Sept. 23, 1947. J. J. AYRES 2,427,940

TRANSMISSION LINE SWITCH

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FIG. 1.

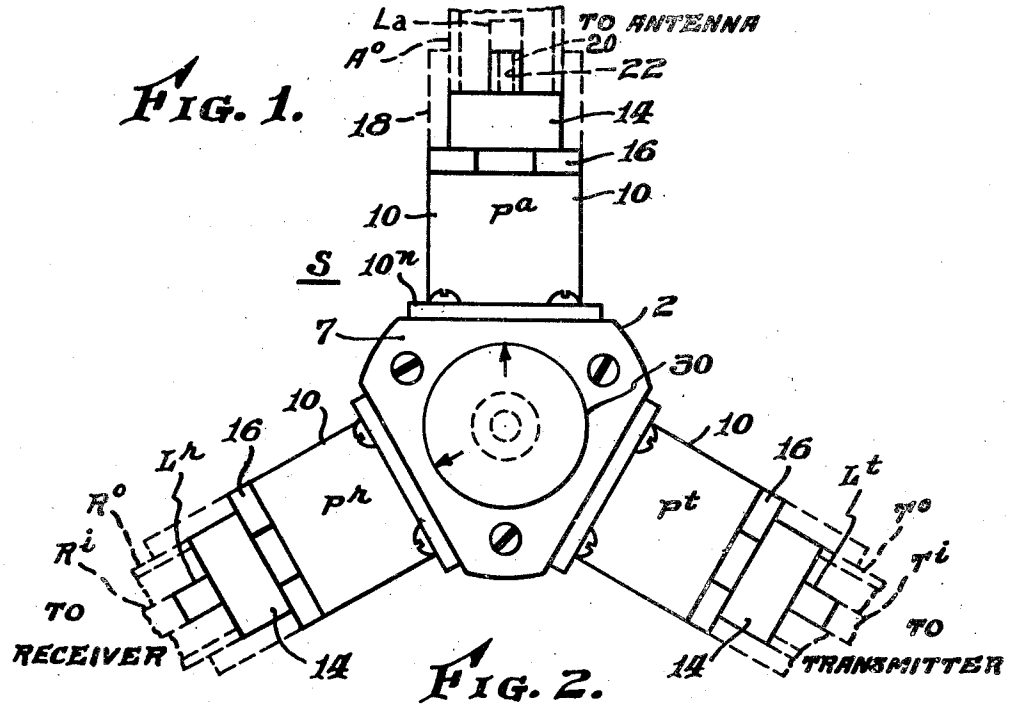


FIG. 2.

