

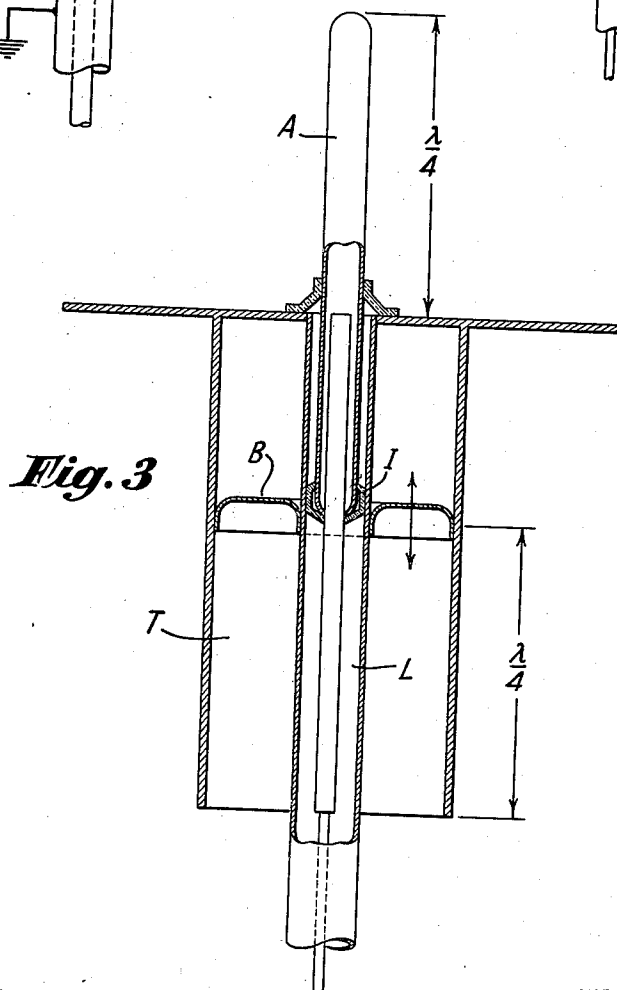
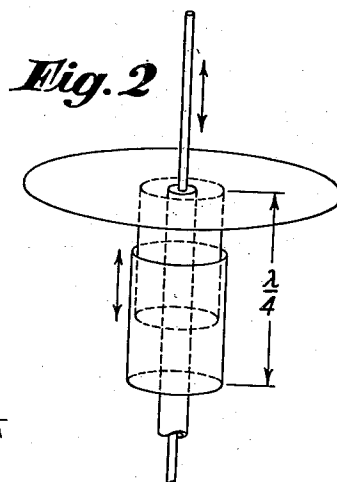
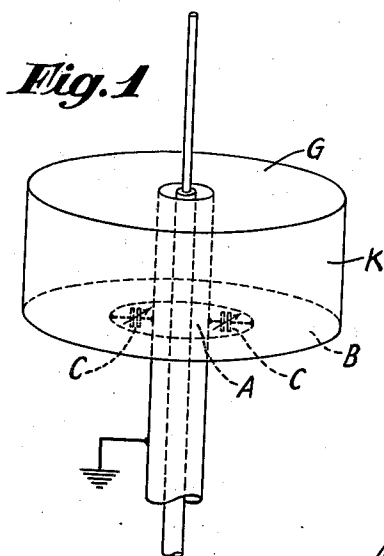
April 29, 1941.

W. BUSCHBECK ET AL

2,239,909

ANTENNA AND COAXIAL TRANSMISSION LINE CIRCUIT

Filed April 22, 1939



BY

INVENTORS
WERNER BUSCHBECK
HANS PROST
H.S. Sover
ATTORNEY.

UNITED STATES PATENT OFFICE

2,239,909

ANTENNA AND COAXIAL TRANSMISSION
LINE CIRCUIT

Werner Buschbeck and Hans Prost, Berlin, Germany, assignors to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

Application April 22, 1939, Serial No. 269,333
In Germany May 20, 1938

2 Claims. (Cl. 250—33)

In the practical use of antenna comprising a counterpoise of finite size certain difficulties are always encountered in the attempt to avoid undesirable resonance points of the counterpoise in reference to the ground. In order to eliminate this difficulty, it has been known for a long while in the art to ground the ends of the counterpoise. Instead of that it would also be feasible to connect the end of the counterpoise, or, under certain circumstances, also the mast forming the outer sheath of the feeder lead or line by way of ohmic resistances and, optionally, inductances with space capacities which serve the purpose of suppressing standing waves upon the counterpoise conductors and which become particularly effective when tuned to the frequency that is concerned, such as, for instance, $\lambda/4$ radiators which could be arranged fan-fashion also in greater numbers on the edge of the counterpoise. Inasmuch as arrangements of this kind may, under certain circumstances, radiate and thereby influence the directional characteristic or diagram, an arrangement is here disclosed which, while avoiding external radiation, results in the same effect, that is to say, to suppress the current upon the outer skin of the feeder.

The principles of the invention are more completely described in the following description in conjunction with a drawing, wherein Figs. 1, 2 and 3 illustrate, by way of example, three circuit embodiments of the invention.

