Feb. 5, 1952 C. F. MILLER ET AL 2,584,901

COAXIAL RELAY

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FIG. 1

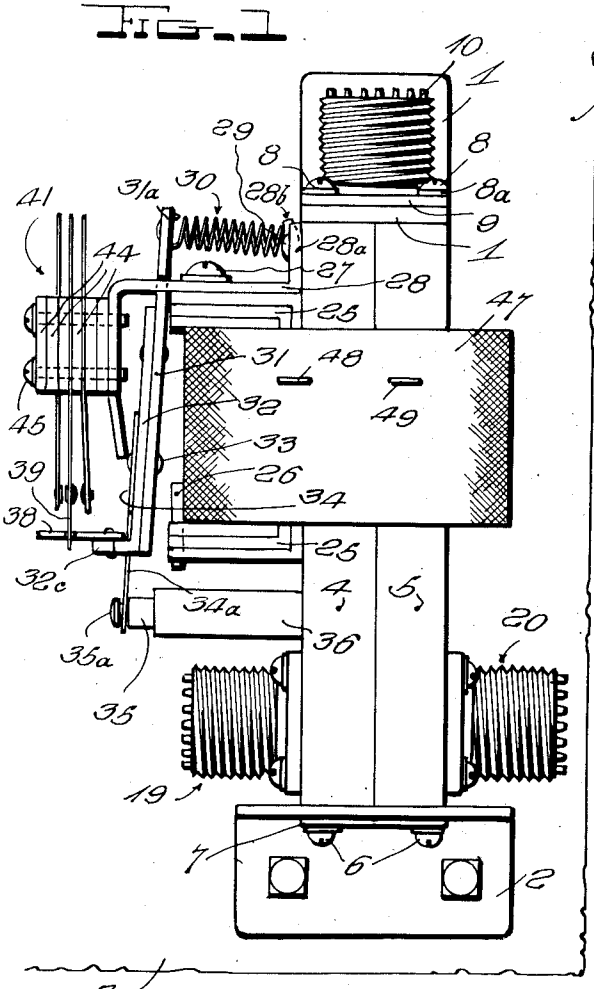


FIG. 2

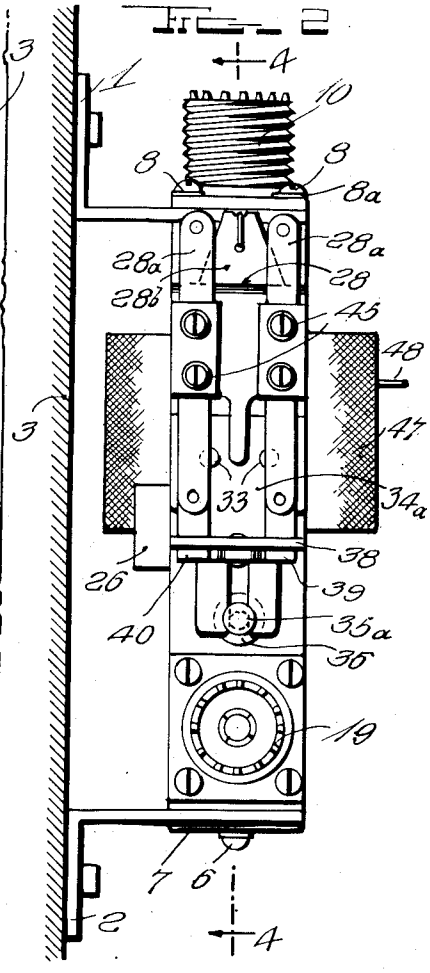


FIG. 3

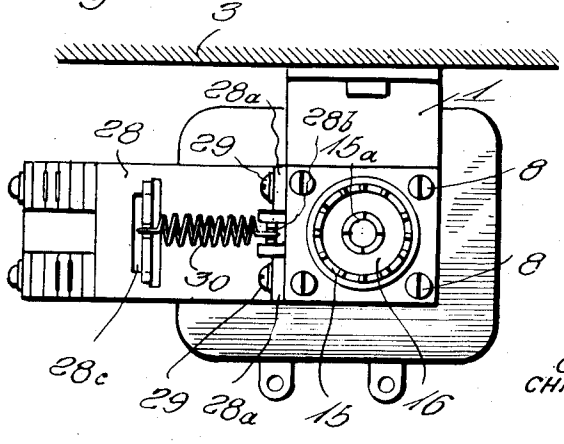


FIG. 11

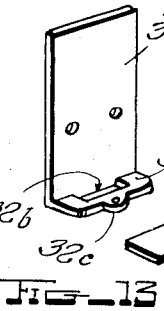


FIG. 12

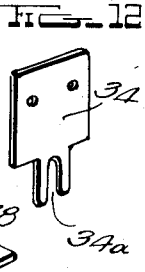


FIG. 13

38a

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FIG. 4

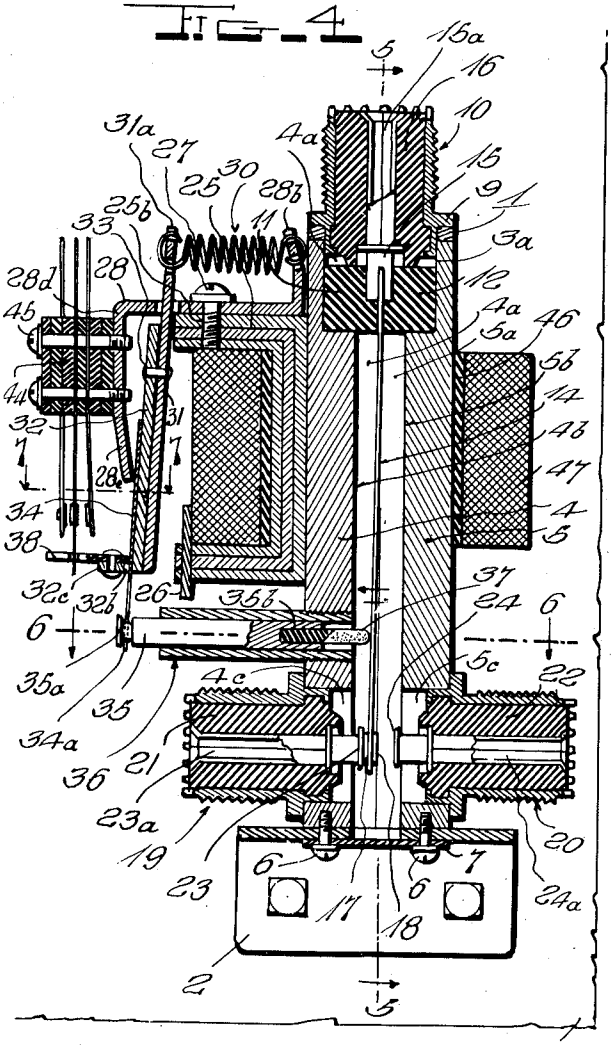


FIG. 5

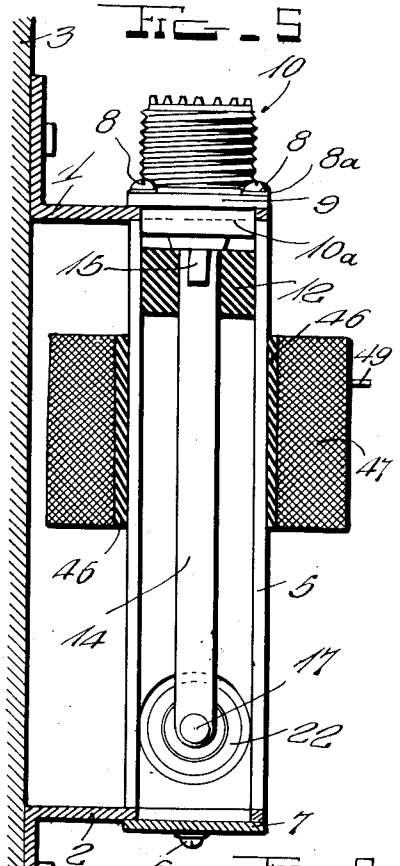


FIG. 6

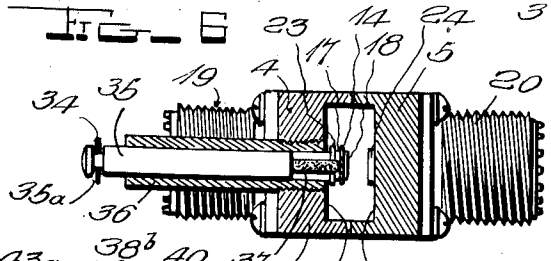


FIG. 7

