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COAXIAL LINE SWITCH

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Fig. 1

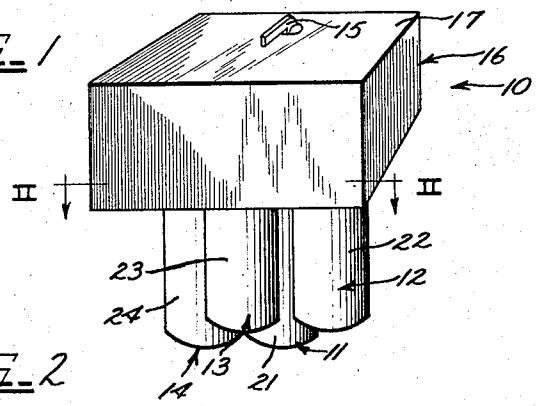


Fig. 2

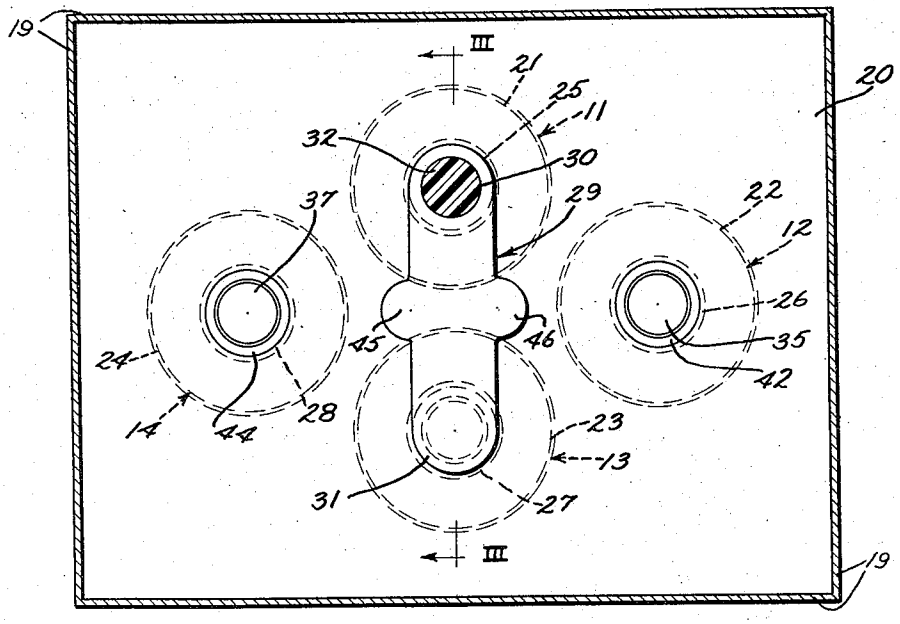
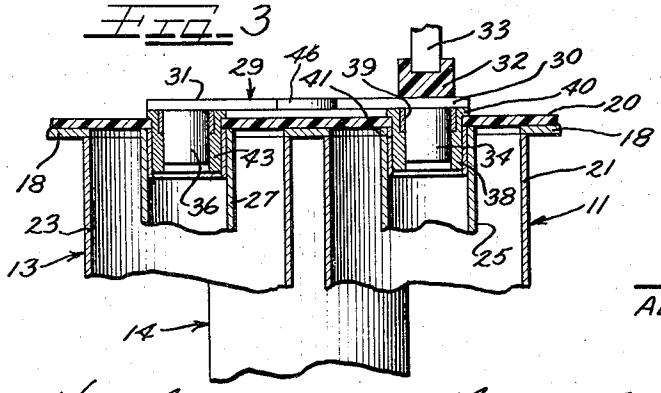


Fig. 3



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COAXIAL LINE SWITCH

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This invention relates to a coaxial line switch in which a wall of conductive material has openings receiving a plurality of coaxial line outer conductors with the wall being electrically joined at the edges of such openings around the terminal ends of such outer conductors so that one surface of the wall (which may be termed the "active" surface) forms a continuation electrically of the inside surfaces of the outer conductors, and a switch blade connects the terminal ends of inner conductors of the lines and extends in spaced relation over the portion of the active surface of the wall between the outer conductors to define a ground plane type of connecting section intermediate the coaxial lines.

