Oct. 25, 1960 C. W. CONCELMAN 2,957,963

COAXIAL LINE SWITCH APPARATUS

Filed Jan. 13, 1958 2 Sheets-Sheet 1

Fig. 1.

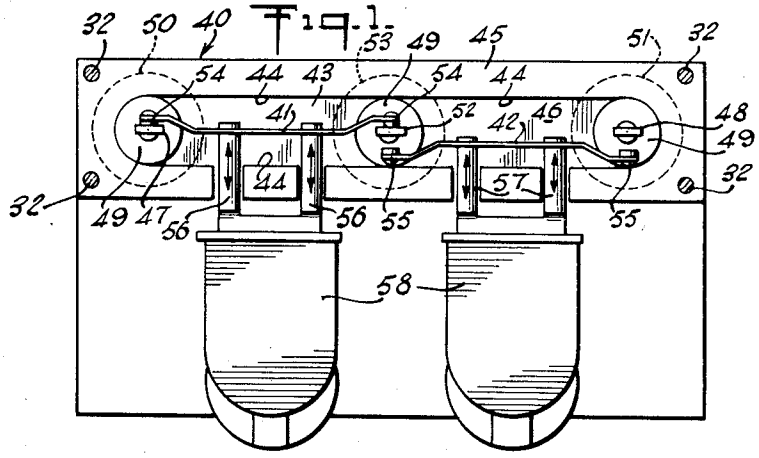


Fig. 5.

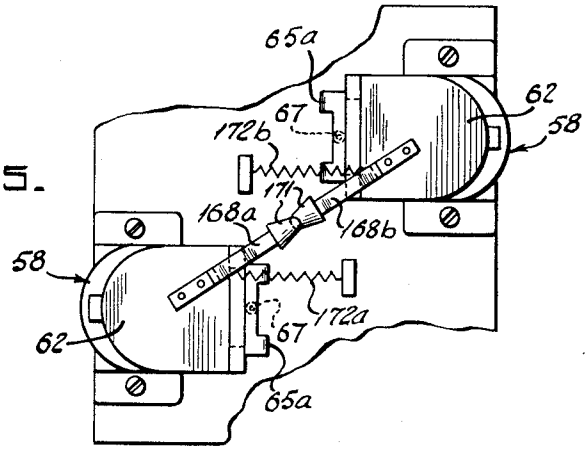
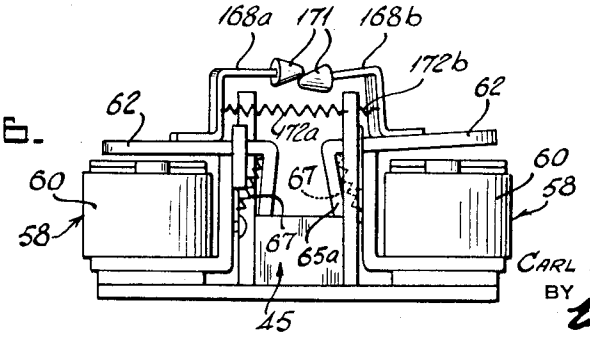


Fig. 6.



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Oct. 25, 1960 C. W. CONCELMAN 2,957,963

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Filed Jan. 13, 1958 2 Sheets-Sheet 2

Fig. 2.

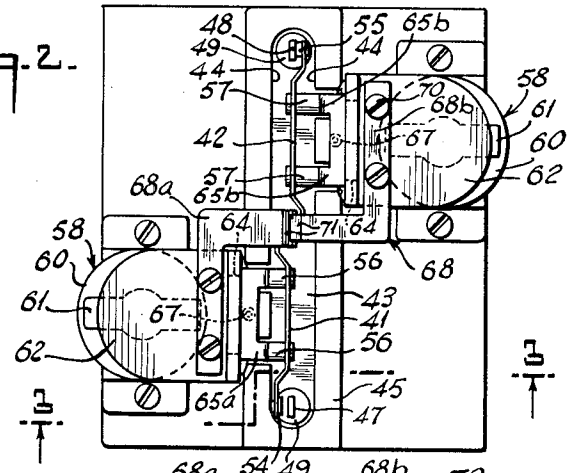


Fig. 3.

