Nov. 1, 1927.

1,647,290

A. HADDOCK

ANTENNA SWITCHING RELAY

Filed June 22, 1922

2 Sheets-Sheet 1

Fig. 1

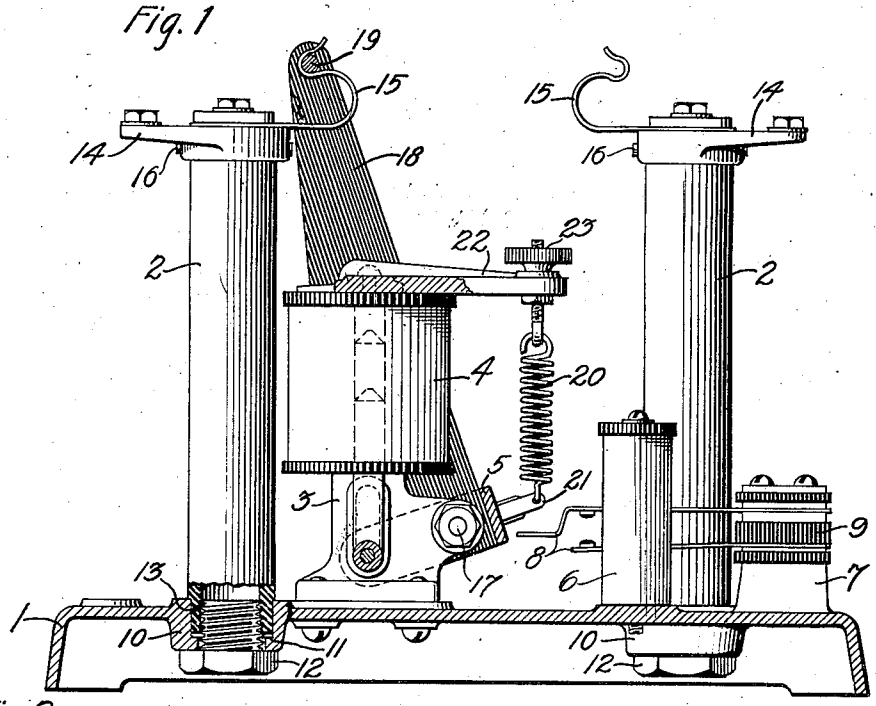
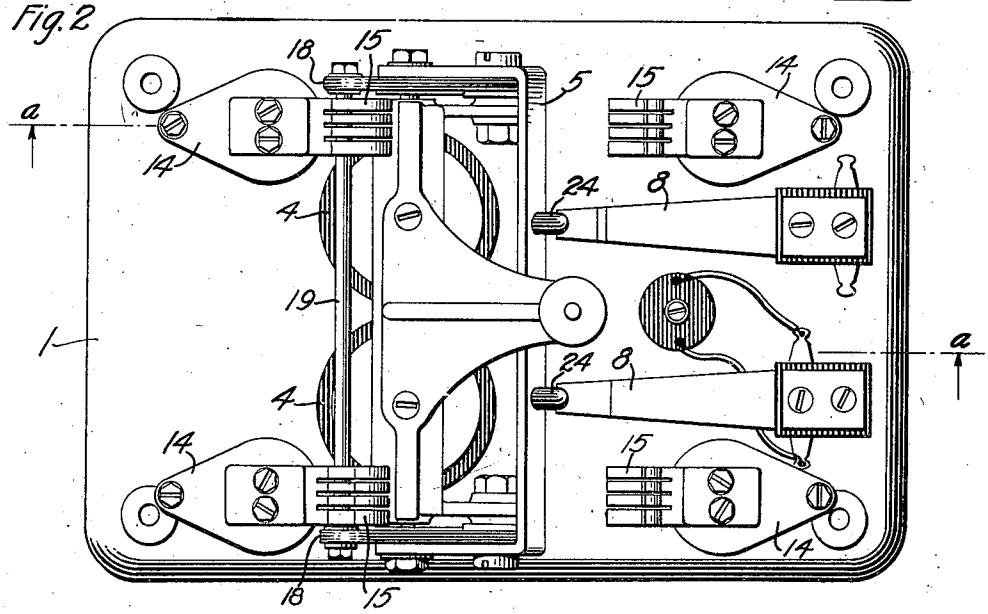


