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Kowalewski

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[54] **RADIO FREQUENCY SWITCH EMPLOYING REED SWITCHES AND A QUARTER WAVE LINE**

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[52] **U.S. Cl.** **325/23,** 335/5, 335/152

[51] **Int. Cl.** **H01p 1/10**

[58] **Field of Search** ..... 325/21, 22, 23; 343/178, 343/180; 335/4, 5, 152, 127; 200/153 S; 333/7, 13

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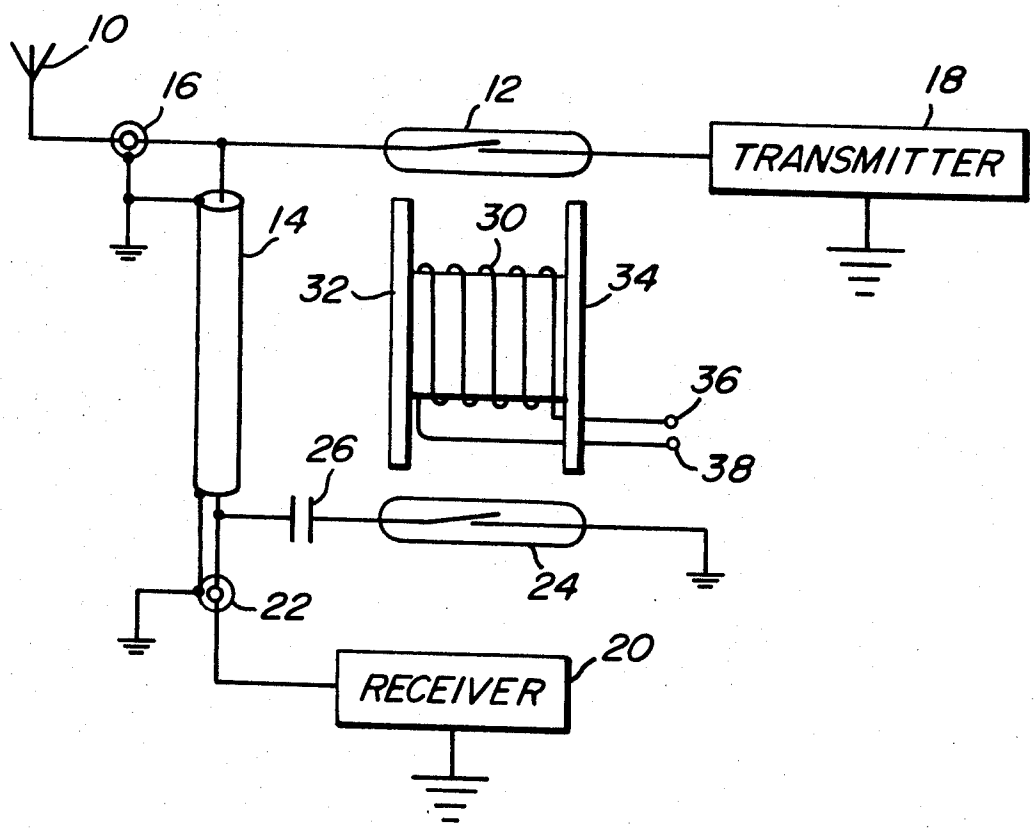
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[57] **ABSTRACT**

An antenna switching relay for selectively switching an antenna to a transmitter or a receiver of a radio transceiver includes a pair of normally open reed switches and a quarter wave transmission line. In the receive mode, the reed switches are open and the antenna is connected to the receiver through the quarter wave transmission line. In the transmit mode, the reed switches are closed and the antenna is connected to the transmitter through one of the reed switches, while the other reed switch shorts out the receiver end of the transmission line, thereby causing an open circuit to be reflected to the antenna terminal thereof.