In a switch of this type heretofore proposed, the adjacent sides of the coaxial line outer conductors are spaced apart a substantial distance, greater than the radius of the outer conductors, and a switch blade is provided having a width equal to or slightly greater than the diameter of the inner conductors. Somewhat improved results are obtained by extending each of the terminal ends of the switch blade beyond the inner conductors toward the outer conductors to obtain an overhang. In this proposed switch, the intermediate connecting section of ground plane type configuration has a characteristic impedance substantially equal to the characteristic impedance of the coaxial lines, as calculated from the spacing of a portion of the active surface of the plate between the outer conductors and the facing portion of the switch blade, the characteristics of the dielectric therebetween, and the width of such portion of the switch blade.

With a switch of this construction, very satisfactory operation can be obtained with a voltage standing wave ratio very close to unity over a wide range of operating frequencies. However, this construction leaves something to be desired in that the coaxial lines must be positioned a substantial distance apart to obtain satisfactory operation and it is desirable that the lines be positioned as close together as possible to obtain a compact switch unit. It is therefore an object of this invention to provide a switch of the type described above in which the coaxial lines can be positioned close together and yet obtain a voltage standing wave ratio very close to unity over a wide range of operating frequencies. According to this invention, a switch is provided in which the coaxial lines are positioned close together with adjacent sides of the outer conductors at their terminal ends being spaced apart a distance less than the radius of the outer conductors. It has been discovered that with this spacing of the lines, the intermediate connecting section of ground plane configuration defined by the portion of the active surface of the wall between the outer conductors and the facing portion of the switch blade should have a calculated characteristic impedance substantially lower than the characteristic impedance of the coaxial line and in the switch of this invention the relation of the spacing of such facing portions, the characteristics of the dielectric material, and the width of the intermediate portion of the switch blade is made such as to obtain such a characteristic impedance. The reason why such a characteristic impedance is required are not known but it will be apparent that the field distribution is very complex, making a theoretical analysis very difficult.

The characteristic impedance of the intermediate section may be decreased to the optimum value by reducing the spacing between the switch blade and the wall. However, it has been found that so reducing the spacing presents a mechanical problem by increasing the difficulty of maintaining the spacing constant, and in addition decreasing the spacing increases the potential gradient in the dielectric. According to a specific feature of the invention, the width of the switch blade is increased to obtain the lowered characteristic impedance.

The width of the entire switch blade may be increased to reduce the characteristic impedance of the intermediate section through the optimum value. However, it has been found that superior characteristics are obtained with only the width of the intermediate portion of the switch blade being increased and with the width of the portions of the switch blade on either side of the intermediate portion being not substantially greater than the diameter of the inner conductors of the coaxial lines.

It has further been found that the overhang of the switch blade beyond the inner conductors as in the switch heretofore proposed is not necessary and is in fact undesirable when the coaxial lines are disposed close together with the adjacent sides of the outer conductors spaced apart a distance less than the radius thereof. According to a further specific feature of the invention, the length of the switch blade is substantially equal to the diameter of the inner conductors plus the distance between the radii thereof. Preferably, the terminal ends of the switch blade are rounded in a manner to obtain maximum contact with the inner conductors without overhang.

This invention contemplates other objects, features and advantages which will become more fully apparent from the following detailed description taken in conjunction with the accompanying drawing which illustrates a preferred embodiment and in which:

Figure 1 is a perspective view of a coaxial switch constructed according to the principles of this invention;

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

Figure 3 is a sectional view taken substantially along line III—III of Figure 2.