Fig. 2



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Fig. 3

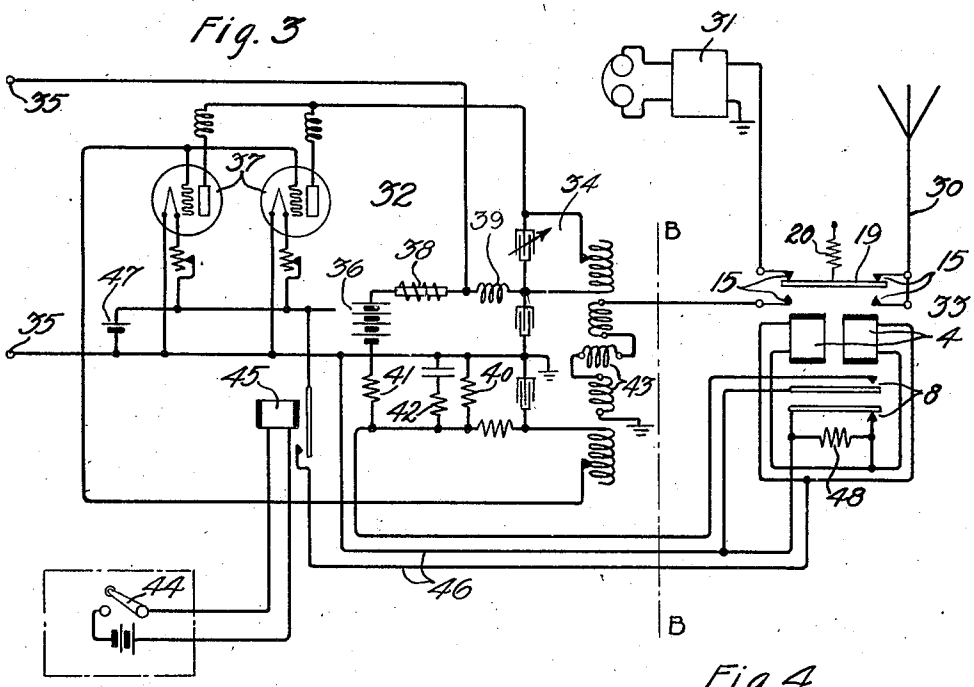


Fig. 4

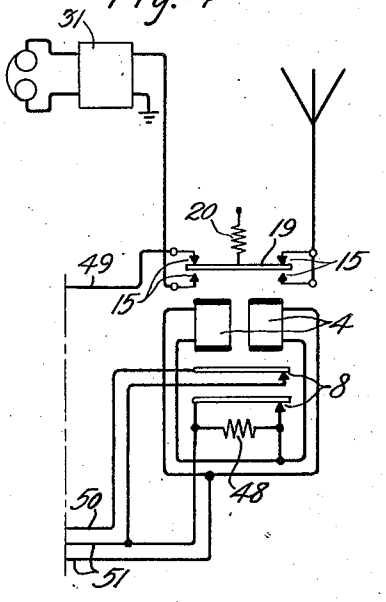
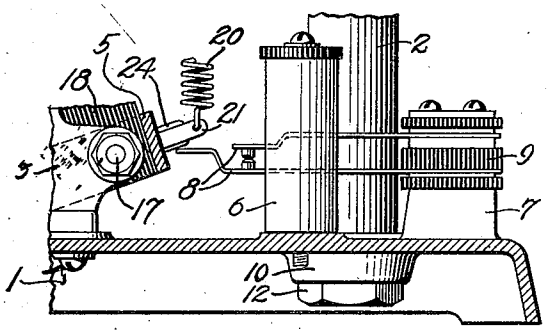


Fig. 5



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UNITED STATES PATENT OFFICE.

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ANTENNA-SWITCHING RELAY.

Application filed June 22, 1922. Serial No. 570,053.

