Feb. 16, 1943. W. BUSCHBECK ET AL 2,311,364

BROAD-BAND ANTENNA

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Fig. 1.

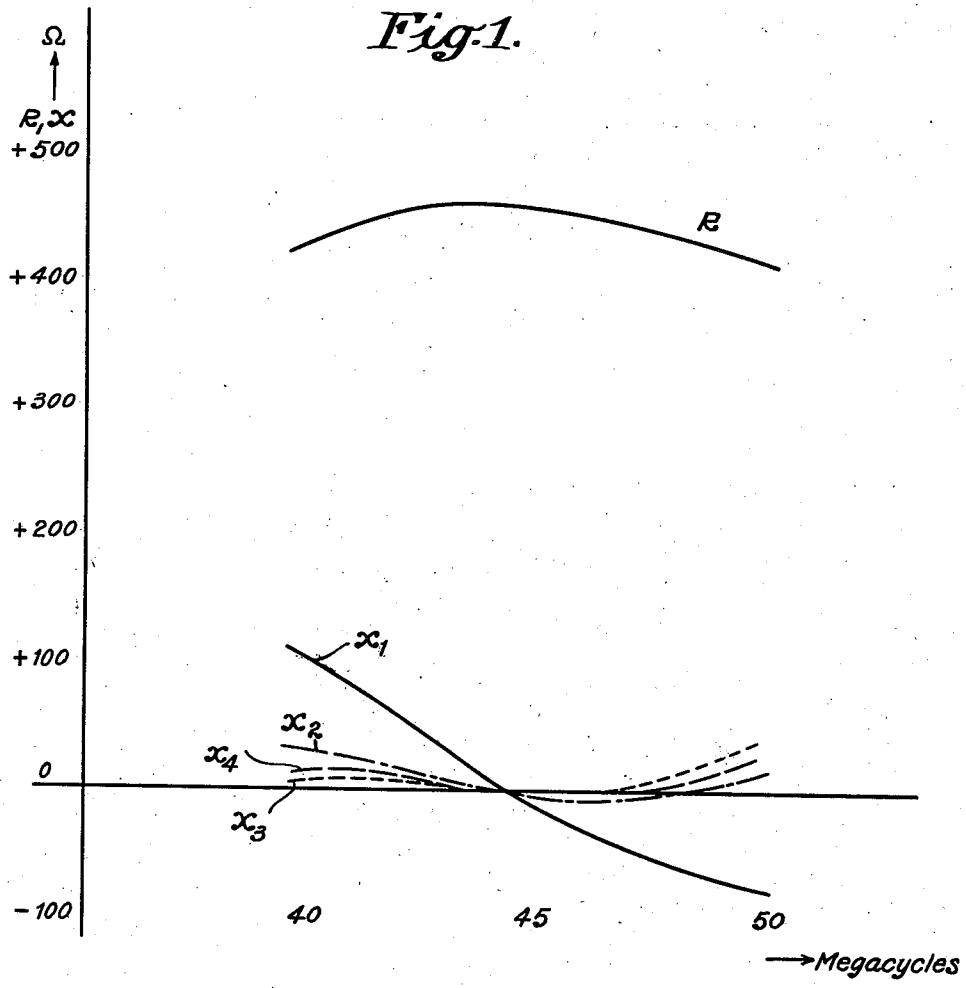
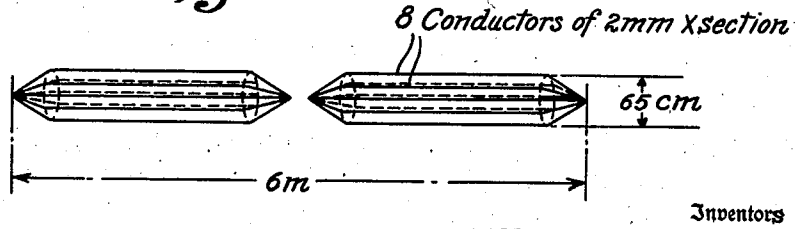


Fig. 1A.



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Fig. 2.

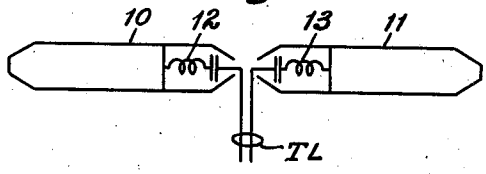


Fig. 3.

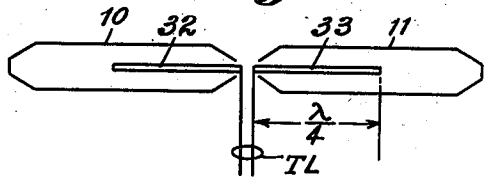


Fig. 4.

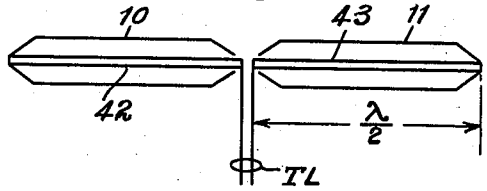


Fig. 5.

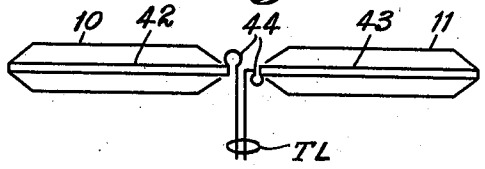
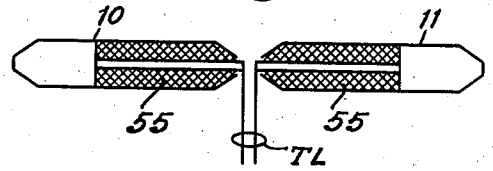


Fig. 6.



