Dec. 8, 1953 J. A. NELSON 2,662,142

COAXIAL-LINE SWITCH

Filed Nov. 3, 1950

Fig. 1

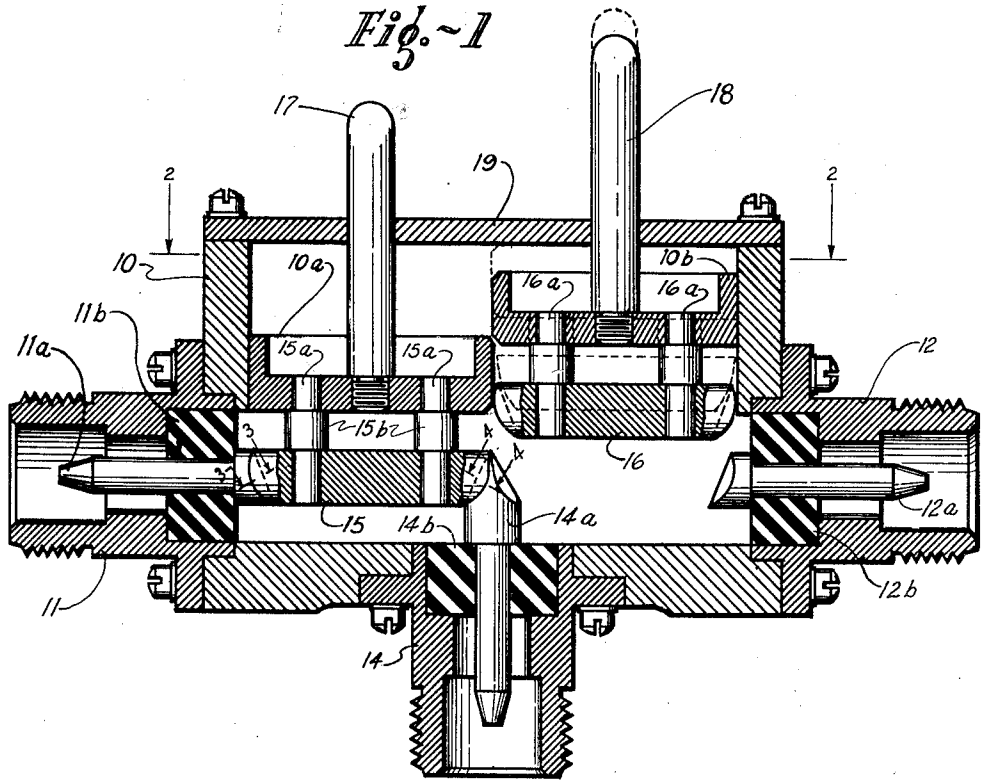


Fig. 2

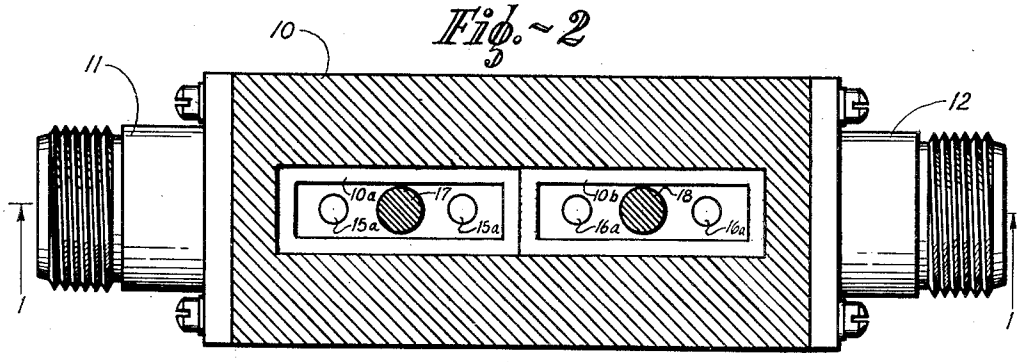


Fig. 3

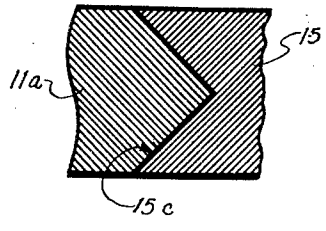
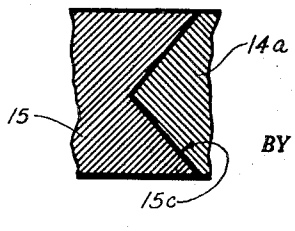


