Dec. 26, 1939. H. O. ROOSENSTEIN 2,184,771

ANTENNA COUPLING MEANS

Filed May 6, 1938

Fig. 1

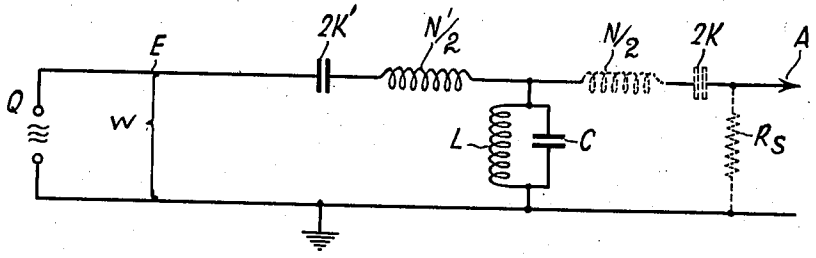


Fig. 2

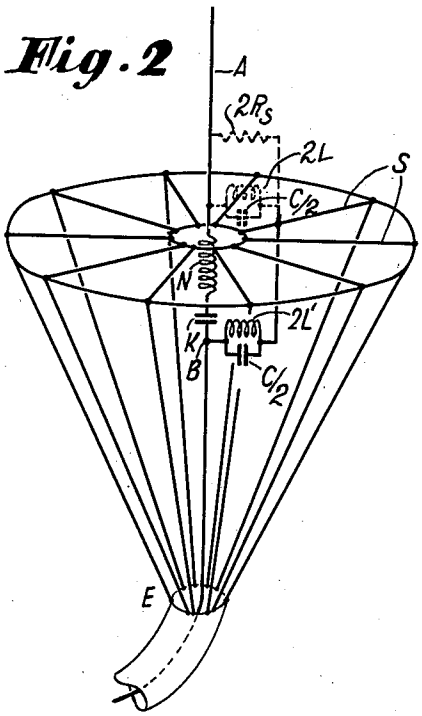
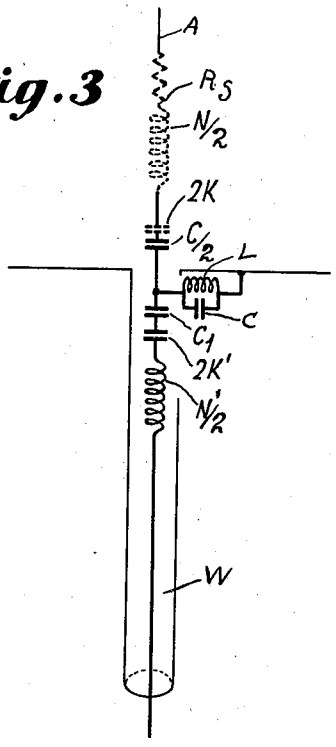


Fig. 3



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ANTENNA COUPLING MEANS

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4 Claims. (Cl. 250—33)

The subject matter of the invention is an arrangement for matching an antenna with a high-frequency energy line, more especially an antenna for transmitting very wide frequency bands, such as, for instance, a television antenna. As is known, a high-frequency load can be easily matched with an energy line if it is a question of a single frequency, but this matching involves difficulties if it is also to be correct for a wider frequency range, because the load represents in general a wattless resistance of a type which varies with the frequency. Thus, for instance, an antenna forms an ohmic resistance at its point of feeding only for some definite frequencies, whereas its substitution circuit is composed for all other frequencies of capacities, inductances and ohmic resistances. In accordance with the invention a matching of an antenna with the high-frequency supply line and whereby said matching is to a wide degree independent of the frequency, is accomplished in that there is formed a band pass filter network at the point of feeding of the antenna by connecting additional impedances in conjunction with the impedances corresponding to the substitution circuit of the antenna, the wave resistance of said network being equal to the radiation resistance of the antenna applied to the point of feeding.

Referring, for a more complete understanding of my invention, to the subsequent detailed description, which is accompanied by drawings in which Figure 1 shows one form of my invention and Figures 2 and 3 show modifications thereof.

Figure 1 shows a mode of construction in accordance with the invention in which a $\lambda/4$-antenna A is connected to the high-frequency source Q by means of an energy line E. A $\lambda/4$-antenna can at its base point be represented by a series connection of a self-inductance N/2 (shown in dotted lines) and a capacity 2K (likewise shown in dotted lines) together with an "equivalent" radiation resistance Rs relating to the point of feeding. This substitution circuit will be extended in accordance with the invention to a T type filter network in that there is inserted in the supply lead the series connection of an inductance N'/2 and the capacity 2K' and that in parallel to antenna and ground a blocking circuit LC is placed. The additional series circuit as well as the parallel circuit are tuned suitably to the center of the frequency band to be transmitted and for which the length of the antenna is exactly $\lambda/4$. The characteristic impedance of the network shown is

$$W=\sqrt{\frac{N}{C}}$$

for the mean frequency and in most cases it suffices if for matching there is taken

$$W=\sqrt{\frac{N}{C}}=R_s$$

A more thorough calculation shows that the errors of transmission of this arrangement are much lower than in the case of the hitherto known circuits.

