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CO-AXIAL SWITCH

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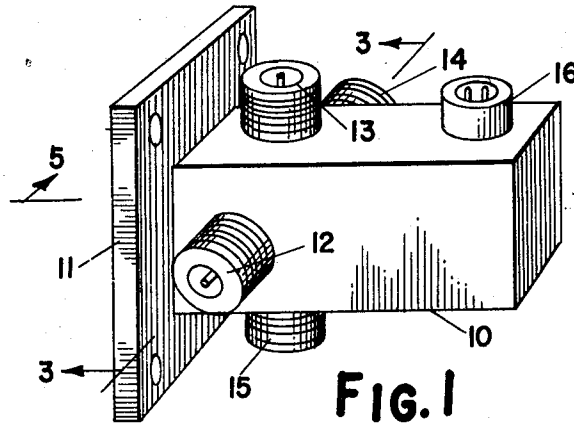

FIG. 1

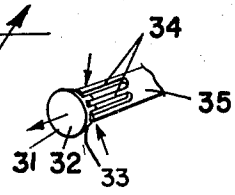

FIG. 4.

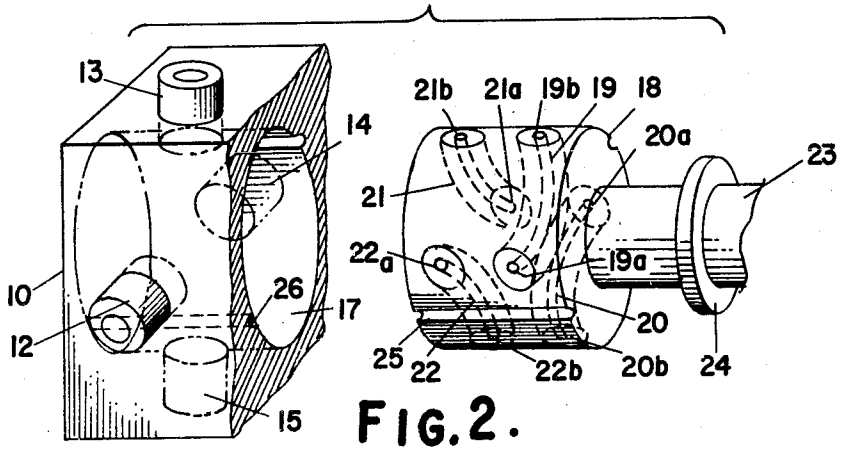

FIG. 2.

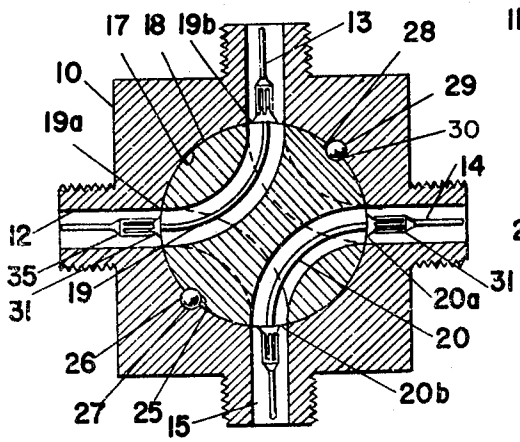

FIG. 3.

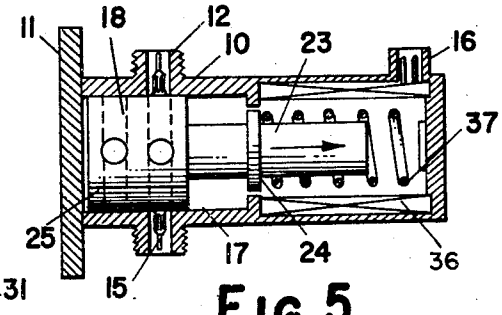

FIG. 5.

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CO-AXIAL SWITCH

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This invention relates generally to co-axial switches for ultra high frequency energy and more particularly to a switch for interchanging connections between a plurality of co-axial terminals.