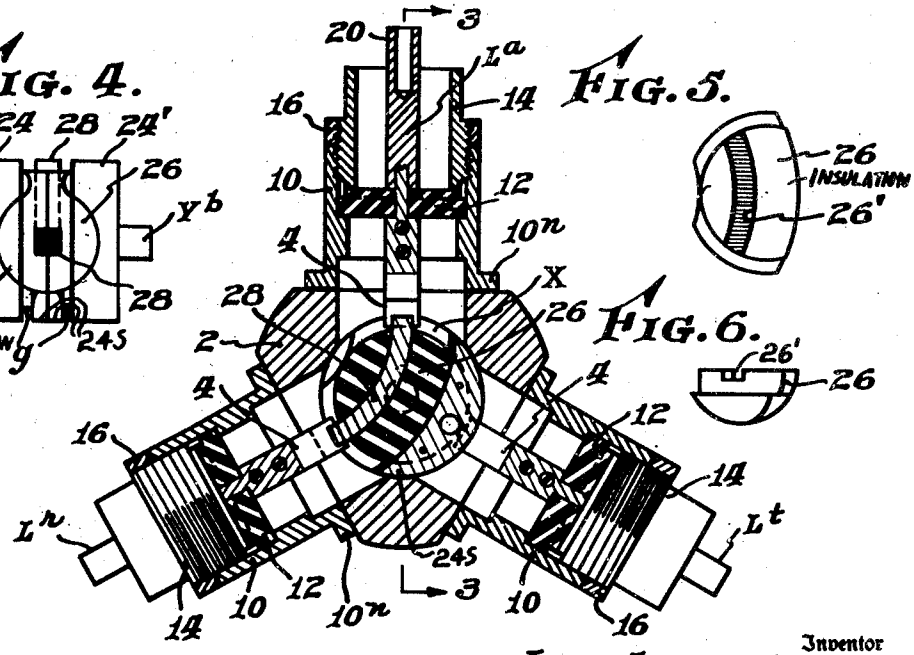


FIG. 4.

FIG. 5.

FIG. 6.

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FIG. 3.

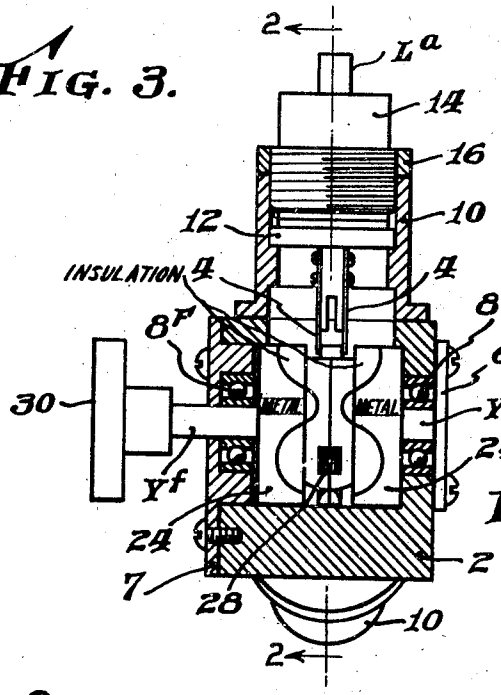


FIG. 4a.

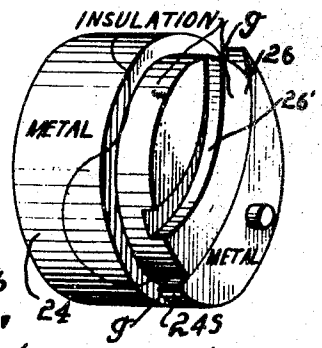


FIG. 7.

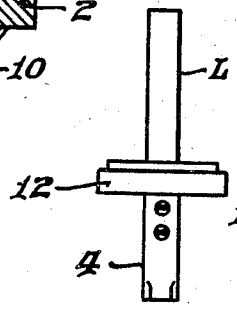


FIG. 8.

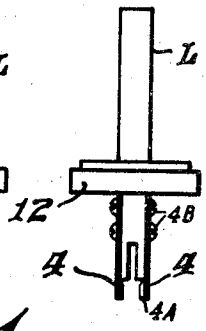


FIG. 9.

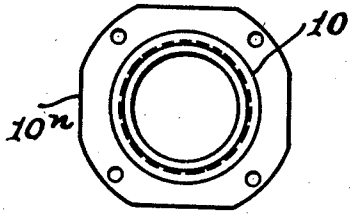


FIG. 11.

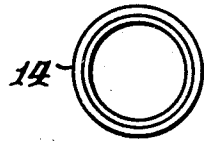


FIG. 13.

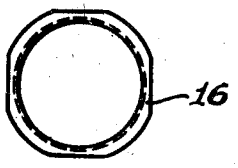


FIG. 10.

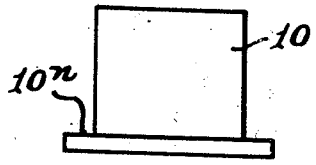


FIG. 12.

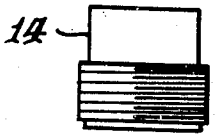


FIG. 14.



