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COUPLING CIRCUIT

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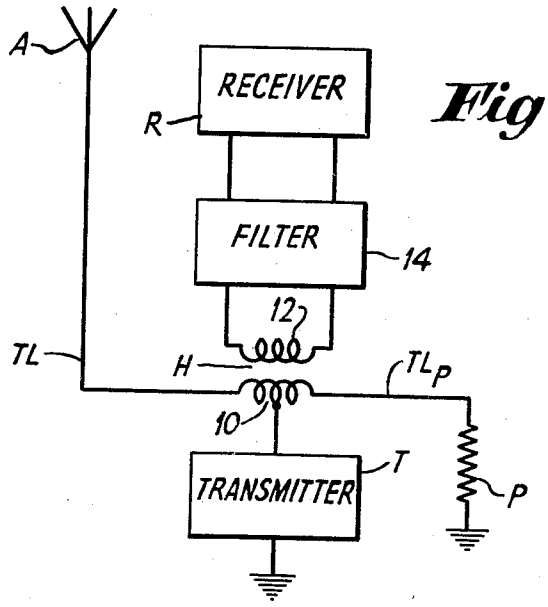
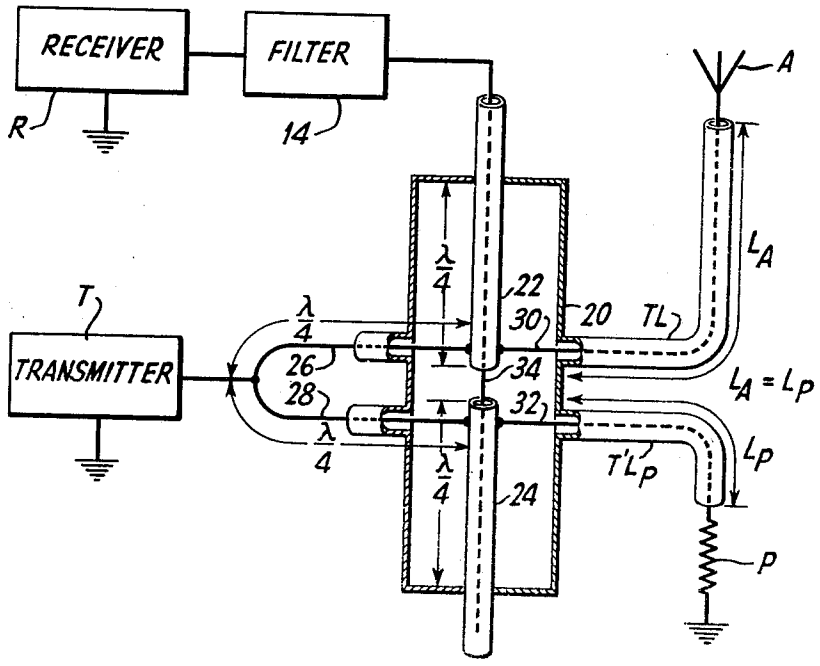


Fig. 1

Fig. 2



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COUPLING CIRCUIT

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The present invention relates particularly to coupling circuits adapted to connect a transmitter and receiver to a common antenna for simultaneous or sequential operation therewith.

An object of the present invention is to so couple a transmitter and receiver to an antenna so that they may be simultaneously operated without interaction therebetween.

Another object of the present invention is the provision of a system operating as aforesaid which will provide maximum decoupling between the transmitter and receiver.

A further object of the present invention is the provision of a system as aforesaid which is more efficient than previously known systems.

Still another object of the present invention is the provision of a system as aforesaid which is less delicate in its adjustments than previously known systems.

Still a further object of the present invention is the reduction of the number of antennas required on high speed aircraft.

The foregoing objects and others which may appear from the following detailed description are attained by providing a hybrid circuit for coupling a transmitter and a receiver to an antenna. Furthermore, I interpose a filter system in the receiver branch to attenuate any signals which are coupled through the hybrid circuit from the transmitter to the receiver. It has been found that the hybrid or phantom circuit does not usually provide sufficient decoupling in most cases. The same situation is true for filter circuits unless they are extremely complicated. In the case of complicated filter circuits, the loss incurred within the filter is so appreciable that it is commensurate with that incurred when utilizing a hybrid circuit. However, the combination of the hybrid circuit with the filter provides a less delicate circuit having a degree of uncoupling.

