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REMOTELY OPERABLE CO-AXIAL SWITCH

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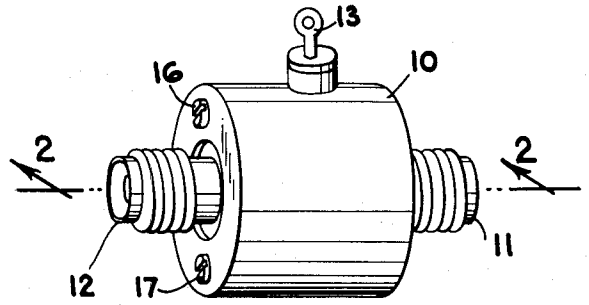


FIG. 1

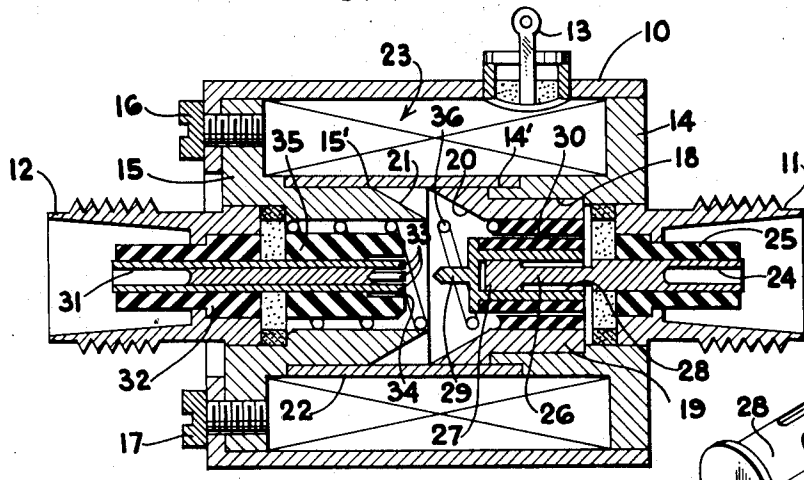


FIG. 2

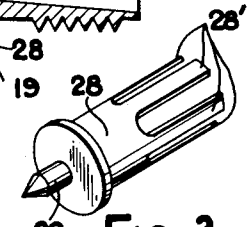


FIG. 3

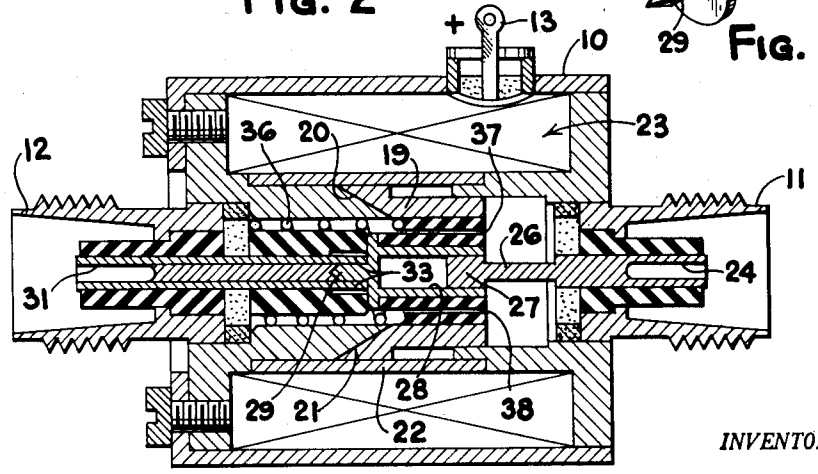


FIG. 4

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REMOTELY OPERABLE CO-AXIAL SWITCH

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This invention relates generally to electrical switches and more particularly to a remotely operable miniaturized co-axial switch for connecting and disconnecting co-axial lines.

It is desirable to provide connect and disconnect switches for co-axial lines which are not only rugged and compact to avoid appreciable increases in the dimensions of the co-axial lines themselves, but which maintain the co-axial relationship between the inner and outer conductors of the lines when connection is effected. It is also a desirable feature to be able to operate such switches from remote quarters to the end that switching of several lines may be controlled from a single location.

With the foregoing in mind, it is a primary object of the present invention to provide an improved co-axial switch design which is both rugged and compact and which will maintain the co-axial relationship of the inner and outer conductors of the lines when in connected position.

Another important object is to provide a switch of the foregoing type which includes input and output connectors in axial alignment so that incorporation of the switch in a co-axial line system will not disrupt the direction of the lines or appreciably increase the overall dimensions of the lines themselves to the end that the switch is extremely useful in environments in which weight and space are at a premium.

Other objects of this invention are to provide an improved switch design which may be remotely operated by electrical power but which has a "fail-safe" feature in that a sudden interruption of power supplied to operate the switch will result in the switch moving to its open position.