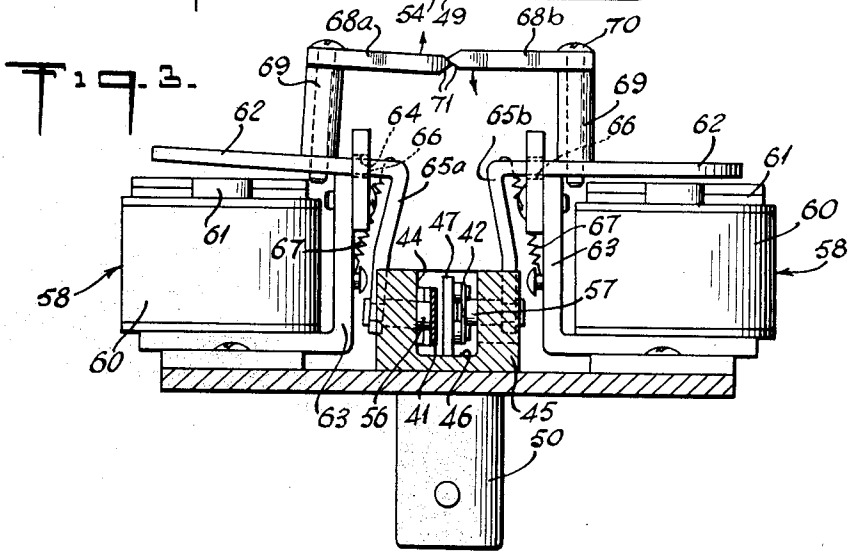
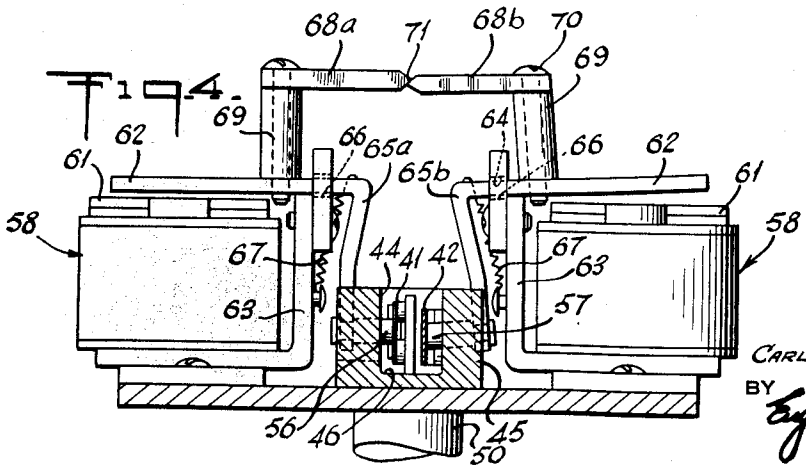


Fig. 4.



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COAXIAL LINE SWITCH APPARATUS

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4 Claims. (Cl. 200—98)

This invention relates to electrical switch relays and more particularly to switch relays adapted to connect independently or selectively a first high frequency coaxial transmission line to any one of a plurality of high frequency coaxial transmission lines.

The instant application is a continuation-in-part of my copending application Serial No. 627,049, filed December 7, 1956 for Coaxial Line Switch Apparatus.

The invention shown and claimed herein contemplates relay switch apparatus affording improved cross-talk characteristics by minimizing cross-talk over a wider band of frequency operation in comparison to the results heretofore achieved. As used herein cross-talk means picking up a signal in the inactive transmission line circuit which may be opened, grounded or resistor terminated as a result of a relatively imperfect isolation of such inactive line from the active circuit.

It is, therefore, the main object of the instant invention to provide electrical switch relay apparatus providing means for interconnecting individually and selectively a first coaxial transmission line to any one of a plurality of coaxial transmission lines and affording improved, broad band operation with better cross-talk characteristics than heretofore achieved.