6 Claims, 2 Drawing Figures



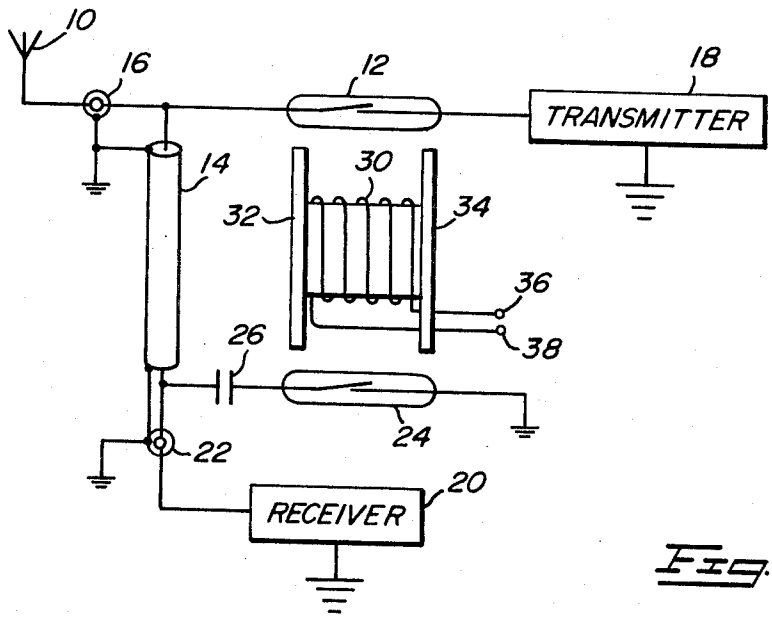

10
16
12
18
TRANSMITTER
14
30
32
34
36
38
26
24
22
20
RECEIVER

Fig. 1

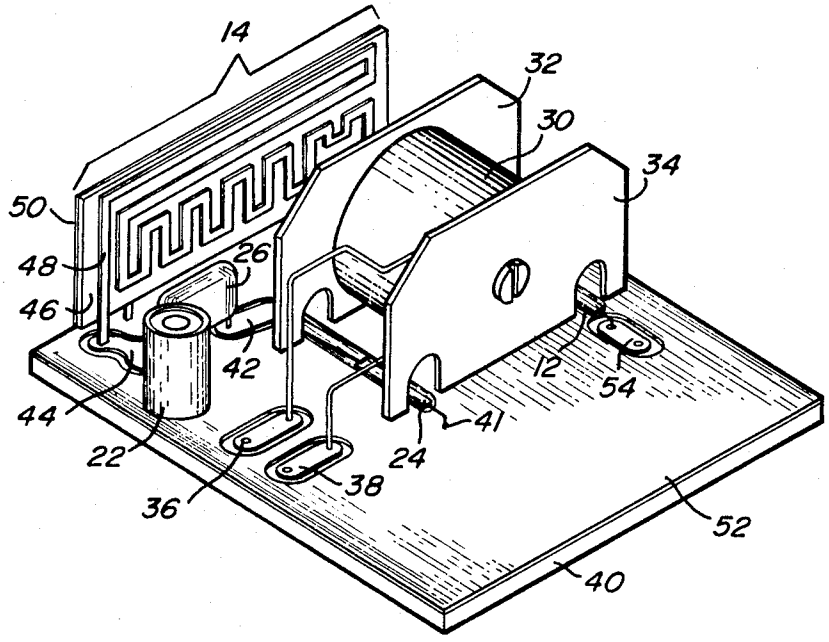

14
32
30
34
50
48
26
46
42
12
54
44
41
22
24
38
36
52
40

Fig. 2

RADIO FREQUENCY SWITCH EMPLOYING REED SWITCHES AND A QUARTER WAVE LINE

BACKGROUND

1. Field of Invention

This invention relates generally to radio frequency switches, and more particularly to antenna switches for radio transceivers.

There are many applications wherein it is necessary to provide a switch for radio frequency electrical signals. One such application is in a radio transceiver wherein it is desired to selectively switch an antenna to either the transmitter or receiver thereof.