Fig. 4



INVENTOR.
JESSIE ANN NELSON
BY
Harry M. Saragovitz
Attorney

Patented Dec. 8, 1953

2,662,142

UNITED STATES PATENT OFFICE

2,662,142

COAXIAL-LINE SWITCH

Jessie Ann Nelson, New York, N. Y., assignor to the United States of America as represented by the Secretary of the Army

Application November 3, 1950, Serial No. 193,836

12 Claims. (Cl. 200—153)

1

This invention relates to improvements in coaxial-line switches.

Examples of coaxial-line switches over which the disclosed embodiment of the present invention is considered to have one or more important advantages, are described in Patent No. 2,427,940, issued September 23, 1947, to Jay J. Ayres, in Patent No. 2,426,186, issued August 26, 1947, to Orville E. Dow, and on pages 528 to 533 in vol. 9 of the Massachusetts Institute of Technology Radiation Laboratory Series, published 1948 by the McGraw-Hill Book Company, Inc.

Among the objects of the invention is the provision of an improved coaxial-line switch of the character referred to, which can function efficiently as a single-pole, double-throw switch in coaxial-transmission-line applications at any frequency, and with which it is possible to switch current between two coaxial lines without affecting the standing-wave ratio existing on the feed or input line.

Other objects and advantages will hereinafter appear.

In accordance with the present invention, a coaxial-line switch is so designed that the characteristic impedance of the coaxial line forming the switch is constant throughout, without discontinuities except at a right-angle turn, at which point the discontinuity is of the same order of magnitude as that found in a right angle adapter or in any 90° bend. Thus, the only sources of standing-wave ratio-distortion are in the 90° bend and in the connectors themselves. The improved switch, accordingly, will not disturb the standing-wave-ratio on a coaxial line to any appreciable extent at any frequency, where a type-N connector may be used.

For the purpose of illustrating the invention, an embodiment thereof is shown in the drawing, wherein:

Fig. 1 is a view partly in section and partly broken away, of a coaxial-line switch constructed and having operating characteristics in accordance with the invention, the section being taken on the line 1—1 in Fig. 2;

Fig. 2 is a plan view, partly in section, of the improved switch, the section being taken on the line 2—2 in Fig. 1; and

Figs. 3 and 4 are enlarged, detail, sectional views, the sections being taken on the lines 3—3 and 4—4, respectively, in Fig. 1.

In the drawing, the reference numeral 10 designates the switch casing to which are secured type-N coaxial-line connectors 11, 12 and 14 of a conventional construction. The connectors 11 and 12 provide, respectively, means for connecting two coaxial output lines to the switch, and the connector 14 provides means for connecting a coaxial input line to the switch. With the switch installed, the coaxial input line forms the stem of a T and may be connected selectively to the coaxial output lines which form the arms of the T. For this purpose, switch elements in the form of relatively short sections 15 and 16 of the inner conductors of the respective arms of the T, are supported for movement into and out of contact with the complementary section or inner conductor 14a of the stem of the T. The outer conductors of the three transmission lines connected into the switch, are connected permanently through the switch casing 10 which is of electrically-conductive material.

2

The inner section or inner conductor 14a of the stem of the T extends through and is supported by the dielectric insert 14b of connector 14. The respective inner sections or inner conductors 11a and 12a of the arms of the T likewise extend through and are supported by the dielectric inserts 11b and 12b, respectively, of connectors 11 and 12.