The present invention will be more fully understood by reference to the following detailed description which is accompanied by a drawing in which:

Figure 1 illustrates in schematic form a circuit diagram of the present invention, while

Figure 2 is a somewhat different showing of the invention utilizing a modified form of a hybrid circuit.

Referring now to Figure 1, I have shown a

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circuit for simultaneously coupling transmitter T and receiver R to antenna A. The transmitter T is coupled to the midpoint of winding 10 of coupling transformer H. One end of winding 10 is connected to antenna A through a transmission line TL. I have shown only a single conductor in transmission line TL but in practice this may be, and preferably is, surrounded by a coaxially arranged grounded sheath whereby radiation therefrom is prevented. The other end of winding 10 is coupled through a second transmission line TL_p to a phantom load P. Load P is so designed as to simulate the electrical characteristics of antenna A as nearly as possible. In inductive relationship with winding 10 of transformer H is a second winding 12. The ends of this winding are coupled through filter network 14 to receiver R. Now, it will be seen that current from the transmitter 10 divides equally at the center tap of winding 10 and flows in opposite directions to the ends of the winding. Thus, one half of the energy from transmitter 10 is applied to antenna A and radiated therefrom, the other half being dissipated in the phantom load resistor P. The current flow in the two halves of winding 10 is in opposite directions and the load characteristics of antenna A and phantom load P being alike the current in both halves is equal. No current therefore is induced in secondary 12 to be coupled to the receiver R. In practice it is difficult to attain such a degree of uncoupling that absolutely no energy is received by receiver R. There will generally be a certain amount of unbalance between the halves of winding 10 or between the currents flowing in said halves and some electrostatic coupling may take place. I, therefore, provide a filter network 14 connected between the winding 12 and the receiver R tuned to reject energy of the frequency generated by transmitter T. By this means I have found that a degree of uncoupling sufficient to insure reliable working can be obtained with less loss than would be incurred by the use of a filter network alone. Further, the combination provides a less delicate circuit which is more tolerant of minor frequency variations than a filter circuit alone would be. It is apparent that the filter is used when transmitting at one frequency, to which the filter 14 may be tuned, and receiving at another, which is passed freely by the filter 14.

The modified form of my invention shown in

Figure 2 utilizes a somewhat different form of a hybrid circuit. Here a hybrid circuit includes within a shielding container 20 a pair of hollow conductors 22 and 24 in a coaxial end-to-end relationship within the container 20. A pair of lines 26 and 28 each a quarter wave or an odd multiple thereof in length are connected to the adjacent ends of hollow conductors 22 and 24 and at their other ends are connected in a parallel relationship to the output of transmitter T. An inner conductor 34 is coaxially arranged with respect to hollow conductors 22 and 24. Conductor 34 may, as shown, be open ended within conductor 24, extending therewithin an odd number of quarter wavelengths. Alternatively it may be directly connected to the end of conductor 24 adjacent conductor 22 or extend into conductor 22 an even number of quarter wavelengths and its end then connected to conductor 24. Further, inner conductors 30 and 32 of transmission lines TL and TL_P are connected to the adjacent ends of hollow conductors 22 and 24. Thus, energy from transmitter T divides equally at the junction of conductors 26 and 28 and one half of the energy is applied through transmission line TL to antenna A. The other half is dissipated in the phantom load P. In order to assure a balance it is desirable that L_A, the length of transmission line TL, and L_P, the length of line TL_P, be equal as well as that the electrical characteristics of load P simulate those of antenna A. Since energy in the same phase relationship is applied to the adjacent ends of hollow conductors 22 and 24, no energy is coupled to the conductor 34 of the transmission line leading to the receiver R. As in the case of Figure 1, the filter 14 is provided to stop any energy from transmitter T which is not balanced out by the hybrid circuit. Energy from antenna A is applied in an unbalanced relationship to one end of conductor 22 and in essentially counter phase relationship to the end of conductor 24. Thus, energy is induced in conductor 34 which is applied to receiver R. Because of the balanced line from the transmitter, substantially no energy reaches the receiver from the transmitter, regardless of the electrical lengths of the line at the transmitted frequency, provided the balance is maintained. Thus the transmitter may work at one frequency, and the antenna receive energy at a second frequency. At the second frequency, the line lengths shown feed energy to the receiver, as already explained. The filter 24 may be tuned to the transmitted frequency to give a degree of uncoupling between receiver and antenna to transmitted energy not achieved heretofore.