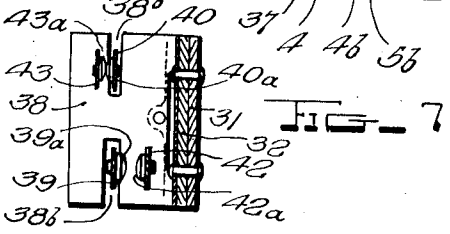


FIG. 8

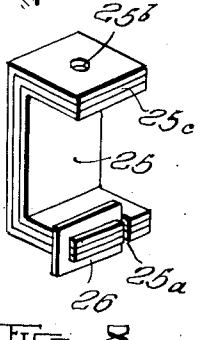


FIG. 9

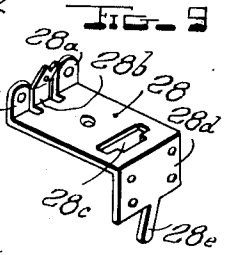


FIG. 10



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FIG. 4

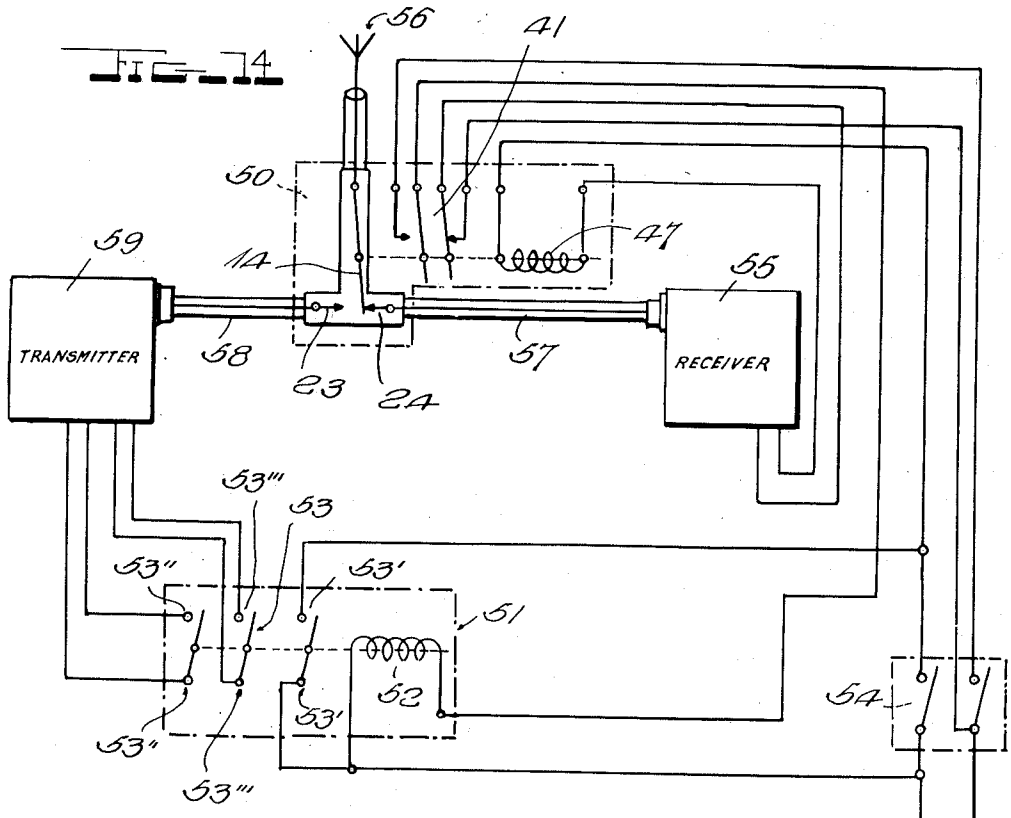


FIG. 5

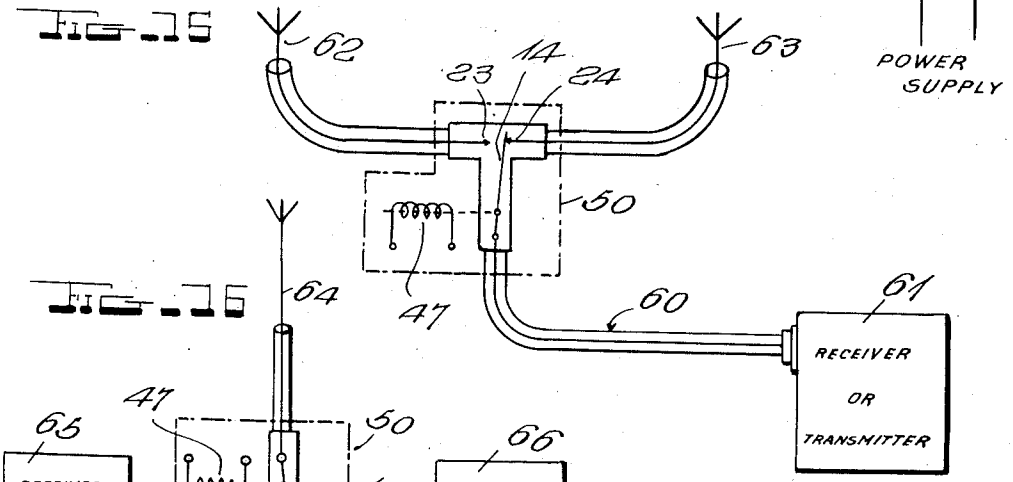
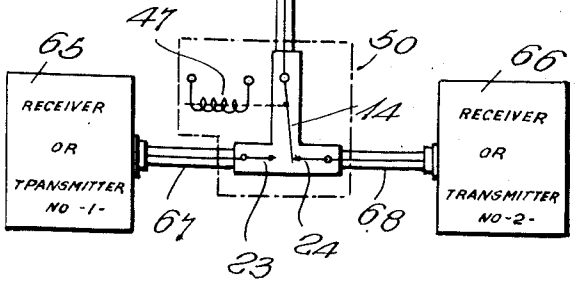


FIG. 6



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Patented Feb. 5, 1952

2,584,901

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2,584,901

COAXIAL RELAY

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Application September 17, 1947, Serial No. 774,590

2 Claims. (Cl. 200—104)

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This invention relates broadly to high frequency electrical switching systems and more particularly to a high frequency electrical switch for coaxial cable systems.

One of the objects of the invention is to provide an improved construction of remotely controlled electrical switching apparatus having low electrical capacity and minimum tendency for sustaining standing waves in the coaxial transmission line.

Another object of the invention is to provide a practical construction of remotely controlled relay for coaxial transmission lines for switching the transmission line to transmission and receiving conditions while maintaining a high electrical efficency of the transmission line.

Another object of the invention is to provide a construction of remotely controlled relay for transferring a transmission line from transmitting to receiving positions while maintaining a match in the impedances of the several lines which are thus interconnected.

Still another object of the invention is to provide a construction of remote controlled coaxial relay for transmission lines which does not cause reflection of energy being transmitted through the relay.