Parts 10a and 10b constitute, in effect, part of the outer conductor, and have a sliding fit with respect to each other and with respect to the casing 10. The inner-conductor section 15 is attached rigidly to part 10a by pins 15a of dielectric material. The diameter of the central portions 15b of these pins is made greater than that of the ends, whereby the central portions 15b serve as spacers. Similar pins 16a of dielectric material serve to attach the inner-conductor section 16 rigidly to the part 10b.

The inner-conductor sections or switch elements 15 and 16 are moved manually, or by any conventional control mechanism, into one or the other of two positions by studs 17 and 18 screwed, respectively, into the parts 10a and 10b and extending through and having a sliding fit with respect to a cover plate 19 secured to casing 10.

With section 15 in the full-line position shown, and with section 16 in the fully-retracted or uppermost position indicated by dash lines, in Fig. 1, the output line screwed to connector 12 will be disconnected from the input line screwed to connector 14, whereas the output line screwed to connnecter 11 will be connected to this input line. With the inner section 15 raised and the inner section 16 lowered, however, the output line screwed to connector 11 will be disconnected from the input line, and the latter will be con-

nected with the output line screwed to connector 12. From this it will be seen that the improved coaxial-line switch can function as a single-pole, double-throw switch in a coaxial-transmission-line system. In other words, the transmission line forming the stem of the T may be switched alternately between the two transmission lines forming the arms of the T.

The inner-conductor sections 11*a*, 12*a*, 14*a*, 15 and 16 have a circular cross-section, and their respective ends are tapered, as shown. The switch-end of the inner-conductor section 14*a* is tapered on both sides, symmetrically with respect to its longitudinal axis, the angle of the taper being substantially 64°. The angle of taper is the same for the other contact surfaces. Just a straight slice for the taper, at any chosen angle, would cause a relatively large discontinuity at the joint, since the T-arms 15 and 16 would have elliptical faces, and the T-stem 14*a* would, in such case, have two half-elliptical faces. Such discontinuity at the joint is reduced, as shown more clearly in Figs. 3 and 4, by V-grooves 15*c* in the tapered contact faces of bar 15. Similar grooves are made in the tapered contact faces of bar 16, and the respective tapered contact faces of sections 11*a* and 12*a* are V-shaped to fit or correspond. In other words, the V-groove faces are concave at the ends of the T-bars or movable switch elements 15 and 16, and are convex at the top of the T-stem 14*a* and at the inwardly directed ends of the inner-conductor sections 11*a* and 12*a*. Another advantage of this V-groove or V-shaped construction is that it makes the movable T-bars 15 and 16 self-aligning when they are pushed inwardly into the casing 10 to engage the complementary contact faces of the sections 11*a*, 12*a* and 14*a*. The angle of the V-groove or V-shape is determined for the best matching of the two faces, shown in Fig. 4.

With the parts of the improved switch in the respective positions thereof shown in Fig. 1, the inner-conductor section or bar 15 attached to the movable outer-conductor section 10*a*, is in contact with the inner section or T-stem 14*a* and with the inner-conductor section 11*a* of the type-N connector 11. Also, the outer-conductor section 10*a* is in position to form a continuous outer-conductor surface with the permanent parts comprising the wall of casing 10, and the outer-conductor section 10*b* and the inner-conductor section or T-arm 16 attached to the latter, are completely withdrawn into the wall of casing 10. With the stud 17 pulled out and the stud 18 pushed in, the conditions are vice versa. It will therefore be seen that of the two bars 15 and 16, the one which is not in use is recessed into the outer-conductor wall of the casing, and thus is grounded (at least capacitatively for R. F. frequencies). By means of this arrangement and operational feature, possible capacitive feed-through due to the proximity of the unused T-bar, is avoided.

When either of the two, movable switch units is in contact position, the characteristic impedance of that portion of the transmission line is undisturbed. In other words, the improved switch is so designed that the characteristic impedance of the coaxial line is constant throughout, without discontinuities except at the right-angle turn. At that point, the discontinuity is of the same order of magnitude as that found in a right-angle adapter or in any 90° bend. Thus, the only sources of standing-wave-ratio-distortion are in the 90° bend and in the connectors themselves, and the switch will not disturb the standing-wave ratio on a coaxial line to any appreciable extent at any frequency, where a type-N connector may be used.