Figure 2 shows a further example of a construction in accordance with the invention wherein a $\lambda/2$-antenna A is to be connected to a concentric line E. The antenna may have a counterbalancing shield S at its base point and which takes over the function of the ground. The substitution circuit of this antenna consists as is known of the parallel circuit of an inductance 2L, a capacity C/2 (shown in dotted lines) and an equivalent radiation resistance 2Rs. This arrangement can be extended to a band-pass in that the antenna is fed across a series connection of a self-inductance N and a capacity K, and that in parallel to the input of this circuit there is placed a parallel circuit consisting of self-inductance 2L' and capacity C'/2. In order to assure the proper matching of this filter network in the vicinity of the center of the band there must again be

$$W=\sqrt{\frac{N}{C}}=R_s$$

The ground connections shown in Figure 2 are to be placed preferably at the counter-balancing shield S, otherwise wave oscillations will be produced on longer ground lines, which cause a detrimental effect upon the filter network and upon the radiation properties of the antenna.

While the radiation resistance Rs and therefore the wave resistance of the network are in general so low that the wave resistance of the energy line E can be matched directly therewith, the arrangement according to Figure 2 has a comparatively high ohmic resistance which can

only be decreased by constructing the antenna system of a parallel circuit of several elements. Therefore in order to be able to provide matching with the concentric cable, a transformation line may in addition be inserted between the antenna and cable, by which the wave resistance of the cable will be transformed upwards upon the input resistance of the network conductor at the antenna side. To this end there is shown in Figure 2 a conical widening of the outer case of the cable. By this means the wave resistance of the cable is gradually increased until reaching the desired high value. This matching is entirely independent of frequency.

The examples of construction, according to Figures 1 and 2, show antennas having at their base point a current node or a current peak; in other words, they represent a purely ohmic resistance at a mean frequency. The invention is not limited to these cases and can be applied also to any desired antenna lengths. Antennas are especially advantageous in which the ohmic component of the radiation resistance is equal to the wave resistance of the feed cable. In this case no additional matching lines are necessary between cable and antenna as shown in Figure 1. An arrangement of this type is shown in Figure 3 in which the length of the antenna is approximately equal to $\lambda/3$. The substitution circuit of the antenna in the feed point thereof consists in this case of a series connection of inductance

$$\frac{N}{2}$$

resistance Rs and capacity 2K in which the value of the self-inductance predominates while R is equal to the wave resistance W of the feed line. In order to render this arrangement purely ohmic for the mean frequency of the band to be transmitted a series capacity C_1 is inserted and the arrangement extended by means of capacity 2K' and inductance

$$\frac{N'}{2}$$

to form a filter network of the type of the arrangement shown in Figures 1 and 2. Regarding the example of construction according to the invention as shown, it should be remarked that in order to assure a uniformity of transmission of the entire frequency band it will be of advantage to utilize a slight deviation from the described conditions of matching in order that the errors produced on account of the residual faulty matchings will be symmetrical to a zero value at a definite frequency.

I claim:

1. Means for coupling an energy line to an antenna including a filter network having a characteristic impedance equal to the radiation resistance of said antenna, said network including a serially connected inductance and capacity of values equal to the capacity and inductance of said antenna and a shunt blocking circuit tuned to the operating frequency of said antenna.

2. Means for coupling an energy line to an antenna including a filter network having a characteristic impedance equal to the radiation resistance of said antenna, said network including serially connected inductance and capacity of values equal to the inductance and capacity of said antenna and a shunt blocking circuit connected between said antenna and said serially connected elements tuned to the operating frequency of said antenna.

3. Means for coupling an energy line to a quarter wave antenna including a filter network having a characteristic impedance equal to the radiation resistance of said antenna, said network including serially connected inductance and capacity of values equal to the capacity and inductance of said antenna and a shunt blocking circuit connected between said antenna and said serially connected elements tuned to the operating frequency of said antenna whereby the capacity and inductance of said antenna, together with the elements of said filter network, form a T type filter.

4. Means for coupling an energy line to a half wave antenna including a filter network having a characteristic impedance equal to the radiation resistance of said antenna, said network including serially connected inductance and capacity of values equal to the inductance and capacity of said antenna and a shunt blocking circuit connected between said energy line and said serially connected elements tuned to the operating frequency of said antenna whereby the capacity and inductance of said antenna, together with the elements of said filter, form a π type filter.

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