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TRANSMISSION LINE SWITCH

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Application January 28, 1943, Serial No. 473,879

6 Claims. (Cl. 200—6)

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This invention relates to switches of the type suitable for use in ultra-short wave transmitting and receiving systems and has for its principal object to provide an improved switch for connecting the inner and outer conductors of one concentric transmission line, selectively, to the corresponding conductors of either of two or more similar transmission lines.

Another and important object of the invention is to provide an improved, simplified switch of the general character described and one which does not require a capacitor or other auxiliary tuning element to achieve a minimum standing wave ratio in the transmission lines in which it is connected.

Another and related object of the present invention is to provide a self-shielded switch whereby to minimize undesired radiation at the switching point in an ultra-short wave transmission system.

Another object of the present invention is to provide an improved switch suitable for use in a short wave signaling system for connecting the transmitter and receiver to a common antenna, and one which operates to ground the unused of said transmission lines and thereby prevent the absorption of energy from the lines in use.

Another object of the invention is to achieve the foregoing objects in a switch capable of use with a gas-filled transmission line, yet which itself need not contain a filling of gas.

Still another object of the present invention is to provide an improved concentric line switch of novel construction including a composite metal and insulating rotor which is characterized by the small torque required to operate it.

Certain preferred details of construction, together with other objects and advantages will be apparent and the invention itself will be best understood by reference to the following specification and to the accompanying drawings, wherein:

Fig. 1 is a front elevation of a switch constructed in accordance with the principle of the invention.

Fig. 2 is a cross section of the switch shown in Fig. 1, the section being taken on line 2—2 of Fig. 3.

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2, with the rotor, operating shaft, and a

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portion of the inner conductors shown in elevation.

Fig. 4 is a side elevational view of the switch rotor.

Fig. 4*a* is a perspective view showing one-half of the switch rotor member.

Fig. 5 is a top plan view showing one half of an insulating member carried by the rotor.

Fig. 6 is an end elevation of the insulating member shown in Fig. 5.

Fig. 7 is a side elevation and Fig. 8 is a front elevation of the stator contact member.

Fig. 9 is a plan view and Fig. 10 is a side view in elevation of one of the cylindrical parts or ports on the switch casing.

Fig. 11 is a top plan and Fig. 12 is a view in elevation of a threaded sleeve or gland nut which is received in the ports of Figs. 9 and 10, and

Figs. 13 and 14 are similar views of a locking nut for the gland nut of Figs. 11 and 12.

The embodiment of the invention which has been selected for purposes of illustration comprises a single pole, double throw, switch S which is shown in Fig. 1 as forming part of a transceiver system comprising three similar coaxial cables, which extend, respectively, to the antenna, the transmitter and to the receiver of said system. This switch is constructed, generally, of a metal casing 2 to which the outer conductors A^o, T^o and R^o of the coaxial cables are connected through three radially extending metal ports P^a, P^t and P^r, respectively, which are spaced 120 degrees apart on the casing. Each port contains a central or axial lead, L^a, L^t and L^r respectively, which comprises an electrically conductive extension of the inner conductor of the coaxial cable to which it is connected. These leads terminate 120 degrees apart about a common center, within the casing, and are each provided with two thin metal wiper arms or fixed switch blades 4 as shown by Figs. 7 and 8. Each one of the two thin metal switch blades are slightly curved at the extreme free end as indicated by the two parallel lines 4A shown in the bottom portion of Fig. 7. Each wiper arm is secured at the upper end thereof by two round-head screws 4B and are thereby held for engagement with the rotor X which is rotatable about an axis through the said center. As will hereinafter more fully appear, the rotor X is of a unique construction

and serves not only to connect the antenna cable selectively to the transmitting and receiving cables, but also serves to effectively ground through the metal portion of rotor X the unused one of said cables, thereby preventing the capacitive absorption of energy from the cables in use. The outer conductors A^o, T^o, and R^o are maintained at ground or equivalent zero potential through the metal ports P^a, P^t, and P^r. The metal casing and the metal portions of the rotor X are, therefore, also maintained at ground or equivalent zero potential.