The invention relates to antenna switching relays and more particularly to a device of this type for use in high power radio systems which utilize a single antenna for transmitting and receiving.

In systems of this character high frequency current is supplied to the antenna during transmission periods at a relatively high voltage and hence electrical discharges are liable to take place between the contacts and the supporting frame of the relay because of the high potential difference between these elements of the relay structure. Moreover, due to the high voltages involved, destructive arcing is liable to occur at the switch contacts whenever the transmitting apparatus is connected to or disconnected from the antenna.

The present invention is directed to an arrangement including a transmit-receive relay having its contacts effectively insulated from the supporting frame and provided with means for controlling the voltage of the high frequency source at the instant when the connection between the transmitting circuit and antenna is made and broken.

In accordance with this invention the switching mechanism comprises a single throw relay switch having a plurality of separate contacts each mounted on a long insulating column. The columns are arranged in pairs and secured to a supporting base in spaced relation to provide a long break path between the pairs of contacts, as well as between the contacts of each pair. A pivoted yoke having correspondingly long insulating arms carrying a contact element normally spring held in engagement with one pair of fixed contacts and adapted to be thrown over into engagement with the second pair of fixed contacts by an electromagnet, and pairs of auxiliary contacts adapted to be actuated by the movement of the pivoted yoke. One pair of contacts serve to reduce the voltage of the high frequency source at the proper instant and the other pair operate to control the value of the holding current supplied to the magnet coils.

The preceding statement is given with the object of describing in a general way one practical form of switching mechanism utilizing the principles of the present invention, but is not to be interpreted as defining its scope. The novel features and combinations believed to be characteristic of this invention will be pointed out with particularity in the attached claims.

One object of this invention is to provide a simple switching arrangement adapted for use in a high power radio system employing a single antenna for transmitting and receiving.

Another object is the provision of a transmit-receive relay for a high power radio system having its contacts effectively insulated from ground and provided with means for controlling the voltage impressed upon these contacts at the instant when the transmitting circuit is connected to and disconnected from the antenna.

The invention itself however, with further objects and advantages thereof, will best be understood by reference to the following description taken in conjunction with the attached drawings in which Fig. 1 shows a sectional view of a relay switch designed in accordance with this invention, the section being taken on the broken line *a*—*a* of Fig. 2; Fig. 2 shows a plan view of the relay; Fig. 3 is a diagrammatic representation of a radio system including the switching mechanism of the present invention; Fig. 4 is a digrammatic illustration of a part of the radio circuit using a relay having its auxiliary contacts arranged in a slightly different manner and Fig. 5 is a sectional view of a portion of the relay structure, showing an alternate arrangement of the auxiliary contacts for controlling the high frequency source.

As shown in Fig. 1 the base plate 1 of the relay has secured thereto four relatively long tubular insulators 2, a supporting frame 3, upon which a magnet 4 and a yoke 5 are mounted, a resistance element 6 and a pair of lugs 7 to which the auxiliary switches are secured, these auxiliary switches each consist of a pair of spring contacts 8 which are insulated from each other by an insulating strip 9 and are also insulated from the lugs 7.

The base plate 1 is provided with four widely spaced reinforcing bosses 10 arranged in pairs which are drilled to provide interior shoulders 11, the insulators 2 being held in position upon the plate 1 with their lower ends in engagement with the shoulders 11 by screws 12 which project through the bosses 10 and engage interiorly threaded portions 13 of the insulators 2.

Mounted upon the upper end of each of the insulators 2 is a terminal lug 14 of conductive material to which is secured a switch contact 15. These terminal lugs are held in fixed position relatively to the insulators by pins 16. This arrangement constitutes an important feature of the relay construction since by loosening the screws 12 the insulators 2 may be separately adjusted to effect proper alignment of the contacts 15 relatively to one another and a cooperating movable contact to be hereinafter referred to.

The electromagnet 4 consists of a pair of coils secured to an upper transverse arm of the rectangular frame 3. The coils are provided with cooperating cores which are connected to the yoke 5. This yoke is pivotally connected to the frame 3 by means of a pair of pins 17.