Other and further objects of the invention reside in the mounting means and actuating means for the coaxial relay as set forth more fully in the specification hereinafter following by reference to the accompanying drawings in which:

Figure 1 is a front elevational view of the coaxial relay; Fig. 2 is a side elevational view of the coaxial relay shown in Fig. 1; Fig. 3 is a top plan view of the coaxial relay; Fig. 4 is a longitudinal vertical sectional view through the relay taken substantially on line 4—4 of Fig. 2; Fig. 5 is a vertical sectional view through the relay taken substantially on line 5—5 of Fig. 4 with certain of the parts shown in elevation; Fig. 6 is a transverse sectional view taken substantially on line 6—6 of Fig. 4; Fig. 7 is a transverse sectional view through the relay operating armature and the spring pile-up contact assembly taken substantially on line 7—7 of Fig. 4; Fig. 8 is a perspective view of the magnetic frame of the control relay for the coaxial switching apparatus; Fig. 9 is a perspective view of the spring pile-up support which is carried by the magnetic frame of the control relay; Fig. 10 is a perspective view of the operating armature of the control relay; Fig. 11 is a perspective view of the plate which is carried by the armature of Fig. 10; Fig. 12 is a perspective view of the resilient spring member

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which is secured to the assembled plate of Fig. 11 and armature of Fig. 10 for imparting movement to the coaxial transfer switch; Fig. 13 is a perspective view of the insulation member which transmits movement from the armature of Fig. 10 to the spring pile-up assembly; Fig. 14 shows a typical installation of the coaxial relay in transferring connections between an antenna system and a transmission and receiving system; Fig. 15 shows the application of our coaxial relay to an installation where a selected antenna of two antennae is switched to a receiver or transmitter; and Fig. 16 illustrates another typical installation of the coaxial relay in switching one antenna system between two receivers or two transmitters.

The coaxial relay of this invention has been developed to control radio frequency power in a transmission line while maintaining the line free of standing waves. The construction of the coaxial relay is such that the relay does not detrimentally upset the transmission line electrically and does not cause reflection of high frequency energy being transmitted by reason of the perfect match between circuits which is maintained through the relay. The construction of the relay is such that the relay may be located at any desired remote location in the line and electrically controlled for transferring connections, for example, between an antenna system and a transmission and receiving system. In a typical installation employing, for example, 750 watts of radio frequency power, the relay may be designed for use with 52 ohm cable and cable fittings which terminate in the relay housing. The antenna or radiating system connected to the load end of the coaxial transmission line must present a real (resistive) impedance of 52 ohms to the antenna end of the transmission cable. This is difficult to accomplish, especially with beam antenna systems, and failure at this point is the most common source of trouble in transmission systems. It must be remembered that an antenna system which has a calculated impedance of 52 ohms at the driving terminals when considered alone may present a line-terminating impedance which differs considerably from 52 ohms when connected to the coaxial line, as a result of the current which flows on the outer conductor of the line due to capacitive coupling with the antenna proper. It must be remembered also that the addition of reflectors and directors to a beam antenna system will change the impedance which the radiating system presents to the transmission line.

Other abnormal circumstances and conditions

may result in standing waves of some magnitude. When standing waves exist in the antenna to transmitter line not only the antenna transfer relay but the entire antenna system must be derated. This reduction in rating results from the fact that excessive voltages and currents exist at regular intervals in the line, also the overall power loss is greater. The amount of reduction in relay capacity will depend upon the seriousness of the standing waves in the line.

Referring to the drawings in detail reference characters 1 and 2 designate supporting brackets arranged to mount the coaxial relay adjacent a support 3. The switch of the coaxial relay is housed within a pair of coacting cavity members 4 and 5 formed from non-magnetic material and adapted to be bound together at their opposite ends by fastening screws 6 passing through plate 7 beneath bracket 2 and extending in the ends of coacting cavity members 4 and 5 at one end of the housing while at the other end of the housing screws 8 pass through apertures formed in the corners of bracket 1 which is centrally apertured for the passage of the cylindrical end of the transmission cable fitting 10 and through flange 9 of the transmission cable fitting 10. Lock washers 8a are disposed beneath the heads of each of the screws 8. Thus the bracket 1 which is centrally apertured for the passage of the cylindrical portion 10a of the transmission line cable fitting 10 serves to center the coaxial relay housing in position with respect to the cavity members 4 and 5 and form a supporting means for the end of the housing.