Reference numeral **10** generally designates a coaxial line switch constructed according to the principles of this invention which is particularly designed to connect one coaxial line **11** to any one of three other coaxial lines **12, 13** and **14**. The switch **10** is operated by rotation of an operating handle **15** on a housing **16** of conductive material including a top wall **17**, a bottom wall **18** and side walls **19**. The bottom wall **18** is covered by a sheet **20** of insulating material and has four circular openings therein, the bottom wall being joined at the edges of such openings around the terminal ends of the outer conductors **21, 22, 23** and **24** of the lines **11, 12, 13** and **14**, respectively. The outer conductors **21—24** may for example be soldered to the bottom wall **18** around the openings thereof and it will be noted that the upper surface of the bottom wall forms an electrical continuation of the inner surface of the coaxial line outer conductors. In the illustrated switch, the upper surface of the bottom wall is in a plane and the axes of the coaxial lines are normal to such plane but such would not have to be the case although it is preferred.

The coaxial line **11** has an inner conductor **25** which is selectively connected to inner conductors **26, 27** and **28** of the coaxial lines **12, 13** and **14**, respectively, by means of a switch blade **29** which is rotatable about the axis of the line **11** and has one end portion **30** engaged

with the terminal end of the inner conductor 25 with the other end portion 31 thereof being selectively engaged with the terminal ends of the inner conductors 26, 27 and 28. In the illustrated position of the blade 29, the end portion 31 thereof is engaged with the terminal end of the inner conductor 27 and with rotation through about 60° in a clockwise direction as viewed in Figure 2, the end portion 31 will be engaged with the terminal end of the conductor 28 or with rotation through about 60° in a counterclockwise direction, the terminal end portion 31 will be engaged with the terminal end of the conductor 26.

For effecting rotation of the switch blade 29, the end portion 30 thereof is connected either directly or through a coupling 32 to the lower end of a vertical shaft 33 which has its upper end connected to the operating handle 15. The shaft 33 may be of insulating material and the coupling 32 eliminated.

To obtain the best possible electrical contact between the switch blade 29 and the terminal ends of the coaxial line inner conductors 25—28, the switch blade 29 is of magnetic material and the permanent magnets 34, 35, 36 and 37 are mounted in the terminal ends of the inner conductors 25, 26, 27 and 28 respectively.

The magnet 34 is mounted in a sleeve 38 the opening of which is enlarged at its upper end to provide a gap of non-magnetic material, either air or solder 39 as desired. The sleeve 38 extends through an opening in the insulating sheet 20 and has an annular flange portion 40 overlying the sheet 20 about such opening. The lower end portion of the sleeve 38 is mounted within a sleeve 41 which is mounted within the inner conductor 25 of the line 11. The magnets 35, 36 and 37 are similarly mounted within sleeves 42, 43 and 44 carried by the inner conductors 26, 27 and 28. The switch blade 29 and at least the upper surfaces of the magnets 34—37 are preferably plated with a highly conductive material such as silver. Spring means may be substituted for the magnets, especially between the conductor 25 and the end portion 30 of the switch blade.

It will be noted that the switch structure is very compact and the coaxial lines are mounted close together. The diameter of the outer conductors 21—24 in the illustrated embodiment may be 3⅛ inches, for example, with a ⅝ inch spacing therebetween, the spacing thus being substantially less than the radius of the outer conductors. As above pointed out, switch constructions of the prior art utilizing such close spacing have not been satisfactory in operation, but it has been discovered that efficient operation can be obtained by reducing the characteristic impedance of the ground plane type transmission line section defined by the intermediate portion of the switch blade 29 and the facing upper surface portion of the bottom wall 18. For this purpose, the spacing between the switch blade 29 and the wall 18 could be reduced, but preferably the width of at least the intermediate portion of the blade 29 is increased, and most preferably only the width of the intermediate portion is increased. In particular, the intermediate portion of the blade 29 is provided with a pair of ear portions 45 and 46 projecting outwardly from either side thereof with the end portions 30 and 31 having a width substantially equal to the diameter of the inner conductors of the lines. Preferably, the ears have a generally semi-circular configuration so as to not present any abrupt discontinuity.