For a particular application of the invention, it might be more expedient or advantageous to shape or otherwise design casing 10 and associated parts so that there is a Y-joint at the center, instead of the arms 15 and 16 and the stem 14*a* being disposed as disclosed herein, to form a T-joint.

A structural feature which is considered to be important, resides in the arrangement and combination of parts whereby the center-conductor connection is made right at the stem-joint so that no metal stub remains to change or disturb the standing-wave ratio, as is the case in some of the designs proposed heretofore. For example, some of the prior switches have a stub on the inner stem of the T-joint so that there can be an undesirable capacitance to the unused arm. This capacitance is determined by the distance between the inner end of the T-stem and the unused arm, and this distance can be greater in a switch of the present construction than has been practical with the switches having stubs on the T-stem.

One of the broader aspects of the invention embodied in the construction disclosed, resides in the provision of a single-pole, double-throw concentric coaxial-line radio-frequency switch constructed in the form of a T or Y, and wherein either of two sections of the inner conductors of the arms can be withdrawn completely into the wall of the switch when not in use, thus leaving a transmission line with no discontinuities other than a right-angle or obtuse-angle bend. Aside from its function as a coaxial-line switch, it is feasible that the device could be used, as well, as a T-junction or as a Y-junction.

An additional reason why the unused arm in the improved switch introduces less disturbance than has been the case in prior constructions, is because when one of the center conductors 15 and 16 is withdrawn, the associated outer-conductor section 10*a* or 10*b* to which it is rigidly attached acts like a wave-guide. The cut-off frequency for this wave-guide can be made higher than the highest operating frequency.

The improved switch can operate over a very wide frequency range, i. e., substantially 100 megacycles or less, to 4,000 megacycles. It provides, furthermore, a fairly good impedance match over this large frequency range, and the standing-wave ratio is relatively low. The upper frequency limit is determined by the connections to the lines and also by the wave-guide consideration above referred to. The lower frequency limit is determined by the contact joints in the inner conductor.

While but one, and a preferred embodiment of the invention has been disclosed, it will be understood by those skilled in the art that various modifications, such as in the size, shape and arrangement of the parts, may be made without departing from the spirit of the invention or the scope of the claims.

The invention claimed is:

1. In a coaxial-line switch of the character described, a casing, a pair of coaxial-line connectors fixed with respect to said casing and each provided with an inner-conductor section, a third coaxial-line connector fixed with respect to said casing and provided with an inner-conductor sec-

tion and disposed intermediate said first-named connectors, and switch elements supported by and for movement with respect to said casing and with respect to each other into and out of contact with said third-named section and with one of said first-named sections to connect said third-named section with either of the latter selectively, the inner wall portion of said casing forming in association with any combination of said three sections the outer-conductor of a coaxial transmission line, each of said switch elements being shaped and disposed for substantially complete withdrawal into the wall structure of said casing when in position out of contact with said third-named section, the longitudinal axes of said first-named connectors being disposed in nonparallel relation with respect to the longitudinal axis of said third connector, said first-named connectors being directed respectively in opposite directions from the longitudinal axis of said third connector.

2. In a coaxial-line switch of the character described, a conductive casing, coaxial-line connectors fixed with respect to said casing and each provided with an inner-conductor section, a conductive part movable with respect to said casing, a switch element, and means of dielectric material attaching said element to and spacing said element from said part for movement into and out of contact with said sections, said element being shaped and disposed for substantially complete withdrawal into the wall structure of said casing when in position out of contact with said sections.

3. In a coaxial-line switch of the character described, a conductive casing, a pair of coaxial-line connectors fixed with respect to said casing and each provided with an inner-conductor section, a third coaxial-line connector fixed with respect to said casing and provided with an inner-conductor section and disposed intermediate said first-named connectors, outer-conductor sections supported by and for movement with respect to said casing and with respect to each other, switch elements, and means of dielectric material attaching said elements respectively to and spacing said elements respectively from said parts for movement into and out of contact with said third-named section and with one of said first-named sections to connect said third-named section with either of the latter selectively, each of said outer-conductor sections and the respective switch element fixed thereto and spaced therefrom being shaped and disposed for substantially complete withdrawal into the wall structure of said casing when in position to place the switch element out of contact with said third-named section.