It is a further object of the instant invention to provide coaxial transmission line relay switch apparatus in which a first of such transmission lines may be individually or selectively connected to a plurality of such lines by movable switching arms, suspended in the relay chamber, which arms are translated through planes substantially parallel to certain of the chamber walls to effect electrical connection and isolation. The apparatus contemplates a further advantage in that the arms may be activated by independent actuators to provide alternatingly electrical engagement and disengagement of any one of the plurality of lines in respect to said first line regardless of the disposition of the remainder of the plurality of lines. The invention also contemplates interlocking said actuators by reciprocating latching means wherein energization of one of said interlocked actuators mutually reverses the respective positions of a pair of switching arms to effect corresponding transmission line connection and disconnection.

It is still a further object of the instant invention to provide a coaxial transmission line relay switch in which position conductive connections are realized by movable switching arms adapted to connect or isolate any one of a number of such coaxial lines in respect to a particular one of such lines.

It is still a further object of the instant invention to provide a coaxial transmission line relay switch that is economical to fabricate and simple to use for connecting and isolating any one of a number of such coaxial lines in respect to a particular one of such lines and adapted to provide improved cross-talk, broad band operation.

It is a further object of the instant invention to provide coaxial transmission line relay switch apparatus in which a first of such transmission lines may be connected

to any one of a plurality of such lines by moving juxtaposed switching arms suspended in the switch chamber from one to another of two positions and wherein adjacent contact points of juxtaposed switching arms are so disposed to effect electrical contact with opposite sides of the inner conductor terminal of the center coaxial line connector of the switch so that said terminal area need be only large enough to accommodate a single contact point wherein the discontinuity provided by said terminal in the chamber is minimized to avoid excessive impedance mismatch by such discontinuities and wherein the aforesaid structural arrangement permits any one of the plurality of coaxial line connectors to be taken out from any one of a pair of opposed chamber side walls to allow connector connections to the switch embodying the invention from either one of the sides as determined by the overall circuit requirements in which the switch is to be installed.

It is a further object of the instant invention to provide electrical switch relay apparatus wherein a first coaxial transmission line may be interconnected with either one of a pair of coaxial transmission lines by means of individual signal responsive actuators mounted on respective ones of opposite sides of said switch and wherein such actuators are interconnected by reciprocating latching means so that the application of a signal to any one of the actuators interconnects the correlated coaxial transmission line of said pair to the first coaxial transmission line and simultaneously disconnects the other transmission line of said pair from said first transmission line.

Further objects and advantages will become apparent from the following description of the invention taken in conjunction with the figures, in which:

Fig. 1 is an elevational view of the switch incorporating the improvements of the instant invention;

Fig. 2 is an elevational view of a modified embodiment illustrating a switch incorporating said improvements wherein the push rods carrying switching arms operated from opposite side walls of the switch chamber and also incorporates synchronizing switching structure wherein operation of one switch arm automatically operates the other interconnected switch arm so that the circuits interconnected thereby are operated whereby one circuit is inactivated as the other circuit is activated;

Fig. 3 is an end view of the apparatus shown in Fig. 2 taken along line 3—3 of Fig. 2 and illustrates the circuit connected to the righthand switching arm in activated position whereas the circuit connected to the lefthand switching arm is inactivated;

Fig. 4 corresponds in all respects to Fig. 3 except that the righthand circuit is now inactivated whereas the lefthand circuit is activated; and

Figs. 5 and 6 are diagrammatic views of a modified version of the switch shown in Figs. 2 to 4 wherein the relay latching mechanism involves certain changes in respect to the prior version.

Reference is now made to Fig. 1 wherein an electrical switch 40 is constructed in accordance with the principles of the instant invention. Switch 40 has a longitudinally extending chamber 43 defined in part by upper and lower conducting side walls 44 in the interior of a current conducting switch support member 45. Chamber 43 is completed by opposite end walls and a second pair of opposite conductive side walls 46, one of which is removable. To permit the interior of chamber 43 to be illustrated Fig. 1 shows one wall 46 removed. Switch 40 may be constructed of any suitable material and in cross-section chamber 43 is substantially uniform and square. A square cross-section provides mechanical convenience of manufacture. Switching action is brought about by lateral movement of two relatively thin inde-