Secured to the yoke 5 are long insulating arms 18 between the outer ends of which extends a long contact element 19 which is normally held in engagement with the left hand pair of contacts 15 by the spring 20, one end of which is connected to the lug 21 carried by the yoke, while the other end is secured to an arm 22 projecting from the magnet frame by an adjustable connection 23, whereby the tension of the spring may be regulated. Upon energization of the magnet 4, the yoke 5 will be rotated about the pins 17 and the contact element 19 will engage the pair of right-hand contacts 15.

The contacts 15 are of resilient conductive material, substantially S-shaped, and are so positioned that the movable contact 19 wipes over an appreciable length thereof before coming to rest in engagement with their upwardly curved rear portions. Thus, the surfaces of these contacts are always kept bright whereby a good contact is assured. Moreover, because of their resiliency these contacts move in the direction of travel of the contact 19 and operate to absorb the shock due to the inertia of the movable element whereby chatter is prevented.

As shown in Fig. 2 the yoke 5 is provided with insulating pins 24 adapted to engage one of the contacts 8 of each of the auxiliary switches. The pins 24 are so positioned relatively to the movable contact 8 that in the normal position of the contact 19, the upper auxiliary switch will be opened, while the lower auxiliary switch will be closed and in the other extreme position of the contact 19, the upper auxiliary switch will be closed and the lower auxiliary switch will be opened.

The antenna will be connected to the upper left-hand terminal lug 14 which in turn may be connected by a strap to the upper right-hand terminal lug 14, the lower left-hand lug 14 being connected to the receiving apparatus, while the lower right-hand lug 14 is connected to the transmitting apparatus. It will be apparent that with the movable switch element in the position shown in Fig. 1 the receiving apparatus will be connected to the antenna, the upper auxiliary switch will be opened and the lower auxiliary switch will be closed.

The upper auxiliary contacts 8 are adapted to control the oscillator so that when the main relay contact 19 is in engagement with the left-hand contacts 15, substantially no oscillating current is generated, while the lower auxiliary contacts serve to complete the energizing circuit for the coils of the magnet 4.

When the relay contact 19 is thrown into engagement with the right-hand contacts 15, the transmitting apparatus will be connected to the antenna, the upper auxiliary contacts will be closed to short-circuit a resistance associated with the high potential source including in the transmitting circuit, whereby oscillating current will be generated and supplied to the antenna.

In order to avoid arcing at the main relay contacts when the transmitting apparatus is connected to the antenna, the upper auxiliary contacts 8 should not be closed until after the movable contact 19 has come into engagement with the right hand stationary contacts 15, whereas upon the reverse movement of the movable switch arm the contact 19, carried thereby, should remain in engagement with the right-hand contacts 15 until the circuit through the upper auxiliary contacts 8 has been opened.

Referring now to Fig. 3 there is shown a radio signal station comprising an antenna 30, a receiving circuit 31, a transmitting circuit 32 and a transmit-receive relay 33 of the type described above. In normal position the relay connects the antenna to the receiving apparatus through the upper contacts 15 and movable contact 19.

For the purpose of disclosing the operation of this invention, it is herein shown as applied to a radio system employing a transmitting apparatus similar to that disclosed in the proceedings of the Institute of Radio Engineers for December, 1921, with special references to the circuit diagrammatically shown in Fig. 11 on page 482. As described with reference to the above mentioned figure speech frequency current is applied to an amplifier, the output of which is impressed on the grid circuits of two parallel modulator tubes, the output voltage of these tubes being impressed upon the plate circuits of two oscillator tubes by a low frequency choke coil common to the modulator and oscillator plate circuits. By this arrangement modulation of the oscillator plate potential is effected and results in speech frequency variations of the amplitude of the antenna current.

The present invention being directed solely

to an arrangement for controlling the operation of the oscillator, the modulator is not illustrated in Fig. 3. However, it is to be understood that the common output circuit of the modulator tubes is connected at 35 to the positive terminal of the supply source 36, adapted to supply direct current to the plate circuits of the oscillating and modulating tubes through the low frequency choke coil 38.