As previously indicated, the present invention contemplates and its practice provides, a switch which does not require a capacitor or other auxiliary tuning device to achieve a minimum standing wave ratio in the coaxial cables to which it is connected. This desired result is achieved, in accordance with the invention when the composite rotor X, the ports P^a, P^t and P^r and the other parts of the switch are so dimensioned, positioned and arranged that the electrical path through the switch possesses substantially the same characteristic impedance per unit length as the said coaxial cables.

As shown more clearly in Figs. 2 and 3, the switch casing 2 comprises a substantially triangular housing constituted of brass or equivalent metal and having a central cylindrical cavity within which the cylindrical switch rotor X is accommodated, and three radially extending apertures which communicate respectively with the ports P^a, P^t and P^r. Another smaller cylindrical opening (see Fig. 3), in the rear of the casing 2 is covered by a removable rear cover plate 6 and contains a bearing 8^b for the rear stub shaft Y^b of the rotor X, another bearing 8^F is provided for a similar stub shaft Y^f in the front cover plate 7 of the casing.

The ports P^a, P^t and P^r are made up of several separable parts (which are shown disassembled in Figs. 7 to 14 inclusive) to facilitate their attachment to the coaxial cables and to provide ready access to the interior of the switch for purposes of assembly and inspection of the rotor X and the contacts 4 therefor. Each port comprises an outer cylindrical shell 10 which is provided with a peripheral outer flange 10^n for attachment by four round head screws to a flat surface of the switch casing 2; an inner coaxial conductor L^a, L^t or L^r, which carries a cable supporting disc 12 of insulating material intermediate its ends; a gland nut 14 which serves to position the disc and cable lead within the shell 10, and a locking nut 16 which serves to hold the said parts in position within the outer shell 10. It will be observed upon inspection of Figs. 1 and 2 that the inside diameter of the gland nut 14 and the outside diameter of the conductor L therein are of the same dimensions as the outer and inner conductors of the coaxial cable which is affixed thereto. Thus, that section of the port which extends inwardly to the outer surface of the insulating disc 12 has the same characteristic impedance per unit length as the coaxial cable. In order to maintain the said characteristic impedance throughout the length of the port, that section of the inner cable lead L which passes through the insulating disc 12 should preferably be of decreased diameter (to offset the added capacitance occasioned by the higher dielectric constant of the insulating material). Similarly, the average diameter of the inner or switch contact end of the said cable leads should also be chosen with a regard to the desired characteristic impedance.

It will be observed upon inspection of Fig. 2 that the insulating disc 12 about the inner lead L fits tightly within the shell 10 and serves not only as a support for the said lead but as a gas-tight seal for the otherwise open bore of the port. Thus, when the coaxial cables contain a filling of nitrogen or other gas there is no danger of the gas escaping from the said cables and into the interior of the rotor switch portion. This feature of the invention is of considerable importance since it obviates the necessity of employing gas-tight packings about the ends of the rotor shaft Y and thus permits the use of ball bearings 8 for the said shaft, whereby the torque required to operate the switch is minimized. If desired, the gland nut 14 may be threaded throughout the length of its outer surface to accommodate a complementarily threaded coupling 18 (Fig. 1) about the abutting end of the outer conductor of the coaxial cable. Alternatively, the coupling 18 may be soldered in position on the unthreaded portion of the gland nut 14. As shown in Fig. 2, it is preferable to provide the outer end of the central lead L with a socket 20 for receiving a pin type contact, 22, on the end of the inner conductor of the cable.