pendently operating resilient conducting arms 41, 42 extending longitudinally in chamber 43. Arms 41, 42 are suspended to move through a plane substantially parallel to side walls 44. Arms are shaped and disposed to connect and disconnect individual and respective ones of a pair of coaxial transmission line connectors made up of inner conductors 47, 48 supported by dielectric material 49 within respective outer conductors 50, 51 to a center coaxial line connector made up of an inner conductor 52 supported by dielectric 49 in outer conductor 53. The output connector 52—53 is disposed between the pair of input connectors 47—50 and 48—51, the latter being at the opposite ends of chamber 43. The three connectors extend along spaced apart substantially parallel axes. The outer conductors 50, 51 and 53, at the inner ends thereof, are conductively connected to the chamber walls and at the outer ends are provided with suitable couplings for connection of individual coaxial transmission lines thereto. The inner ends of conductors 47, 48, 52 terminate within chamber 43.

In the plane of side walls 46 to which the connectors are joined, the inner diameters of outer conductors 50, 51, 53 are approximately equal to the vertical cross-sectional dimension of chamber 43 to minimize impedance mismatch. It will be understood that the parameters of chamber 43 and arms 41, 42 are proportioned to provide an approximate impedance match with the connectors and associated transmission lines. The inner terminating ends of the inner conductors 47, 48, 52 are provided with opposite faces disposed within chamber 43 to permit good electrical contact with contact points 54, 55 at the opposite ends of arms 41, 42.

Arms 41, 42 are suspended within chamber 43 by pairs of cylindrical pin members or push rods 56, 57 of suitable dielectric material projecting through respective sets of openings in either one of chamber walls 44. Arm 41 is shaped and adapted to contact conductively the upper flat faces of the terminating ends of inner conductors 47, 52; whereas arm 42 is shaped and disposed to connect conductively to the lower flat faces of inner conductors 48, 52. The arrangement of employing the opposite sides of the terminating end of inner conductor 52 to accommodate respective ones of the adjacent contact point ends 54, 55 of the two arms 41, 42 minimizes the area of such terminating end and thus decreases the electrical discontinuity created thereby in chamber 43 so as to reduce its mismatch. Actuating means 58 may be suspended from the exterior of support 45 for imparting inward and outward motion to pins 56, 57 as illustrated by the arrows. Such motion produces conductive interconnection between either one of the input conductors 47, 48 to output conductor 52 at the end of travel of arms 56, 57 toward the correlated inner conductors. Travel in the opposite direction grounds arms 41, 42 respectively to the upper and lower chamber walls 44 and thus isolates the connector of the unconnected inner conductor from the remainder of the circuit. Both contact points 54, 55 of each arm are brought in conductive contact with a chamber wall 44 when the arms thereof are in the grounding position to render correlated input connectors and the associated transmission lines inactive. Cross-talk otherwise induced by inductive loops, as noted in prior art apparatus, is thus minimized. In addition, the parameters of chamber 43 may be selected to define in the region of the grounded arm a waveguide operating below cut-off for the frequency band of operation which suppresses cross-talk signals. For example, in Fig. 1, the righthand side of chamber 43 by reason of its parameters acts as a waveguide below cut-off.

In width, arms 41, 42 are less than the wide dimension of chamber 43 to permit up and down translation. In Fig. 1, arm 41 is shown in a position effecting electrical connection between conductor 47 and conductor 52, whereas arm 42 is shown in a position isolating the righthand input connector from the remainder of the relay circuit. The shape and disposition of arms 41, 42 are such that contact points 54, 55 thereof are caused to bear firmly against the terminating ends of correlated inner conductors or against chamber wall 44 upon completion of arm travel. This arrangement produces, for both conditions, positive conductive connections. In addition to the advantages of positive electrical contacts, the low mass, freely moving arms 41, 42 allow the use of a relatively small servo means 58 to effect positive electrical contact. In addition, switch 40 is capable of handling greater power than an equivalent prior art structure because of the double make and break gaps at both ends of arms 41, 42 which increases the arcing and breakdown voltage the switch can withstand. Additionally, each arm may be operated by independent actuating means 58 thereby imparting better control to relay switch operation and providing greater switching versatility. Either one of the input conductors 47, 48 may be connected to or disconnected from conductor 52 as determined by the signals applied to respective actuating means regardless of the position of the other input conductor. Moreover, this type of structure is adaptable to the use of low priced simple hinged clapper types of relay actuators.