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BROAD-BAND ANTENNA

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Application August 24, 1940, Serial No. 354,016
In Germany April 3, 1939

2 Claims. (Cl. 250—33)

The present invention relates to short wave antennae and, more particularly, to those adaptable to a wide frequency range such as used in television.

It is known that half wave antennae are particularly high-damped when fed at a current node or anti-loop. For this reason they have been suggested for broad-band work in the prior art.

An object of the present invention is the utilization of half wave antennae for broad frequency coverage.

Another object of the present invention is the provision of a half wave antenna having a substantially constant reactance over a wide range of frequencies.

Further objects of the present invention will become apparent from the following detailed description which is accompanied by drawings in which Figure 1 shows a series of curves explanatory of the invention, while Figure 1A shows a form of antenna analyzed in the curves of Figure 1; Figure 2 shows a form of the present invention while Figures 3 to 6, inclusive, illustrate modifications of the invention.

Figure 1, for instance, shows the measured effective or ohmic resistance R and the shape of the reactance XI of an antenna arrangement indicated in Figure 1A. As a general rule, the high coupling resistance of the antenna will make transformation to lower values for the sake of a more practical energy lead design not only desirable, but even imperative. However, frequency independence of the resistance transformation means required therefor inside broader frequency bands will be feasible only by the use of terminating resistances being practically purely ohmic in nature. Hence, the general aim must be to minimize the reactive component, no matter how small, of the radiator impedance for the sideband frequencies or other carrier waves, if the antenna is to be operated at will with different carrier waves. Inasmuch as in tuning the radiator to $\lambda/2$ resonance at carrier frequency the radiator input is capacitive for higher frequencies and inductive for lower frequencies, the shape of the reactance characteristic determined by the antenna, as is well known, may be compensated inside wide limits, by a series resonance mesh of suitable dimensions. Inasmuch as the characteristic of this compensating circuit is likely to differ considerably from what would be expected by calculation because of inevitable distributed ground capacitances or as a result of stray or spurious couplings, these disturbing factors are avoided and obviated according to the invention by immersing or accommodating in the interior of the radiator the compensating means in such a way that they will be perfectly shielded in respect to earth and one another.

In this figure, **10** and **11** represent a pair of half wave radiators which may have the dimensions suggested in Figure 1A for a frequency range of 40 to 50 megacycles. They are energized from a suitable source (not shown) through transmission line T_L. The series resonant meshes **12, 13** are electrically interposed between the transmission line T_L and the radiators, as shown in Figure 2. The method previously suggested, namely, to place the compensator means in the interior of the inner energy conductor of the energy feeder line will be found impracticable in the majority of practical instances because of the practical difficulty attended upon an attempt to make energy feeder lines of high characteristic impedance with such heavy inner conductors that there is no room for accommodating the compensation means.

A numerical calculation of the basic idea of the invention shows that the use of conventional series resonance circuits is not entirely practicable from a standpoint of stability. Hence, it will be found expedient to replace them by open $\lambda/4$ lines **32, 33** (Fig. 3) within the radiators **10, 11** or short-circuited $\lambda/2$ lines **42, 43** (Fig. 4). The open $\lambda/4$ line may occasionally not be designable with an adequately high characteristic impedance. In such cases the use of the short-circuited $\lambda/2$ line which requires only one-half the characteristic impedance of the open $\lambda/4$ line, for the same compensation, will be found advantageous. However, what has to be kept in mind is that, as a general rule for these stout radiators the actual radiator length will be somewhat less than $\lambda/2$ so that the compensation means will have to be lengthened electrically by additional steps. In accordance with the invention these may be used for this purpose, for instance, additional series inductances **44** (Fig. 5) or concentrated or lumped cross-arm capacities; or else the mechanical wave-length may be reduced by the use of materials **55** for which μ and/or $\epsilon > 1$ in the compensating space (Fig. 6).

The success obtained with the scheme here disclosed is shown in Fig. 1 in which various compensating principles have been adopted for the antenna there shown. The reactance curve X_2 refers to compensation with an open $\lambda/4$ line as in Fig. 3; graph X_3 to compensation as shown in Fig. 4 and graph X_4 to compensation with short-

circuited lines as shown in Fig. 5 each of .445λ length and series inductances each of 160 cm.

Inasmuch as the radiator resistance where the basic idea of the invention is used is practically purely ohmic in nature throughout a whole band, the invention will be found particularly suited for multiple directive antenna systems.

We claim:

1. A short wave antenna having a substantially constant reactance over a broad band of frequencies comprising a hollow radiator having a length electrically equal to a half of the operating wavelength and a transverse dimension which is a substantial fraction of the operating wavelength and a feeder line for energizing said radiator, said feeder line being connected to one end of a conductor within said radiator, said conductor having an electrical length equal to a half wavelength and having its other end connected to said radiator.

2. A short wave antenna having a substantially constant reactance over a broad band of frequencies comprising a hollow radiator having a length electrically equal to a half of the operating wavelength and a transverse dimension which is a substantial fraction of the operating wavelength and a feeder line for energizing said radiator, said feeder line being connected to one end of a conductor within said radiator, said conductor having its other end connected to said radiator, said conductor within said radiator having a physical length less than said radiator and surrounded by a material such that its electrical length is equal to a half wavelength.

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