The cavity members 4 and 5 are internally recessed at the upper end of the housing, as represented by semi-cylindrical recesses 4a and 5a to provide by their coaction a cylindrical recess for receiving the pair of semi-cylindrical coacting block members 11 and 12. The semi-cylindrical coacting block members 11 and 12 are diametrically divided and serve as supports for the upper end of switch arm 14 and form spacing means for spacing the switch arm 14 with respect to the inner walls 4b and 5b of the cavity members 4 and 5. The blocks 11 and 12 secure and definitely locate the switch arm 14 in position in the cavity between members 4 and 5 without the use of screws or other fastening means. The use of rivets, screws or other methods of securing switch arm 14 in accurate position between cavity members 4 and 5 would in general increase the capacity (capacitance) to ground and decrease the voltage break-down strength of the unit. The switch arm 14 is secured to the post 15 which is supported in the sleeve of insulation material represented at 16 in the transmission cable fitting 10. The post 15 terminates in socket sleeve 15a into which the end of the coaxial cable may be detachably connected.

The switch arm 14 extends longitudinally through the cavity members 4 and 5 intermediate the walls 4b and 5b thereof and terminates in a pair of contacts 17 and 18 on opposite sides of the switch arm 14. The lower ends of the cavity members 4 and 5 are provided with transversely extending cylindrical apertures 4c and 5c axially aligned with each other for receiving the transmission cable fittings shown at 19 and 20. The transmission cable fittings 19 and 20 are similar to the fittings 10 and each constitute an externally screw-threaded sleeve and each containing an insert of insulation material as represented at 21 and 22. The insert 21 forms a support for a stationary contact 23 which extends inwardly into the space between cavity members 4 and 5 and is supported in the insert of insulation material by resilient sleeve socket member 23a. The resilient sleeve socket member 23a is adapted to receive the terminal of a coaxial cable extending to the coaxial relay. Stationary contact 23 is supported in alignment with movable contact 17 carried by switch arm 14. The insert of insulation material 22 serves to support an oppositely disposed stationary contact 24 axially aligned with contact 18 carried by switch arm 14. Stationary contact 24 terminates resilient sleeve 24a adapted to receive the terminal of a coaxial cable.

The electromagnetic operating mechanism which is remotely controlled for displacing switch arm 14 from the normally biased position shown in Fig. 4 in which connection is established between contact 17 and contact 23 to the position in which connection is established between contact 18 and contact 24, is mounted externally of the housing constituted by cavity members 4 and 5. The electromagnetic operating mechanism includes a laminated magnetic frame structure shown more clearly in Fig. 8 consisting of laminated substantially U-shaped magnetic members represented at 25. The magnetic substantially U-shaped members are slotted adjacent one end as represented at 25a forming a pole piece, the area of which is substantially enlarged by magnetic plate 26 secured to the magnetic laminations 25 and extending to the slot 25a therein at one end and projecting substantially beyond the laminations 25 at the opposite end. The magnetic laminations 25 are apertured at the end opposite the magnetic plate 26 as represented at 25b and screw-threaded to form a securing means for securing screw 27 which passes through the bracket member 28 for thus securing the bracket member 28 in position with respect to the magnetic laminations 25. The bracket member 28 is shown more clearly in Fig. 9.

Bracket member 28 is provided with a pair of right angularly extending tongues 28a at one end and a centrally angularly projecting lug 28b between the tongues 28a. Tongues 28a are secured by means of screws 29 to the side of cavity member 4 thereby locating magnetic members 25 with respect to the housing formed by cavity members 4 and 5. The lug 28b serves as a securing means for one end of the coil spring 30, the other end of which is engaged through the projecting end 31a of magnetic armature member 31. The end 31a of armature member 31 is sufficiently reduced in section to readily extend through aperture 28c in bracket member 28 so that magnetic armature 31 is free to rock angularly about the projecting ends 25c of the magnetic laminations 25 when armature 31 is attracted by the pole piece adjacent magnetic plate 26 of the magnetic laminations 25. Coil spring 30 tensions armature 31 for limited movement with respect to magnetic plate 26. Armature 31 has plate member 32 shown more particularly in Fig. 11 secured thereto by suitable rivet members 33. Plate member 32 has the end 32a thereof bent in a plane substantially normal to the plane of plate 32. The end 32a is slotted as represented at 32b and is provided with an apertured extension 32c thereon. The slot 32b in the end 32a of plate 32 serves to permit the passage of the end of the resilient plate 34 shown more particularly in Fig. 12. The resilient plate 34 has a bifurcated end portion shown at 34a which extends through the slot 32b and engages the annular neck 35a of reduced section of plunger member 35. Plunger member 35