The foregoing described switch has actuator servos 58 stationed along the exterior of one side wall of chamber support 45. In addition, all connectors are taken out from the same side wall of switch support 45. Nevertheless the invention permits switch embodiments of different physical arrangements to accommodate the various circuit arrangements in which a switch of this type may be used. For example, it is within the contemplation of the invention to have any of the connectors taken out from one or the other of the opposed side walls 46. Moreover, any one of the end connectors may be taken out from its adjacent end wall. Furthermore, is should be understood that servo actuators 58 may be ganged so that as one end connector is interconnected to the center connector, the other end connector will be disconnected therefrom.

Should the need arise for mounting individual ones of the servo actuators 58 on opposite sides of chamber support 45, or for interlocking said actuators, a switch embodying the invention may be modified as illustrated in Figs. 2 through 6. These figures also show the clapper type of relay actuators in greater detail. In describing the embodiments of Figs. 2 through 6, the reference numbers employed hereinbefore will be used to designate like elements. Servo actuators 58 are clapper type of relays each made up of a relay coil 60 mounted coaxially about a core 61 of magnetic material. Each relay coil 60 is provided with an operatively associated armature 62 suitably spaced from its correlated relay coil by mounting structure including an upright bracket wall 63 having a through slot 64. Each armature 62 is suitably shaped to pass through its respective bracket slot 64 and supported thereat to pivot at a fulcrum 66 provided by the edges of said slot 64. Consequently, it will be understood that the segment of armature structure and juxtaposed edges of bracket slot 64 are suitably shaped and mutually disposed one with respect to the other to permit pivoting of each armature from one to another of two positions. In one position, the armature 62 will be spaced a further distance from their correlated coils 60, note the position of the armature of the lefthand relay in Fig. 3 in contrast with the position of the armature of the righthand relay of the same figure wherein the latter armature is spaced close to its correlated coil which depicts the second position. The exterior ends of push rods 56, 57 carrying respective conductive arms 41, 42 are fastened to the lower ends of depending legs 65*a*, *b* of respective ones of said armatures. Each armature is spring biased by a tension spring 67 connected at one end to its respective armature and the other end to the bracket structure. Spring 67 pulls on its armature 62 so as to maintain armature in its posi-

tion spaced far from its correlated coil, but it will be understood upon energization of the coil **60**, the pivoted clapper armature **62** is drawn toward the coil against the action of the extended spring **67** which in turn causes the conductive arms **41** or **42** carried by depending legs **65***a*, *b* to move in a direction to interconnect the correlated one of said inner conductors to the center inner conductor.

In accordance with the practice of the instant invention, servo actuators **58** may be ganged by a reciprocating latching mechanism so that upon energizing only one relay, that is to say, the relay operatively associated with the conductive arm in its grounded position (note arm **41** in Figs. 2 and 3) switch action is produced wherein the grounded arm is moved to its activated position whereas the initially activated arm (arm **42** in Figs. 2, 3) is simultaneously moved to its grounded position. This may be brought about by the structure shown in Figs. 2 through 4 wherein the latching mechanism includes L-shaped pawl members **68** which are supported from respective armatures **62**. The interlocking structure includes substantially coplanar L-shaped members spaced above and supported from respective armatures **62** by columns **69** and screws **70**. The lateral arms **68***a*, *b* of the L-shaped members are turned towards each other and are aligned to extend over switch support **45** midway between the ends of the switch. This arrangement also provides a clearance at the ends of switch support **45** should one prefer to take either one or both of the end conductors out from the side wall opposite the one from which they are taken in the illustrated embodiment. Arms **68***a*, *b* are provided with slidably interlocking faces **71** substantially V-shaped in cross-section wherein the lower inclined face of either one of the pawl faces is adapted to engage the upper inclined face of the other pawl. It will be understood that these faces are suitably shaped so that upon pivoting of one armature, for example, the armature of the lefthand coil in Fig. 3 in a counterclockwise direction as shown by the correlated arrow, the slidably interlocking pawl faces reverse their respective positions by assuming the position shown in Fig. 4 which means that as the lefthand member lifts up, the righthand member first lifts up slightly until it clears its engagement and then drops down to permit the members to come to rest as shown in Fig. 4.