2. Prior art

Several techniques for providing an antenna switching function are known. One such system employs a double-pole single-throw, or form C, relay to connect the antenna to the receiver when the relay is de-energized, and to connect the antenna to the transmitter when the relay is energized. Another such system employs a pair of magnetically operated reed switches, one of which is normally closed for connecting the receiver to the antenna, and another which is normally open for connecting the antenna to the transmitter. A third technique employs diode switches to provide the antenna switching function.

Whereas these techniques provide a way to selectively connect an antenna to either a transmitter or a receiver, a form C relay is generally costly, does not provide good isolation between the transmitter and receiver, and is easily contaminated by dirt and other foreign matter. Reed switches are hermetically sealed to minimize the contamination problem, however only normally open reed switches are readily available for use at high radio frequencies such as the VHF band. Therefore, two switches must be used, and one must be biased closed by means of a permanent magnet or electromagnet. Diode switches are limited in power handling capability and tend to generate undesired intermodulation products and harmonics.

SUMMARY

It is an object of the present invention to provide an improved antenna switching system that provides a good RF connection between connected terminals while maintaining good isolation between disconnected terminals.

It is a further object of this invention to provide an antenna switching system that utilizes readily available normally open reed switches and does not require a form C relay or a normally closed or magnetically biased reed switch.

A still further object of this invention is to provide an antenna switching system that minimizes contact contamination and the generation of undesired frequency components.

In accordance with the preferred embodiment of the invention, a first normally open reed switch is connected between an antenna and a radio transmitter. A one quarter wavelength transmission line is connected between the antenna and a radio receiver. A second normally open reed switch is connected across the receiver terminals at the junction of the receiver and the quarter wave transmission line. An electromagnet is employed to simultaneously energize the reed switches to a closed position.

In the receive mode, the reed switches are de-energized and the receiver is connected to the antenna through the quarter wave transmission line. Energizing the electromagnet causes the transmitter to be connected to the antenna by means of the first reed switch and causes the second reed switch to short out the input terminals to the receiver. The short circuit at the receiver end of the quarter wave transmission line is reflected as an open circuit to the antenna end thereof, thereby preventing any mismatch from occurring at the antenna.

DESCRIPTION OF THE DRAWING

In the drawing:

FIG. **1** is a schematic circuit diagram of the radio frequency switching system according to the invention; and

FIG. **2** is a perspective drawing of a practical embodiment of the antenna switching system according to the invention.

DETAILED DESCRIPTION

Referring to FIG. **1**, there is shown an antenna **10** connected to one terminal of a normally open reed switch **12** and to the center conductor of a one quarter wavelength transmission line **14**. Although a quarter wave transmission line is shown, any impedance inverting network such as a wave guide, lumped circuit element network or transmission line having a length equal to an odd integral number of quarter wavelengths such as one quarter wavelength, three quarters wavelength, etc., may be used. A coaxial connector **16** is used to make the connection between the antenna **10** and the switch **12** and line **14**, however, a direct connection may be made without the use of the connector **16**. A transmitter **18** is connected to the other terminal of the reed switch **12**. The other end of the one quarter wavelength transmission line **14** is connected to a receiver **20** through a second coaxial connector **22**. The shield of the transmission line **14** is connected to ground and a second reed switch **24** is connected between ground and the ungrounded conductor of the transmission line **14** through a capacitor **26**. An activating means, in this embodiment, an electromagnet having a coil portion **30** and pole pieces **32** and **34** is magnetically coupled to the reed switches **12** and **24**. The coil **30** is energized by applying an electrical current to a pair of leads **36** and **38** from a suitable power source (not shown) such as, for example, the transmitter power supply.