Space current for the oscillating tubes 37 flows through the high frequency choke coil 39, the inductance coil of the oscillator output circuit 34 to the plate elements of the tubes, across the space within the tube to the cathodes thereof, and thence through the series connected resistances 40 and 41 to the opposite terminal of the source 36. Connected in parallel with the resistance 40 is a conductive path 42 for the oscillating current generated by the oscillator.

The input circuit extends from the cathodes through the resistance 40 and shunt path 42, the lower inductance coil to the grids of tubes 37. The output circuit of the oscillating tubes is coupled in feed back relation to the input circuit by the variable coupling coil 43.

As therein shown the movable contact 19 of the relay switch is normally held in engagement with the upper pair of contacts 15, the upper pair of auxiliary contacts are opened and the lower pair of auxiliary contacts are closed. As described above the receiving apparatus 31 is therefore connected to the antenna 30, and the resistance 40 and the shunt path 42 are included in both circuits of the oscillating tubes. The drop of potential across the resistance 40 is impressed upon the grid elements of the tubes 37 and is such that substantially no oscillating current is generated.

When it is desired to transmit a message from a station of this character, the switch 44 is closed to energize the relay 45, the circuit 46 being thereby completed to supply current from the source 47 to the coils of the magnet 4. Upon energization of the magnet coils, the yoke 5, as described above with reference to Fig. 2, is actuated to disconnect the contact 19 from the left-hand contacts 15, herein represented as the upper pair of contacts, and to cause element 19 to engage the right-hand main contacts, herein represented as the lower pair of contacts 15, the upper auxiliary contacts 8 are closed, while the lower pair of auxiliary contacts are opened. The transmitting apparatus is therefore connected to the antenna, the resistance 40 and the shunt path 42 are short-circuited by the upper auxiliary contacts 8 and, as a consequence, the potential impressed upon the grids of the tubes 37 is reduced so that high frequency oscillating current is thereby generated and supplied to the antenna. At the same time, the lower auxiliary contacts 8 are opened and the resistance 48 is included in the energizing circuit 46, whereby the current supplied to the coils of the magnet 4 is reduced from the high amperage initially used to actuate the relay to a value which, while sufficient to maintain the relay contacts in transmit position, may be safely supplied to the magnet coils without causing them to become overheated.

A transmitting apparatus of this character adapted to supply 500 watts to the antenna at about 5,000 volts and controlled in the manner described above has been tested. This apparatus comprised tubes having internal impedances of 2,000 ohms, direct current at about 1,600 volts being impressed upon their plates through a resistance of 2,000 ohms shunted by a path including 200 ohms and a capacity of .5 microfarads, the resistance and path being controlled by the upper auxiliary contacts 8 to determine the potentials impressed upon the grids of the oscillating tubes at the proper instants, as described above. With an apparatus of this type the relay was found to operate substantially without arcing when actuated to connect this apparatus to and disconnect it from the antenna.

By substituting the arrangement diagrammatically shown in Fig. 4 for that portion of the circuit to the right of the section line B—B in Fig. 3, a radio system which is especially adapted for broadcasting is provided. The conductor 49 is connected to the upper terminal of the coupling coil 43, the conductor 50 leads to the common connecting point of the resistance 41 with the alternating path 42 and resistance 40 and the conductors 51 serve to complete the energizing circuit 46 for the coils of the magnet 4.

With the control switch 44 in open position, as shown in Fig. 3, the movable relay contact 19 is held in engagement with the upper pair of contacts 15 which are respectively connected to the antenna 30 and the conductor 49 and both pair of auxiliary contacts 8 are closed. The transmission apparatus is therefore connected to the antenna and resistance 40 and AC path 42 are short-circuited and high frequency current generated by the oscillating tubes 37 and associate circuits is supplied to the antenna.

To "listen-in" the operator closes the control switch 44, the coils of the magnet 4 will be energized and the movable contact 19 will be actuated to disconnect the antenna from the transmitting apparatus and connect it to the receiving apparatus. When this occurs both pairs of auxiliary contacts will be opened, the resistance 40 will be included in the space current path of the tubes 37 to substantially prevent the generation of oscillating current, and the resistance

48 will be included in the energizing circuit of the magnet coils which, as described above, reduces the current flowing through this circuit so that overheating of the magnet coils will not occur.