The operation of the switch shown in Figs. 2 through 4 will now be described. It will be assumed that the switch is in position as illustrated in Fig. 3, wherein armature **62** of the righthand coil is held close to its respective coil, in spite of the fact that this coil is not energized. Thus its operatively associated arm **42** is held in its interconnected position wherein inner conductors **48**, **52** remain connected because its armature cannot pivot clockwise to drop its pawl **68***b* by reason of the fact that said pawl is held in such position by the other pawl **68***a*. Upon energizing coil **60** of the lefthand relay, its armature pivots in the counterclockwise direction as shown by the correlated arrow and now provides clearance to allow clockwise pivoting of pawl **68***b* so that the relay structure comes to rest in the position shown in Fig. 4 which simultaneously causes converse motion of respective ones of arms **41**, **42**. In the aforesaid structure, the circuits of conductors **48** and **52** are disconnected before the circuits of conductors **47** and **52** are connected. As a result, inner conductors **49**, **52** are now connected whereas arm **42** is now grounded. Inner conductors **49**, **52** will remain connected by reason of the foregoing described holding action even though coil **60** of the lefhand relay is then de-energized, and they will remain connected until the coil of the righthand relay is subsequently energized.

In the embodiment shown in Figs. 5 and 6, the relay latching mechanism is modified so that pawl members **168***a*, **168***b* are integral bent brackets at one end attached to respective armatures **62** and at the engaging ends provided with cone-shaped contacts **171**. The contacts **171** serve in lieu of V-shaped faces **71** of the prior embodiment. The members **168***a*, **168***b* are alined aslant with respect to the longitudinal chamber axis. It may also be preferable to spring load the latched relay armatures with additional springs **172***a*, **172***b* mounted to respective members **168***a*, **168***b* from juxtaposed portions of switch support **45**. Each spring **172***a*, **172***b* is loaded to urge its respective armature to pivot away from its correlated coil **60**. In other respects, the operation is that described hereinbefore.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An electrical switch for selectively and individually connecting a high frequency coaxial transmission line to any one of a plurality of transmission lines comprising, a switch support having a longitudinal internal chamber including opposed upper and lower interior conductor walls, a first coaxial connector for connection to said first transmission line and having a first inner conductor extending into said chamber, said first inner conductor having opposite upper and under sides confronting correlated ones of said chamber walls, a plurality of coaxial connectors for individual connection to the plurality of said transmission lines and having respective second and third inner conductors extending into said chamber on opposite sides of said first inner conductor, said second and third inner conductors each having opposite upper and under sides confronting correlated ones of said chamber walls, the respective axes of said inner conductors being normal to the longitudinal axis of said chamber, a plurality of longitudinal and resilient conductive arms supported in said chamber, individual ones of said arms having spaced contact portions bridging said first inner conductor and a correlated one of said second and third inner conductors for conductively contacting same, exterior dielectric means having portions extending into said chamber and operatively engaging a respective conductive arm for moving same from one to another of two positions, both contact portions of a first of said arms alternately undergoing make and break conductive contact with the upper sides of said first and second inner conductors respectively and said upper chamber wall as said arm moves from one to another of its two positions, both contact portions of a second of said arms alternately undergoing make and break conductive contact with the undersides of said first and third inner conductors respectively and said lower chamber wall as said arm moves from one to another of its two positions, individual relay coils on opposite exterior sides of said chamber, a pivotal armature operatively associated with each of said coils for movement from one to another of two positions in response to actuation of its correlated relay coil, means for returning each armature to one of its positions, a leg member carried by each armature to move therewith and also engaging an individual one of said dielectric means to impart movement to same, and a pair of pawl members each carried by a respective armature to move therewith, each pawl member having a V-shaped end surface in slidable reciprocating and interlocking operative engagement with the V-shaped end surface of the other pawl member wherein an upper inclined surface of one pawl member end is adapted to engage a lower inclined surface of the other pawl member end, said engaged pawl member ends releaseably holding each armature in a correlated pivotal position wherein one arm is in conductive contact with a pair of inner conductors and the other arm is in contact with the chamber wall, said pawl member ends also allowing said armatures to pivot to the other of their respective positions upon actuation of one of said relay coils wherein