In many applications, it is desirable to interchange connections between pairs of co-axial terminals. Switches for this purpose are useful, for example when switching the connections from an antenna between a transmitter and receiver or in lobe switching between two antennae.

Heretofore, certain types of co-axial switches have taken the form of a rotatable member including an internal passage opening out on the peripheral surface of the rotatable member. Pairs of co-axial terminals are positioned juxtaposed the end portions of the passage. By rotating the member through a given angle, the internal passage may be positioned to connect different pairs of the co-axial terminals. In the case of four co-axial terminals, a rotation of at least ninety degrees is necessary.

The foregoing design provides a relatively smooth and continuous co-axial line passage with substantially no sharp angles or other discontinuities. On the other hand, a relatively large movement of the switching member is required. Moreover, a rotary motion must be provided to operate the switch which requires more complex structure than is necessary for a simple linear movement as provided, for example, by a solenoid. Further, because of the relatively large movement, the response time of such switches is limited.

With the above in mind, it is a primary object of this invention to provide a greatly improved co-axial switch structure in which effective switching between different pairs of co-axial terminals may be effected more rapidly and with less structure than has been possible heretofore.

More particularly, an object is to provide a switch in which it is not necessary to convert a linear movement into a rotary motion so that a more compact structure may be provided.

Still another object is to provide a co-axial switch in which a continuous, smooth connection is effected between the connected co-axial terminals with minimum discontinuities so that reflections and the like are avoided.

Another object is to provide a co-axial switch in which excellent electrical connections are maintained even after prolonged use.

A particular object of the invention is to provide a switching means for interposing connections between four co-axial terminals by means of a single movement of a switching member.

Briefly, these and many other objects and advantages of this invention are attained by providing a block having a central opening and co-axial terminals extending inwardly from sides of the block to intercept the inner sidewalls of the opening. A switching member, in turn, is axially movable in a reciprocal manner within the central opening.

In the preferred embodiment of the invention, the switching member includes first and second pairs of internal passages opening out on the surface of the switching member in positions to interconnect various ones of the co-axial terminals when the switching member is in a first position and to interconnect other co-axial terminals when the switching member is moved to a second position. By employing a back and forth or reciprocal motion rather than a rotary motion, the actual movement is relatively small as compared to a rotational movement.

A better understanding of the foregoing as well as further features and advantages will be had by now referring to a preferred embodiment of the invention as illustrated in the accompanying drawings, in which:

FIGURE 1 is a perspective view of the co-axial switch of this invention;

FIGURE 2 is a fragmentary exploded perspective view of the basic components of the switch of FIGURE 1;

FIGURE 3 is a cross section taken in the direction of the arrows 3—3 of FIGURE 1;

FIGURE 4 is a fragmentary perspective view of one of the components of the switch; and

FIGURE 5 is a side view partly in cross section taken generally in the direction of the arrows 5—5 of FIGURE 1.

Referring first to FIGURE 1, the switch comprises a block **10** preferably in the shape of an elongated rectangle in side view with a square cross section. As shown, the block includes a mounting flange **11** and first, second, third, and fourth co-axial terminals **12**, **13**, **14**, and **15** extending inwardly from the sides of the block. Also shown in FIGURE 1 is a terminal post **16** for connection to a source of electrical energy to operate the switch.

Referring now to FIGURE 2, the block **10** is shown in fragmentary form wherein it will be noted that there is provided a central opening **17** preferably cylindrically shaped, the axis of the central opening being normal to the axes of the respective co-axial terminals **12**, **13**, **14**, and **15**. The terminals intercept the cylindrical sidewalls of the central opening **17** at points successively circumferentially spaced at ninety degrees.

Arranged to be reciprocally mounted in the central opening **17** is a switching member **18** in the form of a cylinder provided with a first pair of internal passages **19** and **20**. As shown, each of these passages open out on the surface of the cylinder **18** in ends **19***a* and **19***b* for the passage **19** and **20***a* and **20***b* for the passage **20**. The cylindrical block **18** also includes a second pair of internal passages **21** and **22** axially spaced along the cylindrical member and similarly opening out on the surface in ends **21***a*, **21***b*, and **22***a* and **22***b*.

