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W. VAN B. ROBERTS

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METHOD OF AND MEANS FOR COUPLING TWO HIGH FREQUENCY CIRCUITS

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Fig. 1

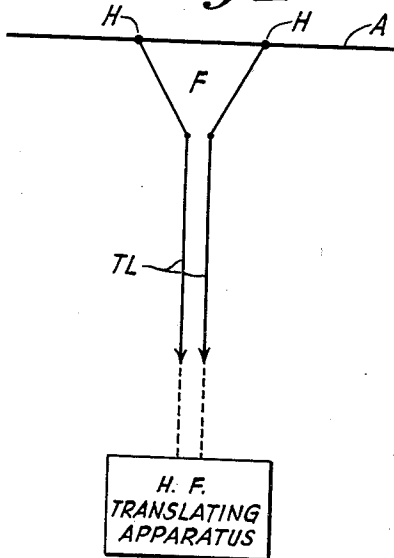


Fig. 2

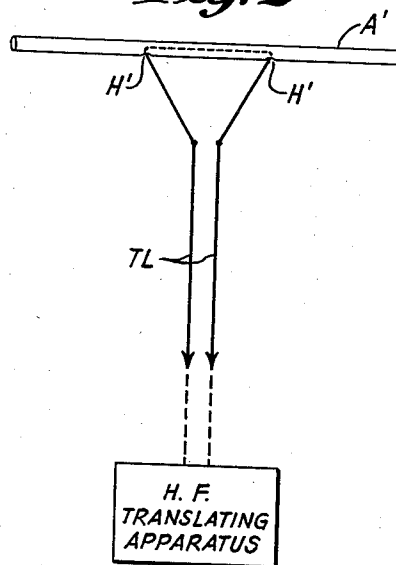


Fig. 3

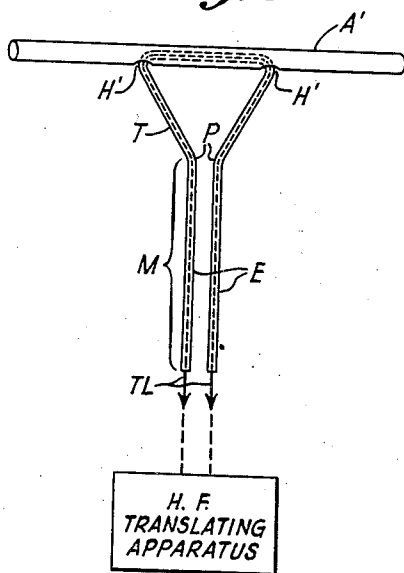
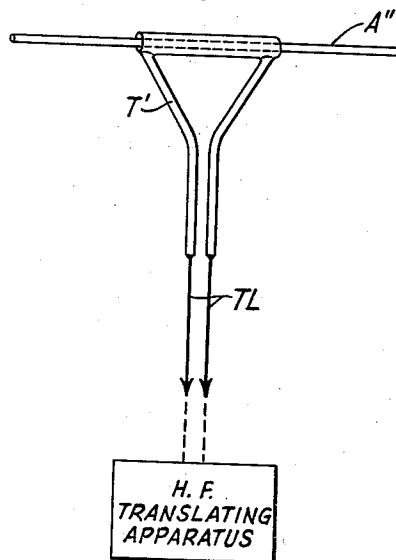


Fig. 4



BY

INVENTOR.
WALTER VAN B. ROBERTS

H. S. Swann
ATTORNEY.

UNITED STATES PATENT OFFICE

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METHOD OF AND MEANS FOR COUPLING
TWO HIGH FREQUENCY CIRCUITSWalter van B. Roberts, Princeton, N. J., assignor
to Radio Corporation of America, a corporation
of Delaware

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10 Claims. (Cl. 250—33)

The present invention relates to improvements in the method of and means for coupling together two high frequency circuits, and particularly to a method of and means for coupling a transmission line to an antenna.

A general object of the present invention is to provide an improved coupling means between a transmission line or other circuit, and a second circuit composed at least in part of a hollow conductor.

A more specific object of the invention is to provide a coupling between circuits of the type referred to above, which coupling is free of metallic contacts.