In operation, when the transceiver is operating in the receive mode, the coil **30** is not energized and the reed switches **12** and **24**, which are hermetically sealed reed switches well known in the art, are open. When the switches **12** and **24** are open, the receiver **20** is connected to the antenna **10** through the quarter wave transmission line **14** to allow the receiver **20** to receive signals picked up by the antenna **10**. When it is desired to transmit a signal from transmitter **18**, the coil **30** is energized from the power source, thereby causing magnetic flux to flow between the pole pieces **32** and **34** through the reed switches **12** and **24** to close the reed switches **12** and **24**. Closing the reed switch **12** completes the path between the transmitter **18** and the antenna **10**, and allows signals from transmitter **18** to be applied to the antenna **10** for transmission. Simultaneously, the reed switch **24** provides a path between

the antenna terminal of the receiver **20** and ground through the capacitor **26,** which has a value chosen such that capacitor **26** resonates with the inductance of the reed switch at radio frequencies. The low impedance of the series combination of capacitor **26** and reed switch **24** between the receiver antenna terminals and ground shunts any signals from transmitter **18,** which may pass through the transmission line **14,** to ground, thereby preventing signals from transmitter **18** from damaging the receiver **20.** The termination of the transmission line **14** provided by the series combination of capacitor **26** and reed switch **24,** which is a low impedance and may be chosen to be substantially a short circuit, appears as a high impedance at the terminal of transmission line **14** that is connected to the antenna **10.** When the impedance provided by the capacitor **26** and reed switch **24** is substantially a short circuit, the impedance that is reflected to the antenna **10** through the quarter wave transmission line **14** is substantially an open circuit, thereby preventing the closed reed switch **24** from substantially affecting the signal flowing from the transmitter **18** to the antenna **10.**

In the switching system of the present invention, both of the reed switches **12** and **24** are either open or closed, thereby eliminating biasing magnets which are required in switching systems of the prior art wherein one of the reed switches is open while the other is closed. In addition, when the transceiver is in the receive mode, which is a major portion of the time, the electromagnet coil **30** is not energized, thereby saving electrical power. The electromagnet coil **30** need be energized only during the relatively brief intervals when a transmission from transmitter **18** is taking place. The receiver **20** is isolated from the transmitter **18** during transmission by the low impedance to ground provided by the capacitor **26** and reed switch **24** when the reed switch **24** is closed during transmission.

Referring to FIG. **2,** there is shown in perspective view a preferred embodiment of the antenna switching system according to the invention. Like numbers are used to indicate analogous components in FIGS. **1** and **2.** The components comprising the antenna switching system are mounted on a board **40** having copper cladding **52** bonded thereto. The reed switches **12** and **24** are mounted directly on the board **40,** and the electromagnet assembly comprising the coil **30** and pole pieces **32** and **34** is mounted over the reed switches. The reed switches **12** and **24** are positioned on opposite sides of the coil **30** to minimize electromagnetic coupling between the switches. The pole pieces **32** and **34** are steel pole pieces extending from the coil **30** to simultaneously couple magnetic flux from the coil **30** to the reed switches **12** and **24.** The magnet coil **30** is energized by applying electric current to leads **36** and **38** as in FIG. **1.** The reed switch **24** is connected to the copper cladding **52** at point **41** to provide the gound connection and to the capacitor **26** through the island **42.** The capacitor **26** is coupled to the transmission line **14** through another island **44.**

The transmission line **14,** in this embodiment, is a strip line or microstrip type of transmission line comprising a ceramic or other dielectric substrate **46,** a screened or printed conductor **48,** which is analogous to the center conductor of a coaxial transmission line, on one side of the ceramic substrate, and a copper ground plane **50** on the opposite side of the substrate. The copper ground plane **50** of the transmission line **14** is connected to the copper cladding **52** of the board **40** to provide a ground connection to the ground plane **50.** This connection if analogous to the ground connection made to the shield of the transmission line **14** of FIG. **1.** The printed conductor **48** has one end connected to the capacitor **26** and the other end connected to the reed switch **12** and the antenna connector **16** (not shown in FIG. **2**). The island **44** connects the transmission line **14** to the center conductor of the receiver jack **22.** The outer conductor of the jack **22** is connected to the copper cladding **52** to provide a ground. The transmitter **18** (not shown in FIG. **2**) is connectible to the island **54** for connection to the reed switch **12.** Operation of the circuit of FIG. **2** is similar to the operation of the circuit of FIG. **1,** already explained.

