Delaware by the Polychemicals Dept., E. I. du Pont de Nemours & Co., 174/110.6.

"Cold Treating Practice with Deepfreeze," Motor Products Corp., copyright 1946, pages 23–28.

"Modern Plastics," June, 1946, pages 134 and 135. (Copy in Scientific Library and Div. 37.)

KEL–F Technical Bulletin # 2–1–49, published January 1949, by M. W. Kellogg Co. (Copy in Div. 50.)