extends slidably through the tubular member **36** which is screw-threaded into the side of cavity member **4**. Tubular member **36** is disposed intermediate the contact portion **17—18** of switch arm **14** and the fixed end of the switch arm **14** and intermediate the magnetic frame **25** of the magnetic operating mechanism and the transmission cable fitting **19**.

The plunger member **35** which slidably operates in tubular member **36** is recessed in the end thereof as represented at **35***b* and receives the actuating member **37** formed from insulation material. Actuating member **37** of insulation material engages switch arm **14** and by reciprocal movement thereof serves to shift switch arm **14** from the biased position illustrated in Fig. 4 with contact **17** in engagement with contact **23** to the opposite position with contact **18** in engagement with contact **24**.

Plunger **35** is controlled as explained by the electromagnetic operating mechanism and is definitely limited in its reciprocative movement by the mounting of the armature **31**. Bracket **28** is shaped as represented more clearly in Fig. 9 to provide for a flattened supporting area **28***d* and an angularly extending tongue **28***e*. The tongue **28***e* serves as a limiting stop for the movable armature system, abutment being established between plate **34** and tongue **28***e* in the deenergized position of armature **31**.

The apertured end **32***c* of plate **32** serves as a securing means for the plate **38** of insulation material. Plate **38** includes a pair of oppositely disposed slots **38***a* and **38***b* which engage the projecting ends of contact springs **39** and **40**. The contact springs **39** and **40** are part of the spring pile-up assembly represented generally at **41** which is supported by the flattened area **28***d* of bracket **28**. The spring pile-up assembly may comprise any complement of contacts which may be required. For purposes of illustration I have shown contact springs **39** and **40** as carrying contacts **39***a* and **40***a* as represented more clearly in Fig. 7. Contacts **39***a* and **40***a* are arranged to coact with fixed contacts **42***a* and **43***a* carried by spring contact strips **42** and **43** respectively and so arranged that one set of contacts **40***a* and **43***a* are closed while the other set of contacts **39***a* and **42***a* are open. The several spring contact strips are substantially insulated from each other and maintained in operating position by the insulation strips **44** and securing screws **45**.

The magnetic frame **25** which directly abuts against the side of the housing formed by cavity member **4** is wrapped with insulation material **46** which encircles the housing constituted by cavity members **4** and **5**. Around this insulating wrapping **46** I arrange the operating winding of the relay system as shown at **47**. The operating winding **47** is provided with terminal members **48** and **49** for connection of the opposite ends of the winding to the remote control circuit.

The assembly of the relay is accomplished by first introducing the frame **25** around one side of the insulated core **46** with the actuating winding **47** mounted thereon and then sliding the upper end of the housing through the insulated core **46** and thereafter proceeding to anchor the bracket **28** in position with respect to the housing by screws **29** and proceeding to effect the assembly of the armature **31** and the spring pile-up assembly **41**. The plunger **35** is mounted in position and the bifurcated end **34***a* of spring member **34** secured around annular recess **35***a* whereupon the relay is ready for connection of the coaxial cables with the transmission cable fitting.

It will be observed that each of the transmission cable fittings **10**, **19** and **20** are externally screw-threaded and are provided with serrated teeth adapted to establish a fluid tight connection with the gasket in the end of the coaxial cable transmission line which is connected to the fitting.