4. In a coaxial-line switch of the character described, a casing, a pair of coaxial-line connectors fixed with respect to said casing and each provided with an inter-conductor section, a third coaxial-line connector fixed with respect to said casing and provided with an inner-conductor section and disposed intermediate said first-named connectors, and switch elements supported by and for movement with respect to said casing and with respect to each other into and out of contact with said third-named section and with one of said first-named sections to connect said third-named section with either of the latter selectively, the inner end of said third-named section being tapered and substantially V-shaped on opposite sides thereof, both ends of each of said switch elements being tapered and provided with a V-groove.

5. In a coaxial-line switch of the character described, a conductive casing, coaxial-line connectors fixed with respect to said casing and each provided with an inner-conductor section, a conductive part movable to a retracted position within the wall structure of said casing and to a forward position to constitute part of the inside surface of said casing, a switch element, and means of dielectric material attaching said element to and spacing said element from said part for movement into and out of contact with said sections, said element being shaped and disposed for retraction with said part into said wall structure.

6. In a coaxial-line switch of the character described, a casing, a pair of coaxial-line connectors fixed with respect to said casing and each provided with an inner-conductor section having a circular cross-section, a third coaxial-line connector fixed with respect to said casing and provided with an inner-conductor section having a circular cross-section, said third connector being disposed intermediate said first-named connectors, and switch elements each having a circular cross-section and supported by and for movement with respect to said casing and with respect to each other into and out of contact with said third-named section and with one of said first-named sections to connect said third-named section with either of the latter selectively, the inner end of said third-named section being tapered and substantially V-shaped on opposite sides thereof, both ends of each of said switch elements being tapered and provided with a V-groove.

7. In a coaxial line switch, a pair of switch contacts for the center conductor of said line, one contact having a V-shaped wedge and the other contact having a V-shaped groove shaped to fit said wedge.

8. In a coaxial line switch as set forth in claim 7, the line defining the bottom of said V-shaped groove being at an angle of 64° with the axis of said coaxial line.

9. In a coaxial line switch, a center conductor of said coaxial line having a tapered end which is V-shaped on opposite sides thereof, the line defining the bottom of each V of said end being at an angle of 26° with respect to the center axis of said center conductor, a first switch arm having a V-grooved end shaped to fit one side of said tapered end, a second switch arm having a V-grooved end shaped to fit the other side of said tapered end, and means for engaging and disengaging the grooved ends of said arms with the tapered end of said center conductor.

10. A coaxial line switch comprising a pair of spaced coaxial line sections, a conductive rod forming an arm of said switch, proximate ends of the center conductors of said sections being wedge-shaped, said rod having a length sufficient to permit simultaneous engagement of the ends thereof with the ends of said center conductors, and means for engaging said rod with and disengaging said rod from both said center conductors.

11. A coaxial line switch comprising a pair of spaced coaxial line sections, a conductive rod having a diameter approximately equal to that of proximate ends of the center conductors of said sections forming an arm of said switch, said proximate ends being V-shaped, said rod having V-grooved ends shaped to fit respective ones of said V-shaped ends, said rod having a length sufficient to permit simultaneous engagement of

the ends thereof with the ends of said center conductors, and means for simultaneously engaging said rod with both said center conductors and simultaneously disengaging said rod from both said center conductors.

12. A switch according to claim 11, in which the axes of said center conductors are at an angle with respect to one another.

JESSIE ANN NELSON.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,406,122	Young	Aug. 20, 1946
2,426,186	Dow	Aug. 26, 1947
2,498,907	Atwood et al.	Feb. 28, 1950

OTHER REFERENCES

Abstract of Wahl application S. N. 632,584, published April 4, 1950.