The embodiment of the antenna switching system according to the invention shown in FIG. **2** is included as an illustration of a practical embodiment of the system. It should be noted that variations of the basic system, such as, for example, the use of a coaxial rather than a microstrip transmission line for line **14,** different placement of the reed switches **12** and **24** and a different configuration of pole pieces **32** and **34** may be used and still fall within the scope of the invention. In addition, although the switching system according to the invention has been illustrated in a system using unbalanced transmission lines (one conductor grounded), the techniques are equally applicable to systems utilizing balanced transmission lines wherein both conductors are floating.

I claim:

1. A radio frequency switch for operation at a predetermined frequency for selectively coupling one of a transmitter and a receiver to a common antenna, including in combination:

a mounting board;

first and second magnetically actuated reed switches mounted on said mounting board, each reed switch comprising a normally open magnetic reed contact pair, each reed switch having a first conductor extending from one of the contacts of said pair and a second conductor extending from the other of the contacts of the pair;

a microstrip transmission line mounted on said board, said microstrip transmission line having a quarter wavelength conductor at said predetermined frequency having first and second ends and a common conductor;

means for connecting the first conductor of said first reed switch and the first end of said quarter wavelength conductor to said antenna;

means for connecting the second conductor of said first reed switch to said transmitter;

means for connecting the second terminal of said quarter wavelength conductor to said receiver and to the first conductor of said second reed switch;

means for connecting the second conductor of said second reed switch to the common conductor of said microstrip transmission line; and

a magnetic actuator mounted to said mounting board, said magnetic actuator having an electromagnetic coil positioned between said reed switches, said actuator having a pair of magnetic pole pieces attached to said electromatic coil and extending radially therefrom beyound the radius of the electromagnetic coil and overlapping said reed

switches for simultaneously closing said reed switches when said electromagnetic coil is energized for allowing radio frequency signals to flow between said transmitter and said antenna.

2. A radio frequency switch as recited in claim **1** wherein the transmission line comprises a dielectric substrate having said first conductor bonded thereto.

3. A radio frequency switch as recited in claim **2** wherein said means connecting the first conductor of said second reed switch to the second terminal of said quarter wavelength conductor includes a capacitor.

4. A radio frequency switch as recited in claim **3** wherein the capacity of said capacitor is chosen for resonance with the inductance associated with said second reed switch at the operating frequency of said radio frequency switch.

5. A switch as recited in claim **1** wherein each pole piece has an edge contacting a major surface of said mounting board, and wherein each of said edges has a pair of notches defined therein for receiving said reed switches.

6. For use with a radio frequency antenna switching system employing a quarter wavelength transmission line, an electrically actuated switch, comprising:

a mounting board,

first and second magnetically actuated reed switches mounted on said mounting board in a parallel spaced relationship, each reed switch having a sealed normally open magnetic reed contact pair; and

an electromagnetic actuator mounted to said board, said actuator having a bobbin having first and second opposing ends and a single coil of conductive wire wound around the bobbin, said bobbin being positioned between said reed switches and parallel thereto, said actuator having first and second planar pole pieces attached to the first and second ends of said bobbin, respectively, and extending radially from said bobbin beyond the radius of said coil and partially encircling said reed switches, each of said pole pieces having a substantially straight edge contacting said mounting board, each of said substantially straight edges having first and second notches defined therein for receiving said reed switches, said pole pieces being positioned substantially perpendicular to said mounting board and adaped to conduct magnetic flux from said coil to said reed switches for simultaneously closing both of said magnetic reed contact pairs upon electrical energization of said coil.

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