While I have illustrated a particular embodiment of the present invention, it should be clearly understood that it is not limited thereto since many modifications may be made in the several elements employed and in their arrangement and it is therefore contemplated by the appended claims to cover any such modifications as fall within the spirit and scope of the invention.

What is claimed is:

1. An arrangement for coupling a transmitter and a receiver to an antenna including an outer shield having a pair of hollow conductors in an end-to-end coaxial relationship within said shield, said hollow conductors each having a length equal to one quarter of the operating wavelength, a coaxial transmission line from said receiver having an inner conductor extending through said hollow conductors, a pair of conductors from said transmitter in a parallel relationship and connected to adjacent ends of said hollow conductors, one of said pair of conductors extending to said antenna and the other of said pair of conductors extending to a phantom load having electrical characteristics equivalent to those of said antenna, the lengths of said pair of conductors from said hollow conductors to said antenna and said phantom load respectively being equal.

2. An arrangement for coupling a transmitter and a receiver to an antenna including an outer shield having a pair of hollow conductors in an end-to-end coaxial relationship within said shield, said hollow conductors each having a length equal to one quarter of the operating wavelength, a coaxial transmission line from said receiver having an inner conductor extending through said hollow conductors, a pair of conductors from said transmitter in a parallel relationship and connected to adjacent ends of said hollow conductors, one of said pair of conductors extending to said antenna and the other of said pair of conductors extending to a phantom load having electrical characteristics equivalent to those of said antenna, the lengths of said pair of conductors from said hollow conductors to said antenna and said phantom load respectively being equal and a filter network tuned to reject energy of the frequency of said transmitter connected between said receiver and said hollow conductors.

3. An arrangement for coupling a transmitter and a receiver to an antenna including an outer shield having a pair of hollow conductors in an end-to-end coaxial relationship within said shield, a coaxial transmission line from said receiver having an inner conductor extending through said hollow conductors, a pair of conductors from said transmitter in a parallel relationship and connected to adjacent ends of said hollow conductors, one of said pair of conductors extending to said antenna and the other of said pair of conductors extending to a phantom load having electrical characteristics equivalent to those of said antenna, the lengths of said pair of conductors from said hollow conductors to said antenna and said phantom load respectively being equal.

4. An arrangement for coupling a transmitter and a receiver to an antenna including an outer shield having a pair of hollow conductors in an end-to-end coaxial relationship with said shield, a coaxial transmission line from said receiver having an inner conductor extending through said hollow conductors, a pair of conductors from said transmitter in a parallel relationship and connected to adjacent ends of said hollow conductors, one of said pair of conductors extending to said antenna and the other of said pair of conductors extending to a phantom load having electrical characteristics equivalent to those of said antenna, the lengths of said pair of conductors from said hollow conductors to said antenna and said phantom load respectively being equal and a filter network tuned to reject energy of the frequency of said transmitter connected between said receiver and said hollow conductors.

5. An arrangement for coupling a transmitter and a receiver to an antenna including an outer shield having a pair of hollow conductors each having one end thereof connected to said shield, said hollow conductors being arranged with ends thereof closely adjacent within said shield, said hollow conductors each having a length equal to one quarter of the operating wavelength, a coaxial transmission line from said receiver having an inner conductor extending consecutively within

both of said hollow conductors, a pair of conductors from said transmitter in a parallel relationship and connected to said adjacent ends of said hollow conductors, one of said pair of conductors extending to said antenna and the other of said pair of conductors extending to a phantom load having electrical characteristics equivalent to those of said antenna, the lengths of said pair of conductors from said hollow conductors to said antenna and said phantom load respectively being equal.

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