the V-shaped ends of said pawl members shift one with respect to the other to reverse their respective positions thereby permitting converse shifting of said armatures to effect converse shifting of said arms from one to the other of their respective positions, the resilient characteristics of said arms allowing said engaging pawl member ends to overrun during shifting of same and to return to interlocked holding relationship.

2. Apparatus as defined in claim 1 wherein, said end surfaces are cone-shaped tips.

3. An electrical switch for selectively and individually connecting a first high frequency coaxial transmission line to any one of a plurality of transmission lines comprising, a switch support having a longitudinal internal chamber including opposed upper and lower interior conductive walls, a first coaxial connector for connection to said first transmission line and having a first inner conductor extending into said chamber, said first inner conductor having opposite upper and under sides confronting said chamber walls, a plurality of coaxial connectors for individual connection to the plurality of said transmission lines and having respective second and third inner conductors extending into said chamber on opposite sides of said first inner conductor, said second and third inner conductors each having opposite upper and under sides confronting correlated ones of said chamber walls, the respective axes of said inner conductors being normal to the longitudinal axis of said chamber, a plurality of longitudinal and resilient conductive arms supported in said chamber, individual ones of said arms having spaced contact portions bridging said first inner conductor and a correlated one of said second and third inner conductors for conductively contacting same, exterior dielectric means having portions extending into said chamber and operatively engaging a respective conductive arm for moving same from one to another of two positions, both contact portions of a first of said arms alternately undergoing make and break conductive contact with the upper sides of said first and second inner conductors respectively and said upper chamber wall as said arm moves from one to another of its two positions, both contact portions of a second of said arms alternately undergoing make and break conductive contact with the undersides of said first and third inner conductors respectively and said lower chamber wall as said arm moves from one to another of its two positions, individual relay coils on opposite exterior sides of said chamber, a pivotal armature operatively associated with each of said coils for movement from one to another of two positions in response to actuations of its correlated relay coil, means for returning said armature to one of its positions, a leg member carried by each armature to move therewith and also engaging an individual one of said dielectric means to impart movement to same, and a pair of pawl members each carried by a respective armature to move therewith, each pawl member having a V-shaped end surface in reciprocating and interlocking operative engagement with the V-shaped end surface of the other pawl member, wherein an upper inclined surface of one pawl member end is adapted to engage the lower inclined surface of the other pawl member end, said engaged pawl member ends releasably holding each armature in a correlated pivotal position wherein one arm is in conductive contact with a pair of inner conductors and the other arm is in conductive contact with said chamber wall, said pawl member ends also allowing said armatures to pivot to the other of their respective positions upon actuation of one of said relays wherein said pawl member ends shift one with respect to the other to reverse their respective positions thereby permitting converse shifting of said armatures, whereby each of said conductive arms shifts conversely from one correlated position to the other position.

4. Apparatus as defined in claim 3 wherein, said armatures having planar portions substantially parallel to the longitudinal axis of said chamber and adapted to pivot towards and away from its correlated coil, the leg member carried by each armature depending therefrom to engage an exterior end of an individual one of said dielectric means for effecting movement of same and the pawl member carried by each armature comprising, a first extension supported upright from its armature and a second extension supported from the upright end of said first extension, the second extensions of both pawl members being substantially aligned and extending in a plane substantially parallel with the longitudinal axis of said chamber, the V-shaped surfaces of said pawl members being at adjacent ends of said second extensions removed from the ends thereof joined to the upright ends of said first extensions.

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