The ends **19***a*, **19***b*, **20***a*, **20***b*, **21***a*, **21***b*, **22***a*, and **22***b* are positioned such that when the cylinder is received within the central opening **17** and moved to a first position all the way within the opening, the internal passage **19** will connect the first and second co-axial terminals **12** and **13** and the internal passage **20** will connect the third and fourth co-axial terminals **14** and **15**. When the switching member **18** is moved to a second or slightly retracted position, the second and third co-axial terminals **13** and **14** are connected by the internal passage **21** and the fourth and first co-axial terminals **15** and **12** are connected by the internal passage **22**.

The cylinder **18** includes a plunger element **23** forming an axial extension thereof and an annular stop flange **24**, the purposes for which will be described subsequently.

The manner in which the various connections are actually effected will become clearer by reference to FIGURE 3 wherein the switching member is shown in its first position so that the passages **19** and **20** are connected to the co-axial terminals **12** and **13** and the co-axial terminals **14** and **15**. It will be evident from FIGURE 3 that the internal co-axial lines **19** and **20** define smooth arcuate passages which intercept the surfaces of the cylinder **18** normally so that they will form proper continuations of the ninety degree spaced co-axial terminals to which they are connected.

In order to prevent rotation of the switching member **18**

within the central opening 17, there are provided keying means in the form of a pair of opposed annular grooves 25 and 26 running laterally on the surface of the cylindrical member 18 and the internal wall of the central opening 17, respectively. As shown in both FIGURES 2 and 3, when the annular grooves are juxtaposed, they define a circular race in cross section for receiving any suitable keying means such as ball bearings 27. The diametrically opposite portions of the cylinder 18 and opening 17 similarly include opposed annular grooves 28 and 29 defining a closed race for receiving ball bearings 30. The ball bearings prevent relative rotation and also facilitate reciprocating movement of the member 18 within the central opening 17.

In order to insure good conductivity, even after prolonged use, the co-axial terminals include biased conducting contacts such as indicated at 31 arranged to physically engage the inner conductors of the connecting lines within the internal passages and the inner conductors of the co-axial terminals themselves. These conducting contacts are identical for each of the co-axial terminals and, therefore, description of one will suffice for all.

Thus, referring to the enlarged view of FIGURE 4, there is shown the contact 31 including a flat head portion 32 for engagement with the end of the inner conductor in the internal passage 19 of FIGURE 3. The contact also includes a body portion having a conical surface 33. This surface is arranged to cooperate with a plurality of spring fingers 34 at one end of a cylindrical element 35, the other end of which is secured to the inner conductor of the associated co-axial terminal 12. With this arrangement, and the plurality of spring fingers 34 biased radially inwardly, it will be evident that as a consequence of their engagement with the conical surface 33, the conducting contact will be urged in the direction of the arrow away from the fingers and thus pressed into engagement with the outer surface of the cylindrical switching member 18. The biasing feature will maintain good contact even after considerable wearing of the contact head 32 has taken place.

Proper electrical continuity between the outer conductors of the co-axial lines is realized by making the cylinder 18 fit within the central opening 17 with a very close tolerance so that a large capacitance between the cylinder 18 and block 10 is realized in any small spaces that are not actually in electrically conducting engagement.

FIGURE 5 illustrates diagrammatically one means for actuating the switching member 18 from a remote location. As shown, electro-magnetic coils 36 surround the plunger 23 such that upon energization, the switch member 18 will be moved from its first to its second position. A biasing return spring 37 extends between the annular flange 24 and end of the casing 10 for the assembly. The biasing spring 37 biases the switch member 18 to its first position as shown in FIGURE 5. The coils 36 are energized by connecting the leads in the terminal post 16 to a suitable source of electrical energy.

From the foregoing description, the operation of the switch of this invention will be evident. In the absence of any electrical energy for the coils 36, the spring 37 biases the switching member 18 to its innermost position within the central opening 17 as shown in the solid lines of FIGURE 5. In this position, the first and second co-axial terminals 12 and 13 are connected together by the internal passage 19 and the second and third co-axial terminals 14 and 15 are connected together by the internal passage 20.