As further discussed above, the ends of the switch blade 29 should not overhang the terminal ends of the inner conductors and according to a specific feature of the invention, the ends 30 and 31 of the blade 29 are rounded so as to obtain maximum area of contact with the terminal ends of the inner conductors without overhang. The total length of the switch blade 29 should be not greater than the diameter of the inner conductors plus the distance between the axes thereof.

It will be understood that modifications and variations

may be effected without departing from the spirit and scope of the novel concepts of this invention.

I claim as my invention:

1. In a switch for interconnecting a plurality of coaxial lines having inner and outer conductors, a wall of conductive material having openings receiving the outer conductors, said wall being electrically joined at the edges of said openings around the terminal ends of the outer conductors, and a switch blade for connecting the terminal ends of inner conductors of the lines and having an intermediate portion in spaced facing relation to a surface portion of said wall disposed between outer conductors of the lines to define a ground plane type transmission line section, the outer conductors of the coaxial lines interconnected by said switch blade being spaced apart a distance less than the radius thereof, and said transmission line section having a characteristic impedance substantially less than the characteristic impedance of the coaxial line to minimize the voltage standing wave ratio.

2. In a switch for interconnecting a plurality of coaxial lines having inner and outer conductors, a wall of conductive material having openings receiving the outer conductors, said wall being electrically joined at the edges of said openings around the terminal ends of the outer conductors, and a switch blade for connecting the terminal ends of inner conductors of the lines and having an intermediate portion in spaced facing relation to a surface portion of said wall disposed between outer conductors of the lines to define a ground plane type transmission line section, the outer conductors of the coaxial lines interconnected by said switch blade being spaced apart a distance less than the radius thereof, and said intermediate portion of said switch blade having a width substantially greater than the diameter of the coaxial line inner conductors with said transmission line section having a characteristic impedance substantially less than the characteristic impedance of the coaxial lines to minimize the voltage standing wave ratio.

3. In a switch for interconnecting a plurality of coaxial lines having inner and outer conductors, a wall of conductive material having openings receiving the outer conductors, said wall being electrically joined at the edges of said openings around the terminal ends of the outer conductors, and a switch blade for connecting the terminal ends of inner conductors of the lines and having an intermediate portion in spaced facing relation to a surface portion of said wall disposed between outer conductors of the lines to define a ground plane type transmission line section, the outer conductors of the coaxial lines interconnected by said switch blade being spaced apart a distance less than the radius thereof, said intermediate portion of said switch blade having a width substantially greater than the diameter of the coaxial line inner conductors with said transmission line section having a characteristic impedance substantially less than the characteristic impedance of the coaxial lines to minimize the voltage standing wave ratio, and the width of the portions of said switch blade on either side of said intermediate portion being not substantially greater than the diameter of the coaxial line inner conductors.

4. In a switch for interconnecting a plurality of coaxial lines having inner and outer conductors, a wall of conductive material having openings receiving the outer conductors, said wall being electrically joined at the edges of said openings around the terminal ends of the outer conductors, and a switch blade for connecting the terminal ends of inner conductors of the lines and having an intermediate portion in spaced facing relation to a surface portion of said wall disposed between outer conductors of the lines to define a ground plane type transmission line section, the outer conductors of the coaxial lines interconnected by said switch blade being spaced apart a distance less than the radius thereof, said intermediate portion of said switch blade having a width

substantially greater than the diameter of the coaxial line inner conductors with said transmission line section having a characteristic impedance substantially less than the characteristic impedance of the coaxial lines to minimize the voltage standing wave ratio, and said switch blade having rounded ends and having a length substantially equal to the diameter of the coaxial line inner conductors plus the distance between the axes thereof.

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