A further object of the invention is to provide both a coupling and an impedance matching device for transmitting energy from one alternating current circuit to another, without a metallic contact between the circuits.

A known method of coupling two high frequency circuits is shown in Fig. 1, which shows a transmission line TL connected to a dipole antenna A. In such a known arrangement it has been found that where a dipole is made of aluminum there is difficulty in making a reliable low resistance contact from the transmission line to the dipole antenna, without interfering with the current flow along the outer surface of the dipole antenna.

The present invention overcomes the foregoing difficulty, among others, by enabling coupling to be effected between the dipole antenna and the transmission line without utilizing any metallic contact at all between the two circuits.

A more detailed description of the invention follows in conjunction with the drawing, wherein:

Fig. 1 illustrates a known type of coupling arrangement between an antenna and a transmission line, while

Figs. 2, 3, and 4 illustrate several embodiments of the present invention given by way of example only, in order to illustrate the principles involved.

As mentioned above, Fig. 1 illustrates prior practice wherein a transmission line TL extending from suitable high frequency transmitting or receiving apparatus, shown conventionally in box form, connects with an antenna A by direct metallic connection at two spaced points H, H on the antenna. These points are so spaced that the impedance of the transmission line TL is approximately matched by the load impedance into which it works.

A further difficulty which the known system of Fig. 1 experiences lies in the fact that the spacing between the junction points of the antenna A and the transmission line TL may not be such that there is obtained a sufficiently good impedance match between the two circuits at the terminals of the transmission line so as to

avoid standing waves on the transmission line. This difficulty is overcome, in accordance with another embodiment of the invention, by providing a matching section of transmission line which is added to the contactless coupling arrangement, while still maintaining a complete lack of metallic contacts between the various parts of the system.

In Fig. 2, illustrating one embodiment of the present invention, the dipole antenna A consists, at least in that part thereof between the coupling points H', H', of a hollow conductor, and the transmission line TL is brought through the hollow portion of the tubular antenna A' between the holes H', H' at positions corresponding substantially to the positions at which contacts would be made if the contacts were to be used in the manner shown in Fig. 1. As shown in the drawing, the transmission line TL is spaced or insulated from the antenna A' in such manner that there is no direct metallic connection between the transmission line and the antenna either at the holes H, H or throughout the length of the portion of the transmission line within the hollow dipole. The mutual inductance between the antenna A' and the transmission line circuit TL is exactly the same as if the wires of the line were metallically connected to the antenna A' at the points where the transmission line wires enter the holes H', H', in the antenna.

Fig. 3 shows a modification wherein an impedance matching section is effectively added to the contactless coupling arrangement of Fig. 2. In this figure, there is shown a tubular antenna A' which is coupled without metallic contacts to a tubular conductor T of smaller diameter, which conductor T is bent around so that the end portions E thereof lie parallel to each other so as to form a matching section M. This matching section M of the tubular conductor T is continuous with the coupling portion extending through the holes H', H' of the antenna, and has a length and spacing which is determined in accordance with the input impedance of the coupling portion. Effectively, we thus have a matching section of line inserted between the transmission line TL proper and the terminals P, P whose impedance is to be matched to that of the line. By suitable choice of the length and characteristic impedance of the matching section M of tubular conductor T, the complex load presented at points P, P of the antenna coupler T is transformed into a pure resistance equal to the characteristic impedance of the transmission line TL. The separation between the conductors E, E of the matching section M and the length thereof are determined in part by the impedance measured at the points P, P where the matching section M changes into the coupling loop or

triangular portion of tube T which provides the desired mutual inductance with the antenna. The length and spacing of the matching section M is determined for the rest by the characteristic impedance of the main transmission line. A more detailed description of the manner in which this matching section functions to transform the complex load of the antenna into a pure resistance equal to the characteristic impedance of the transmission line proper is described in more detail in my copending application, Serial No. 162,302, filed September 3, 1937, to which reference is here made.

Although it is possible to connect the transmission line TL metallically to the ends of the matching section M remote from the antenna A', in accordance with the present invention, such metallic contact is avoided by passing the transmission line TL through the entire tubular conductor T which acts both as a coupling loop and a matching section. It should be noted in Fig. 3, that the transmission line TL makes no direct metallic connection with the tubular conductor T, and the tubular conductor T in turn makes no direct metallic connection with the antenna A. For this purpose, if desired, insulators may be provided between the conductors of the line TL and the tubular conductor T, and also between the tubular conductor T and the antenna A, thus insuring the avoidance of all metallic contacts which are subject to corrosion. This insulation need not be of high quality, since little potential difference exists thereacross.