When used for broadcasting the following changes will be necessary. The transmission apparatus will be connected to the lower left-hand terminal lug 14 of the relay as shown in Fig. 2, while the receiving apparatus will be connected to the lower right-hand terminal lug, the upper auxiliary contacts 8 will be reversed so that they are normally closed, and the cooperating pins 24 will be closely spaced relatively to the movable contact of this pair. As described above, the position of the auxiliary contacts for controlling the high frequency source is such that they are open circuited, to include resistance 40 and shunt path 42 in both circuits of the tubes 37, before the contact 19 moves out of engagement with the right-hand pair of contacts 15 and are held in open circuit position until after the element 19 again engages this pair of contacts upon its return to normal position.

Fig. 5 illustrates the arrangement of the auxiliary contacts 8 for controlling the high voltage source when the relay is used in a broadcasting station and also indicates the position of the actuating pin 24 relatively to the movable contact of the auxiliary pair. Moreover, it serves to represent the arrangement of the lower auxiliary contacts 8 of Fig. 2, though in this case the position of the insulating pins 24 relatively to the movable contact of the auxiliary pair will be such that these contacts will not be opened to include the resistance 48 in the energizing circuit 46 until the switch arms 18 have about come to rest in the transmit position.

With the arrangement just described the movable relay contact is spring held in the transmitting position and the coils of the magnet 4 are only energized during "listening-in" periods, which are relatively brief. When the arrangement shown in Fig. 3 is used for broadcasting, current must be supplied almost continuously to the magnet coils with the result that energy is wasted, and the danger of overheating the magnet coils is increased. Hence, for broadcasting, the circuit of Fig. 4 not only effects a material saving in the energy used to control the relay, but the liability of overheating the magnet coils is reduced to a minimum.

From the preceding description, it will be apparent that the present invention provides a simple rugged relay structure having its contact effectively insulated to withstand high voltages. Because of the use of the auxiliary contacts, associated with its movable element for controlling the high frequency source, this device is especially adapted for use in a high power radio station employing a single antenna for both transmitting and receiving. Obviously, with this arrangement, flashing across between the relay contacts is prevented, a good contact is always assured, and the inertia of the movable element is effectively absorbed to prevent chatter. Again, the voltage of the high tension source is substantially nil at the moment when the transmitting circuit is connected to and disconnected from the antenna, whereby destructive arcing at the main relay contacts is avoided.

While a specific arrangement has been described with the object of completely and clearly disclosing the principles of the invention, it is to be understood that this invention is not limited to the specific details herein shown and described, but only by the scope of the attached claims.

What is claimed is:

1. An antenna switch relay comprising a base, a plurality of relatively long insulators connected to and extending an appreciable extent from said base, said insulators being arranged in pairs, a contact mounted on each of said insulators, said contacts being arranged in pairs, a pivoted yoke provided with relatively long insulating arms, a single contact element carried by said arms for bridging a pair of said contacts in either extreme position of the yoke, a spring for normally holding said single contact element in engagement with one pair of said first mentioned contacts, and an electromagnet, associated with said yoke, adapted when energized to bring said contact element into engagement with said other pair of first mentioned contacts.

2. An antenna switching relay comprising a base, a plurality of long insulators secured to and extending a substantial extent from said base, said insulators being arranged in pairs, a contact carried by each of said insulators, said contacts being arranged in pairs, the insulators being spaced apart to provide a long break path between the pairs of contacts secured thereto, a pivoted yoke provided with relatively long insulating arms, a single contact element carried by said arms for bridging a pair of said contacts in either extreme position of said yoke, a spring for normally holding said contact element in engagement with one of said pairs of first mentioned contacts, and an electromagnet, associated with said yoke, adapted when energized to bring said contact element into engagement with said other pair of first mentioned contacts.