Referring now to Figs. 2 to 6 inclusive, and particularly to Figs. 4 and 4*a*: The rotor X of the switch is cylindrical in outline with shafts Y^f and Y^b integral therewith, and is preferably constituted of two duplicate, separable or split metal parts 24 and 24' to facilitate the assembly therein of a complementary split insulating semi-circular arcuate curved piece 26 which is provided with an arcuate groove 26' containing a similarly shaped metal arm insert 28 of square cross section and of slightly greater length than the groove 26'. The metal insert 28 serves to connect, selectively, the separate extensions or switch blades 4 on leads L^a, L^t and L^r with the inner conductors one to another. The separable metal parts 24 and 24' which form the cylindrical shell of the rotor are each provided with a circumferential groove *g* within which the wiper arms or blades 4 (see Figs. 2, 3 and 8) of the stationary leads L are accommodated and permitted to pass therethrough. The central portion forms a ridged sector 24S which serves as the ground switch blade. It will be observed from an inspection of Fig. 2 the opposite terminal ends of the arcuate metal insert 28 lie 120 degrees apart on the face of the ridge formed between the circumferential grooves *g* of the rotor X and are hence in the path of the stationary contacts 4 of the central leads L as the rotor is turned on its bearing 8 so that when, as shown in Fig. 2, the rotor is turned to the left, one end of the arcuate insert 28 is connected to the contacts 4 of the antenna lead L^a and the opposite end of the contacts 4 of the receiver lead L^r, and the transmitter lead L^t connected to ground through the contacts 4 to the metal ridge sector 24S of rotor X, thus grounding the transmitter circuit. Alternatively, when the rotor is turned to the right (as viewed in Fig. 2), the end of the arcuate lead 28 which was formerly connected to the antenna lead L^a will be brought into register with the transmitter lead L^t, and the opposite end of the said arcuate insert will be brought into contact with the antenna lead L^a, thus connecting the transmitter to the antenna. The receiver will then be connected to ground through the metal ridge sector 24S of rotor X and contacts 4. It will also be observed

that the receiver or the transmitter is alternately grounded, as mentioned above, since the unused one of the radially extending leads L^a, L^t, and L^r is arranged to have the switch blades 4 located in grooves *g* and in contact with the metal ridge sector 24S of the rotor. The inner conductor of the coaxial cable is connected to ground and the unused lead is thereby effectively grounded to the outer conductor by the metal portion of the rotor X and is also shielded, thus preventing it from absorbing energy from the lines in use.

It should be borne in mind that the separable metal shells 24 and 24' of the rotor X comprise the ground circuit of the outer conductor and that the arcuate metal insert 28 which is secured in grooves 26' comprises the inner conductor of a short section of a concentric line. This section of the line, like the sections embraced by the ports P^a, P^t and P^r should, for optimum results, match the characteristic impedance of the coaxial cables served by the switch. Such an impedance match can be simply achieved by a proper selection of the type and quantity of the dielectric material 26 (Figs. 5 and 6) which serves to insulate the shell or outer conductor of the rotor from its arcuate, inner conductor 28.

In Figs. 1 and 3 the outer end of the shaft which serves to turn the rotor of the switch is shown provided with a knob 30 for manual operation. Since the design of the switch permits the use of a ball bearing support for the rotor X it is apparent that a remotely controlled mechanism capable of developing a very small torque may be substituted for the manually controlled knob.

What is claimed is:

1. A switch for selectively connecting one coaxial cable to another electrically similar coaxial cable, said switch comprising a metal casing having an aperture and a plurality of radially extending metal ports adapted to be connected, respectively, to the outer conductors of said coaxial cables, an insulating member for retaining an axially located metallic lead element in each of said ports to which the inner conductors of said cables are adapted to be connected, and a slit rotor member composed of insulating and metallic material, said rotor element located in the aperture of said casing for selectively connecting said axially located metallic leads, and hence said coaxial cables, one to another; said insulating and metallic switch elements selected and positioned to possess substantially the same characteristic impedance, per unit length, as said electrically similar coaxial cables.