These and many other objects and advantages of this invention are attained by providing a casing structure having input and output axially aligned exterior connectors for input and output co-axial lines. Within the casing there is provided an axially aligned movable plunger. This plunger includes a central probe and an outer annular conductor in slidable telescopic relationship with the inner and outer conductors of one of the connectors. The arrangement is such that movement of the plunger from a first to a second position will cause the central probe and outer annular conductor to engage the inner and outer conductors of the other connector so that the plunger itself constitutes a co-axial bridge structure for the inner and outer conductors of the connectors.

The casing also includes a bias means in the form of a spring normally urging the plunger to the first position in which it is disengaged from the inner and outer conductors of the other of the connectors. Movement of the plunger is accomplished by electro-magnetic coils surrounding the plunger, the plunger itself including magnetic material so that it will be moved axially upon energization of the coils. By this arrangement, the entire switch is of annular form having a central axis of symmetry and thus may be made relatively compact and with minimum overall outside dimensions.

A better understanding of the preferred embodiment of the invention will be had by referring to the accompanying drawings, in which:

Figure 1 is an overall perspective view of the co-axial switch;

Figure 2 is an enlarged cross sectional view taken in the direction of the arrows 2—2 of Figure 1 showing the switch in open position;

Figure 3 is a perspective view of the inner probe member of the plunger of Figure 2; and,

Figure 4 is another cross sectional view similar to Figure 2 but illustrating the switch in its closed or connected position.

Referring first to Figure 1, the switch comprises a casing **10** provided with input and output threaded connectors **11** and **12**. When suitable input and output co-axial lines are threaded to the connectors **11** and **12**, the overall dimensions of the casing **10** are not appreciably larger than the outside dimensions of the co-axial lines.

As shown in Figure 1, there is provided an electrical terminal lug **13** for energizing suitable electro-magnetic coils within the casing **10**.

Referring to Figure 2, the casing **10** includes annular end cap structures **14** and **15**, respectively, on the right hand and left hand end of the casing. The end cap **15** may be secured to the left hand end of the casing as by screws **16** and **17**. By this arrangement, the casing may be readily disassembled.

In effect, the end caps **14** and **15** form continuations of the outer conductors of the connectors **11** and **12**. As shown, the end cap **14** includes a reduced annular section extending within the casing and defining an inside cylindrical surface portion **18** which is in electrically conductive relationship with the outer connector **11**. Within this cylindrical portion **18**, there is provided a plunger including an outer annular conductor **19** terminating in a first conical end surface **20**, also in electrically conductive relationship with the connector **11**. The end cap **15** which effectively forms a continuation of the outer conductor for the connector **12** terminates in a second annular conical surface **21** arranged to mate with the surface **20** of the plunger.

A cylindrical sleeve **22** is secured within annular reduced diameter portions **14'** and **15'** of the end caps **14** and **15** respectively, and serves as a core for electromagnetic coils connected to the terminal lug **13** and schematically indicated at **23**. The center of these coils is axially positioned to the left of the plunger so that energization of the coils will move the plunger to the left.

Referring particularly to Figure 2, the inner conductor **24** of the connector **11** is held in co-axial relationship by a conventional insulating spacer **25**. As shown, this inner conductor extends centrally within the plunger and includes a recessed portion **26** terminating in a contact head **27**. This head in turn fits within a central probe **28** constituting a part of the plunger. The probe **28**, as shown in Figure 3, is in the form of a tubular member having a series of lateral slots defining a plurality of spring fingers **28'**. The head of the probe **28** terminates in a contacting stem **29**. The entire central probe **28** is rigidly supported by an annular insulating member **30** to the outer annular conductor **19** of the plunger and thus is movable as a part of the plunger.

The inner conductor **31** of the connector **12** at the left hand portion of Figure 2 extends within the casing and is held in co-axial relationship by means of an annular insulating spacer **32**. This inner conductor terminates within the casing in a plurality of spring fingers **33** arranged to receive the stem **29** of the central probe of the plunger. The fingers **33** may radially flex within an annular recessed area **34** in a surrounding insulator **35**.

The insulator **35** has an outside diameter slightly less

than the inside diameter of the inner surface of the end cap **15** to define an annular space for receiving one end of the compression spring **36**. The other end of this compression spring exerts a biasing force against the annular insulating member **30** of the plunger to hold the plunger structure to the extreme right as illustrated in Figure 2. The annular insulating member **30** itself may contain a plurality of small bores or bleeder holes **37** and **38** to permit air to pass from one side of the plunger to the other upon movement of the plunger.

The operation of the co-axial switch will be evident from the foregoing description. In the absence of any electrical energy passing into the terminal lug **13** and through the coils to ground via the outer casing itself, the coils will be unenergized. The spring **36** will accordingly maintain the plunger structure in its first or open position as illustrated in Figure 2. In this position, the inner conductor **24** of the input connector **11** is electrically disconnected from the inner conductor **31** of the output connector **12** and thus co-axial lines connected to the connectors **11** and **12** will be disconnected.