In Fig. 1 the counterpoise G is confined by a collar K which towards the bottom is either open or else is provided with a bottom B in which is a circular hole. This container or case may be of such a geometric size that inherently it will be in a state of resonance with the desired wave, or, if necessary, it may be tuned to the working or signal wave by parallel capacities C between the edge of the hole and the outer surface of the mast. Suppose it has been possible to make conditions so that the mast is free from external currents; then ground potential will prevail as far as the beginning of the container or case. If, then, there acts a potential across the condensers C due, say, to field lines embracing the arrangement, an equalizing current will flow inside the case or pot which will pass over the external skin of the supporting mast, so that at the point marked A ground potential will as a matter of fact prevail, as assumed, inasmuch as in a concentric or coaxial line the fall of potential arises only at the inner conductor. In other words, the case acts just like a stopper circuit for currents which have been induced on the outside of the line, and it prevents the outer conductor of the cable from experiencing natural oscillations as a result of these currents. Inasmuch as the inner and outer conductor of the concentric or coaxial cable

are linked with the field in the interior of the cable in an identical manner, the cable matching will thus not be affected in any manner at all by the said step and measure. Since, moreover, the field of this equalizing current pervades only the interior of the pot, it follows that this arrangement, contradistinct to the methods known in the prior art, is perfectly nonradiating. There is no absolute need for the collar K being just arranged at the edge of the counterpoise. In fact, Fig. 2 illustrates an embodiment of the invention in which the stopper pot, without the aid of supplementary or accessory capacities C, by being designed in the form of a coaxial cable of $\lambda/4$ length, is caused to be in resonance, while at the same time, with a view to avoiding undue stray or leakage fields, the diameter is appreciably reduced at the open end as compared with that of the counterpoise. By constructing the outer shell telescopic fashion, it will be feasible to change the length of the stopper pot so as to obtain the proper value conjointly with the variation of the antenna length.

But if complicated annular members fitted or nested inside one another are to be avoided, an arrangement of the kind just disclosed at most will cover a wave band of 1:2. However, no such limitation in coverage will be imposed if the pipe length of the stopper pot is from the outset proportioned to the greatest necessary wavelength, and if the tuning of the stopper pot is simply effected by a shiftable bottom. This last-mentioned method, from a constructional angle, is practicable and particularly easy to construct, as shown in Fig. 3, since when moving the antenna radiator the bottom can be shifted anyway at the same time. Inasmuch as both the free antenna length as well as the length of the pot must be $\lambda/4$, the tuning of the stopper pot will always be assured automatically in this arrangement. At all events, it is only necessary to make and keep the impedance of the stopper pot high in contrast to the antenna base impedance. Inasmuch as the effective reactance X_0 at resonance for a surge impedance W_T of the pot is of this value

$$X_0 = \frac{4}{\pi} W_T$$

it follows that in the presence of detuning

$$y = n - \frac{1}{n}$$

the remaining reactance X will have this value.

$$X = \frac{X_0}{y} = \frac{4}{\pi} W_T \cdot \frac{1}{n - \frac{1}{n}}$$

In other words, even in the presence of 5% detuning, it will just be still $13 W_T$. Inasmuch as W_T can be readily kept of an order of magnitude

of around 50 ohms, while the resistance prevailing at the base of a $\lambda/4$ antenna lies in the neighborhood of only 30 ohms, this means that even for 5% detuning there is still a reactance of 650 ohms in parallel relation to the antenna base, and in practice this may be entirely connected. Fig. 3 shows, together with the tunable pot, a variable transformation line disclosed in an earlier application which is designed to insure constant matching also in case of changes of the tuning. I is a shiftable insulator, L the transformation line.

It will be understood that the basic idea of this invention is not confined to the forms herebefore described for the counterpoise of the line. What is essential is that the counterpoise should be arranged so as to surround or embrace the concentric or coaxial line or lead and that the hollow space due to the counterpoise and the lead (mast) should be roughly tuned to the working or signal wave either by choosing the size of construction in a suitable way or else by providing accessory means to that end.

What is claimed is:

1. In combination, an antenna adapted to be varied in length so as to be selectively operated on a plurality of frequencies, a coaxial feeder line having its inner conductor connected to said antenna, a counterpoise for said antenna connected to the end of the outer conductor of said feeder line, a hollow conductor surrounding a portion of the outer conductor of said feeder line and connected to said counterpoise, said hollow con-

ductor having a length equal to a quarter of the length of the longest operating wave of said antenna and means connecting said hollow conductor to the outer conductor of said coaxial line, said last means being adjustable along said hollow conductor whereby the length thereof between said means and its free end may be adjusted to a quarter of the length of the operating wave.

2. An antenna system selectively operable over a range of frequencies comprising a coaxial feeder line having an inner conductor and an outer shell, an antenna conductor having a length equal to a quarter of the longest wave to be transmitted and arranged to telescope over said inner conductor, a counterpoise connected to the end of the outer shell of said feeder line, a hollow conductor surrounding a portion of the shell of said feeder line and connected at one end to said counterpoise, said hollow conductor having a length equal to that of said antenna conductor, and means connecting said hollow conductor to the outer shell of said feeder line, said last mentioned means being movable along said hollow conductor in alignment with the end of said radiating conductor in contact with said inner conductor whereby the free length of said antenna and of said hollow conductor may be simultaneously adjusted to a quarter of the operating wavelength.

WERNER BUSCHBECK.
HANS PROST.