With reference to Fig. 14 we have illustrated a combination block and schematic diagram showing a typical application of the coaxial relay designated at **50** as applied to a radio communication system. The coaxial relay **50** is shown in the unenergized position, as is the power control relay **51**. Power control relay **51** includes actuating winding **52** and set of contacts **53**. Under the conditions illustrated the "transmit-receive" switch **54** is open. The normally closed auxiliary contacts **41** of the coaxial relay **50** energize the receiver **55** while the coaxial contacts through switch arm **14** of the coaxial relay **50** connect the antenna system **56** to the receiver input cable **57**.

When the "transmit-receive" switch **54** is closed, one side of this (double-pole, double-throw) switch closes the coil circuit **47** to the coaxial relay **50**. The other side of this switch **54** closes the coil circuit **52** to the power control relay **51** (as soon as the coaxial relay **50** operates to close its normal open auxiliary contacts **41**). It can be seen that with this circuit arrangement, the power control relay **51** cannot operate until the coaxial relay **50** has connected the antenna system **54** to the transmitter output cable **58**, leading to transmitter **59**.

As soon as the power control relay **51** operates set of contacts **53** its normally open auxiliary contacts **53'—53'** lock this relay in electrically. Contacts **53''—53''** **53'''—53'''** energize the transmitter **59** by closing the primaries of the high voltage plate supply transformers. When the "transmit-receive" switch **54** is open (i. e. thrown to the receive position) the "lock-in" contacts **53'—53'** of the power control relay **51** hold the coaxial relay **50** in the operated position until the power control relay **51** has fallen open and de-energized the transmitter **59** and its output cable **58**. This circuit is required in order to prevent the operation of the coaxial antenna contacts while the transmitter is energized and delivering power to the antenna.

Fig. 15 shows the application of the coaxial contacts of the coaxial relay **50** to a situation where it is desired to transfer the antenna cable **60** of a given receiver (or transmitter) **61** from one antenna system **62** to another antenna system **63**. This problem arises, for example, where two antenna systems having different directional characteristics are to be employed with a single receiver or transmitter.

Fig. 16 shows an application of the coaxial relay to the problem of switching one antenna system **64** between two receivers or two transmitters, **65—66**, connected through cables **67—68** with the coaxial relay **50**. This problem arises in many installations where a standby receiver or transmitter is held in readiness for operation in the event of failure of the operating equipment.

The relays of Figs. 15 and 16 do not show the auxiliary contacts because these contacts may, or may not, be required.

While we have illustrated certain applications of the coaxial relay of our invention, we realize that many other applications of our invention

will suggest themselves and that variation in structural detail of the coaxial relay may be made, we desire that it be understood that no limitations upon our invention are intended, other than may be imposed by the scope of the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A high frequency electrical switch comprising a pair of linearly extending coacting cavity members terminating in flat coplanar surfaces at each end thereof, said cavity members having semi-cylindrical internally aligned recesses at their upper ends, a sleeve of insulation material mounted in said internally aligned recesses and supporting an angularly displaceable switch arm extending centrally between said coacting cavity members, said cavity members being recessed at opposite sides thereof adjacent their lower ends, stationary contact members insulatingly mounted in each of the last mentioned recesses and directed toward each other on opposite sides of said angularly displaceable switch arm, contacts carried by said switch arm operative to establish make and break connection with said stationary contacts, a substantially U-shaped electromagnetic frame structure having a portion thereof mounted in contacting relation against one of the external sides of one of said cavity members, an electromagnetic winding surrounding that portion of the substantially U-shaped electromagnetic frame structure which is disposed in contacting relation with the external side of said one of said cavity members and surrounding the cavity members, an armature movable with respect to said frame structure and controlled by

said electromagnetic winding and a displaceable member operated by said armature and through one wall of one of said cavity members for moving said switch arm from one of said stationary contacts to the other.

2. A high frequency electrical switch as set forth in claim 1 in which the cavity member through which said displaceable member operates supports a tube at one side thereof through which said displaceable member slides and wherein said displaceable member has a lost motion connection at its exterior end with said armature and carries a terminus of insulation material at the other end establishing tangential contact with one side of said switch arm.

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CHARLES J. MURPHY.

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