When electrical power is supplied to the lug **13** from a remote location to operate the switch, the magnetic field established by the electro-magnetic coils will move the plunger to the left until the first conical end surface **20** of the outer annular conductor of the plunger **20** engages the corresponding mating conical end surface **21** of the end cap **15**. The stem **29** in turn will be received within the spring fingers **33** of the inner conductor **31** as shown in Figure 4. By providing conical surfaces, not only is a large contact area provided but centering action is insured.

Referring to Figure 4, it will be noted that there is full electrical continuity between the inner and outer conductors of the output connector **12** and the central probe **28** and outer annular conductor **19** of the plunger respectively. Also, it will be noted that the contact head **27** of the inner conductor **24** is in engagement with the spring fingers **28'** of the central probe but that the central probe has not been telescoped beyond this end. Similarly, a portion of the outer circumferential surface of the outer annular conductor **19** is retained in enagement with the inner surface **18** of the end cap **14** which forms a continuation of the outer conductor of the connector **11** so that complete connection between the input and output connectors **11** and **12** obtains. Moreover, as a consequence of the construction described, the co-axial relationship of the various inner and outer conductors is maintained.

Should electrical power to the terminal lug **13** fail, the biasing spring **36** will immediately throw the plunger to the right back to the position illustrated in Figure 2 to disconnect the circuit. The entire structure is rugged and reliable in operation. Preferably, the center of action of the coils **23** is displaced sufficiently with respect to the movable plunger that wearing of any of the contact surfaces will simply result in the plunger moving further to the left as viewed in Figures 2 and 4 to insure consistent physical engagement. As mentioned heretofore, as a consequence of the symmetry of the switch about its central longitudinal axis, its outside dimensions can be maintained at a minimum and thus the desired feature of compactness is achieved.

Minor modifications that fall within the scope and spirit of this invention will readily occur to those skilled in the art. The remotely operated co-axial switch is, therefore, not to be thought of as limited to the exact embodiment merely set forth for illustrative purposes.

What is claimed is:

1. A co-axial switch for connecting and disconnecting two co-axial lines each having inner and outer conductors, including: a casing; a plunger made of magnetic material movable in said casing, said plunger having a central probe and outer annular conductor in telescoping slidable relationship with the inner and outer conductors respectively of one of said co-axial lines; and electromagnetic coils surrounding said plunger for moving said plunger from a first position in which said central probe is disconnected from the inner conductor of the other of said co-axial lines to a second position in which said central probe is in electrical engagement with the inner conductor of said other of said co-axial lines, said plunger serving the dual function of moving one inner conductor of said two co-axial lines into engagement with the other and defining a bridging outer conductor therefor when said connection is effected.

2. A co-axial switch comprising, in combination: a casing having an input and an output co-axial connectors in axial alignment, each connector having inner and outer conductors; a plunger movable back and forth in said casing, said plunger including an inner coducting probe and outer annular conductor co-axially surrounding said probe, said plunger being in slidable engagement with the inner and outer conductors of said input connector respectively; and means for moving said plunger from a first position in which said probe and annular conductor are separated from the inner and outer conductors of said output connector respectively to a second position in which said probe and annular conductor are in engagement with said inner and outer conductors of said output connector.

3. The subject matter of claim 2, in which said outer annular conductor of said probe terminates in a first conical end, the outer conductor of said output connector terminating in a second conical end mating with said first conical end when said plunger is in said second position; and a biasing spring within said casing biasing said probe towards said first position.

4. The subject matter of claim 3, in which said means for moving said plunger comprises electro-magnetic coils surrounding said plunger within said casing and axially positioned with respect to said plunger to move said plunger upon energization of said coils towards said output connector.

5. A remotely operable co-axial switch comprising, in combination: a casing having input and output co-axial connectors in axial alignment; a cylindrical sleeve co-axially positioned with respect to the outer conductors of said connectors; a movable plunger co-axially positioned within said sleeve and made of magnetic material, the inner conductor of said output connector terminating centrally in said sleeve and the inner conductor of said input conductor being connected to said plunger; and electro-magnetic coils surrounding said sleeve and adapted upon energization to move said plunger axially within said sleeve from a first position in which said inner conductors are separated to a second position in which said inner conductors are connected.

6. The subject matter of claim 5, in which said plunger includes an outer annular conductor terminating in a first conical end surface, the outer conductor of said output connector terminating within said sleeve in a second conical end surface for mating with said first conical end surface when said plunger is moved to said second position, said plunger including a central tubular conductor having longitudinally extending slots over a portion of its length to define spring fingers; and an annular insulator positioned between said tubular conductor and said outer annular conductor, said spring fingers engaging said inner conductor in telescoping sliding relationship to maintain electrical contact therewith as said plunger moves from said first to said second position.

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