Fig. 4 illustrates a further modification of the invention, wherein the coupling member T' (triangular shaped circuit) is made of hollow tubing of larger diameter than the dipole antenna A'', the antenna being passed through a portion of the coupling member.

One advantage of providing insulation between the wires of the transmission line TL and the antenna A' of Fig. 2, and between various conductors of the system of Fig. 3, is that there is avoided variable and sporadic contacts which may cause electrical disturbances in the system.

What is claimed is:

1. In combination, an antenna having a hollow portion in the interior thereof communicating with the exterior through a pair of spaced apertures located intermediate the ends of said antenna, a continuous hollow conductor extending in the interior of said hollow portion and emerging through said apertures, said hollow conductor being insulatingly arranged with respect to said antenna, and a transmission line coupled to said hollow conductor.

2. In combination, an antenna having a hollow portion in the interior thereof communicating with the exterior through a pair of spaced apertures, a continuous hollow conductor extending in the interior of said hollow portion and emerging through said apertures, said hollow conductor being insulatingly arranged with respect to said antenna, and a transmission line passing through the interior of said hollow conductor.

3. In combination, an antenna having a hollow portion in the interior thereof communicating with the exterior through a pair of spaced apertures, a continuous hollow conductor extending in the interior of said hollow portion and emerging through said apertures, said hollow conductor being insulatingly arranged with respect to said antenna, and a transmission line passing through

the interior of said hollow conductor and insulated therefrom.

4. In combination, an antenna having a hollow portion in the interior thereof communicating with the exterior through a pair of spaced apertures, a continuous hollow conductor extending in the interior of said hollow portion and emerging through said apertures, said hollow conductor being insulatingly arranged with respect to said antenna, and having end portions extending parallel to each other, a transmission line coupled to said end portions, said end portions having such length and being so spaced that the complex load of said antenna is transformed into a pure resistance equal to the characteristic impedance of the transmission line.

5. In combination, an antenna having a hollow portion in the interior thereof communicating with the exterior through a pair of spaced apertures located intermediate the ends of said antenna, and a transmission line having a pair of conductors extending through said apertures and joined together in the interior of said antenna to form a continuous conductor, said line being insulatingly arranged with respect to said antenna to prevent metallic contact therebetween.

6. In combination, an antenna having a hollow portion in the interior thereof communicating with the exterior through a pair of spaced apertures, and a transmission line having a pair of conductors extending through said apertures and joined together in the interior of said antenna to form a continuous conductor, said line being insulatingly arranged with respect to said antenna to prevent metallic contact therebetween, said apertures being so spaced that standing waves on the transmission line are rendered negligible.

7. In combination, an aerial element, and a feeder element coupled to said aerial at points intermediate the ends of said aerial, said feeder element being in the form of a loop, one of said elements being hollow for at least part of its length for accommodating the other element therein, said elements being insulated from each other.

8. In combination, an aerial and a feeder in the form of a conducting loop coupled to said aerial at a location intermediate the ends of said aerial, a portion of said loop being hollow for accommodating an intermediate portion of said aerial, and high frequency translating apparatus coupled to the ends of said loop.

9. In combination, a dipole antenna which is effective as a radiator throughout its entire length, said dipole having a hollow portion intermediate the ends thereof, a two-conductor feeder having its circuit completed through said hollow portion but insulatingly arranged with respect to said dipole antenna, and high frequency translating apparatus coupled to the two conductors of said feeder.

10. In combination, an antenna having a hollow portion in the interior thereof communicating with the exterior through a pair of spaced apertures located intermediate the ends of said antenna, and a continuous conductor loop passing through said apertures, the portions of said loop external of said apertures being brought into parallelism to form a parallel wire transmission line, whereby there is obtained inductive coupling between said antenna and said loop, the spacing of said apertures being substantially greater than the spacing of the parallel wire transmission line.

WALTER VAN B. ROBERTS.