When it is desired to change the connections, the elctromagnetic coils are energized to retract the switching member 18 or move it to the right as viewed in FIGURE 5. As described heretofore, the ball bearings 27 and 30 facilitate this motion and also key the member 18 within the cylindrical opening 17 to prevent relative rotation.

When the member has been moved to the second position, the second co-axial terminal 13 will be connected to the third co-axial terminal 14 as indicated faintly by the dotted line passages in FIGURE 3 and the fourth co-axial terminal 15 will be connected to the first co-axial terminal 12 as also indicated by dotted lines representing the second pair of internal passages. De-energization of the coils 36 will result in the spring 37 returning the switching member 18 to its first position.

The actual movement of the member 18 need be only slightly greater than the diameter of the co-axial lines connected.

From the foregoing, it will be evident that the present invention has provided a greatly improved co-axial switch structure. Not only is compactness achieved as a consequence of the particular design requiring only a linear motion which may be readily effected by a solenoid type structure as described, but proper continuity is also assured. Further, switching is extremely rapid since the switch member need only move a relatively short linear distance.

While only one particular embodiment has been shown and described, changes and modifications which fall clearly within the scope and spirit of this invention will occur to those skilled in the art. The co-axial switch is therefore not to be thought of as limited to the one example set forth merely for illustrative purposes.

What is claimed is:

1. A co-axial switch comprising, in combination: a block having a central opening; first, second, third, and fourth co-axial terminals extending inwardly from the sides of said bolck in directions normal to the axis of said central opening to intercept the inner sidewalls of said central opening; a switching member in said central opening movable along said axis between first and second positions, said switching member including a first pair of internal passages opening out on the surface of said member in positions to connect said first and second co-axial terminals together and said third and fourth co-axial terminals together when said member is in said first position, and including a second pair of internal passages opening out on the surface of said member in positions to connect said second and third co-axial terminals together and said first and fourth co-axial terminals together when said member is in said second position.

2. A co-axial switch according to claim 1, including a plunger secured to said switching member; electromagnetic coils surrounding said plunger in position to actuate said plunger to move said switching member from said first to said second position upon energization; and means biasing said member to said first position when said coils are de-energized.

3. A co-axial switch according to claim 2, in which said central opening is cylindrical and said switching member has an exterior cylindrical surface receivable with close tolerance in said central opening, said co-axial terminals including inner conductor contacts intercepting said sidewalls at points successively circumferentially spaced ninety degrees; means biasing said inner conductor contacts towards said exterior cylindrical surface of said switching member; and means keying said member within said central opening to prevent relative rotation therebetween.

4. A co-axial switch according to claim 3, in which said inner conductor contacts each have an engaging head and a body including a conical surface portion, said means biasing said conductor contacts each comprising a cylindrically shaped element secured at one end to the inner conductor of its associated co-axial terminal and including at its other end a plurality of spring fingers biased radially inwardly, said spring fingers engaging said conical surface portion of said body.

5. A co-axial switch, including,

a block having an annular opening extending in an axial direction through the block and having first and second openings which are disposed in axially spaced

relationship and which extend radially into communication with the annular opening;

first and second electrically conductive terminals each disposed in an individual one of the first and second openings in the block and each extending into the central opening in the block;

an electrically conductive switching member mounted in the central opening of the block and each movable axially to first and second positions and electrically engaging the first terminal in the first axial position of the switching member and electrically engaging the second terminal in the second axial position of the switching member;

means extending from the block into the central opening and into coupled relationship with the switching member for inhibiting any annular displacement of the switching member relative to the block and to the first and second terminals;

means operatively coupled to the switching member for biasing the switching member to the first axial position; and

means operatively coupled to the switching member for actuating the switching member to the second axial position.

6. The co-axial switch set forth in claim 5, including,

means operatively coupled to the first and second terminals for biasing the first and second terminals toward the central opening in the block to enhance the electrical engagement between the terminals and the switching member.

References Cited in the file of this patent

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