3. An antenna switching relay comprising a base, a plurality of relatively long insulators secured to and extending an appreciable extent from said base, a contact carried by each insulator, said contacts being arranged in pairs and said insulators being relatively widely spaced apart in two

directions to provide a long break path between the pairs of contacts carried thereby and also between the contacts of each pair, a pivoted yoke provided with relatively long insulating arms, a single contact element carried by said arms for bridging a pair of said contacts in either extreme position of said yoke, a spring for normally holding said contact element in engagement with one of said pairs of first mentioned contacts, and an electromagnet, associated with said yoke, adapted when energized to bring said contact element into engagement with said other pair of first mentioned contacts.

4. In a radio signal system a transmitting circuit having a source of high frequency oscillating current included therein, a receiving circuit, an antenna switching relay adapted to connect either said transmitting circuit or said receiving circuit to said antenna, said relay comprising a base, a plurality of relatively long insulators connected to said base and arranged in pairs, a main contact mounted on each of said insulators, said main contacts being arranged in pairs, a pivoted yoke provided with relatively long insulating arms, a single contact element carried by said arms, a spring for normally holding said contact element in engagement with one of said pairs of first mentioned contacts, and an electromagnet, associated with said yoke, adapted when energized to bring said contact element into engagement with said other pair of first mentioned contacts, an energizing circuit for said electromagnet, a pair of auxiliary contacts operated by said yoke for controlling said supply of high frequency oscillating current when said contact element is in engagement with one pair of said main contacts, and a second pair of auxiliary contacts operated by said yoke and included in said electromagnet energizing circuit, said first mentioned auxiliary contacts being closed after the bridging of the first pair of main contacts by the contact element and opened prior to the disconnecting of the first pair of main contacts from the contact element so that no high potential energy is supplied to the main relay contacts at the instant when said antenna is connected to or disconnected from said transmission circuit and said second pair of auxiliary contacts being closed upon operation of the electromagnet to reduce the current supplied to the electromagnet for holding said contact element in engagement with said other pair of main relay contacts.

5. An antenna switching relay comprising a base having a plurality of pairs of openings provided with interior shoulders, a plurality of insulators having one end portion interiorly threaded, the interiorly threaded portion of each insulator projecting into an opening in the base, a screw projecting through each of the openings in the base adapted to engage the interiorly threaded portions of the insulators to thereby hold them in engagement with the shouldered portion of the opening, a terminal lug rigidly secured to the opposite end of each insulator, a spring contact carried by each of said lugs, and a movable contact adapted to be controlled to cause it to engage either pair of spring contacts.

6. An antenna, a receiving apparatus, a transmitting apparatus, an antenna switch for connecting the antenna either to the transmitting apparatus or to the receiving apparatus, resilient means normally operating to connect the antenna to the transmitting apparatus, an electromagnet remotely controlled for operating said switch to connect the antenna to the receiving apparatus, an auxiliary switch for controlling said transmitting apparatus, said auxiliary switch being in closed position to energize the transmitting apparatus, and means for closing the auxiliary switch after operating the antenna switch to connect the antenna to the transmitting apparatus and for opening the auxiliary switch prior to the opening of the antenna switch to disconnect the antenna from the transmitting apparatus, whereby flashing over at the antenna switch is prevented.

7. An antenna, a receiving apparatus, a transmitting apparatus, an antenna switch comprising two pair of contacts and a movable contact element, said movable contact element engaging one pair of said contacts to connect the transmitting apparatus to the antenna and engaging the other pair of contacts to connect the receiving apparatus to the antenna, resilient means normally operating the contact element to connect the transmitting apparatus to the antenna, an electromagnet for moving the contact element to connect the receiving apparatus to the antenna, remote control means for energizing said electromagnet, an auxiliary switch for controlling said transmitting apparatus, said auxiliary switch being in closed position to energize the transmitting apparatus, and means for closing the auxiliary switch after the contact element engages the contacts to connect the transmitting apparatus to the antenna and for opening the auxiliary switch prior to separation of the contact element from the contacts to separate the transmitting apparatus from the antenna, whereby flashing over between the contacts is prevented.

In witness whereof, I hereunto subscribe my name this 20th day of June A. D., 1922.

ARTHUR HADDOCK.