2. A switch for a transmission system employing a plurality of coaxial cables, said switch comprising a grounded metal casing to which the outer conductors of said coaxial cables are adapted to be connected, a plurality of leads having inner switch terminals arranged in spaced relation about a common center aperture within said casing and exterior terminals to which the inner conductors of said cables are adapted to be connected, a metal rotor having an arcuate conductive switch element mounted between insulating material and located within the center aperture in said casing for rotation about an axis which extends through said common center, said conductive switch element insulatingly supported by the insulating material on said metal rotor for connecting selected of said leads one to another, and means comprising a portion of said metal rotor for electrically connecting the unconnected of said leads to said grounded metal casing.

3. A switch for selectively connecting a gas-filled coaxial cable to another gas-filled coaxial cable, said switch comprising a metal casing having a cylindrical aperture and a plurality of ports communicating with the interior of casing and to which the outer conductors of said coaxial cables are adapted to be connected, an axially located fixed switch element in each of said ports to which the inner conductors of said cables are adapted to be connected, a gas-tight bushing in each of said ports through which said leads extend to the interior of said casing, a bearing in said casing, a rotary switch element mounted for rotation on said bearing and adapted to rotate in said cylindrical aperture, an insulated movable contact member arranged to selectively electrically-connect said fixed switch elements and hence said gas-filled cables one to another, and means exterior of said casing for rotating said switch element.

4. A switch for a transmission system employing three coaxial cables, said switch comprising a metal casing having a cylindrical aperture, three outer conductors of said coaxial cables being adapted to be connected to said metal casing, a plurality of switch terminal elements for the inner conductors of said coaxial cables terminating 120° apart about a common center within the cylnidrical aperture of said casing, an anti-friction bearing supported within said casing at opposite ends of an axis extending through said common center, a rotor member composed of insulating and metallic material, said rotor member mounted for rotation in said cylindrical aperture and on said anti-friction bearings, and a bridging switch contact member insulatingly carried by and rotatable with said rotor, said bridging member having its terminals disposed 120° apart around said center and said switch terminal elements lying in the path of movement of said bridging member terminals whereby, upon rotation of said rotor, said bridging switch contact member is brought into position to bridge any two preselected ones of said terminals.

5. A switch for coaxial cables comprising a metal casing having a cylindrical aperture therein, a plurality of ports communicating with said cylindrical aperture to which the outer conductor of each one of said coaxial cables is connected to said casing, an axially located fixed switch element located in each one of said ports to which the inner conductor of each one of said coaxial cables is adapted to be connected, a disc of insulating material secured adjacent each one of said fixed switch elements forming a center support for the inner conductor and a fluid tight seal for each port, a cylindrical metallic rotor arranged to rotate in the cylindical aperture of said casing, a movable metallic contact arm insulatingly supported in an aperture in said rotor and arranged to simultaneously make contact with two of said fixed switch elements, said switch elements selected and positioned to possess substantially the same characteristic impedance, per unit length, as the coaxial cables to which the switch is connected.

6. A switch for coaxial cables comprising a metal casing having a cylindrical aperture therein, a plurality of ports communicating with said cylindrical aperture to which the outer conductor of each one of said coaxial cables is connected to said casing, an axially located fixed switch element located in each one of said ports to which the inner conductor of each one of said coaxial cables is adapted to be connected, a disc of insu-

lating material secured adjacent each one of said fixed switch elements forming a center support for the inner conductor and a fluid tight seal for each port, a cylindrical complementary split metallic rotor arranged to rotate in the cylindrical aperture of said casing, a movable metallic contact arm supported by a split insulating member located in an aperture in said rotor and arranged to simultaneously make contact with two of said fixed switch elements, said switch elements selected and positioned to possess substantially the same characteristic impedance, per unit length, as the coaxial cables to which the switch is connected.

JAY JESSE AYRES.

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