March 7, 1944. H. J. R. VON BAEYER ET AL 2,343,475

TRANSMISSION LINE

Filed Nov. 30, 1940

Fig. 1

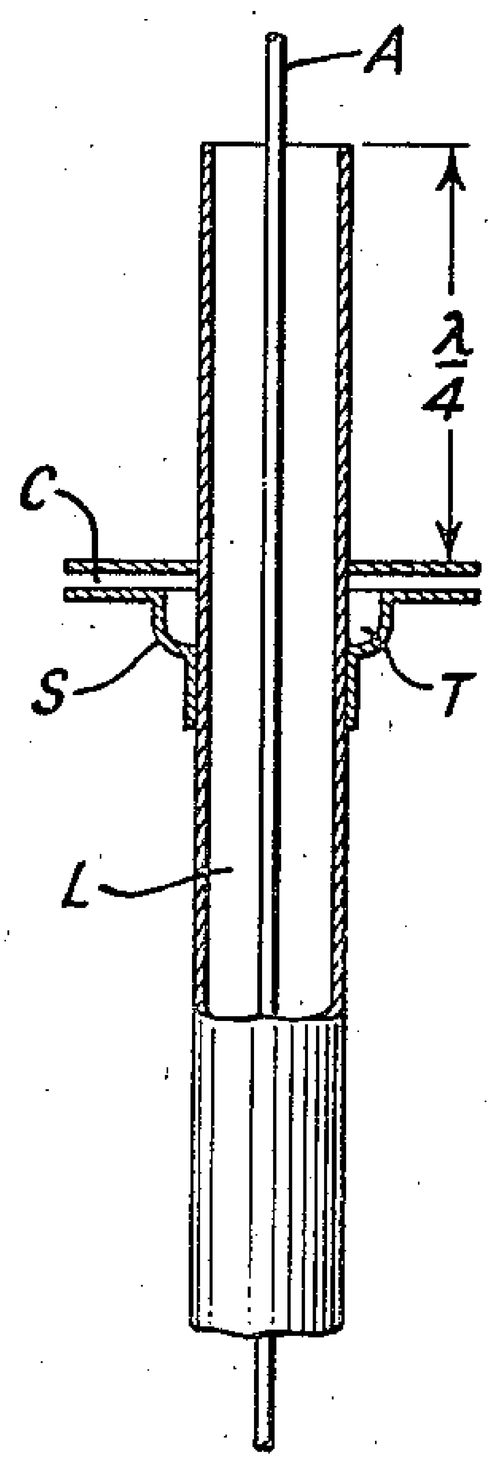


Fig. 2

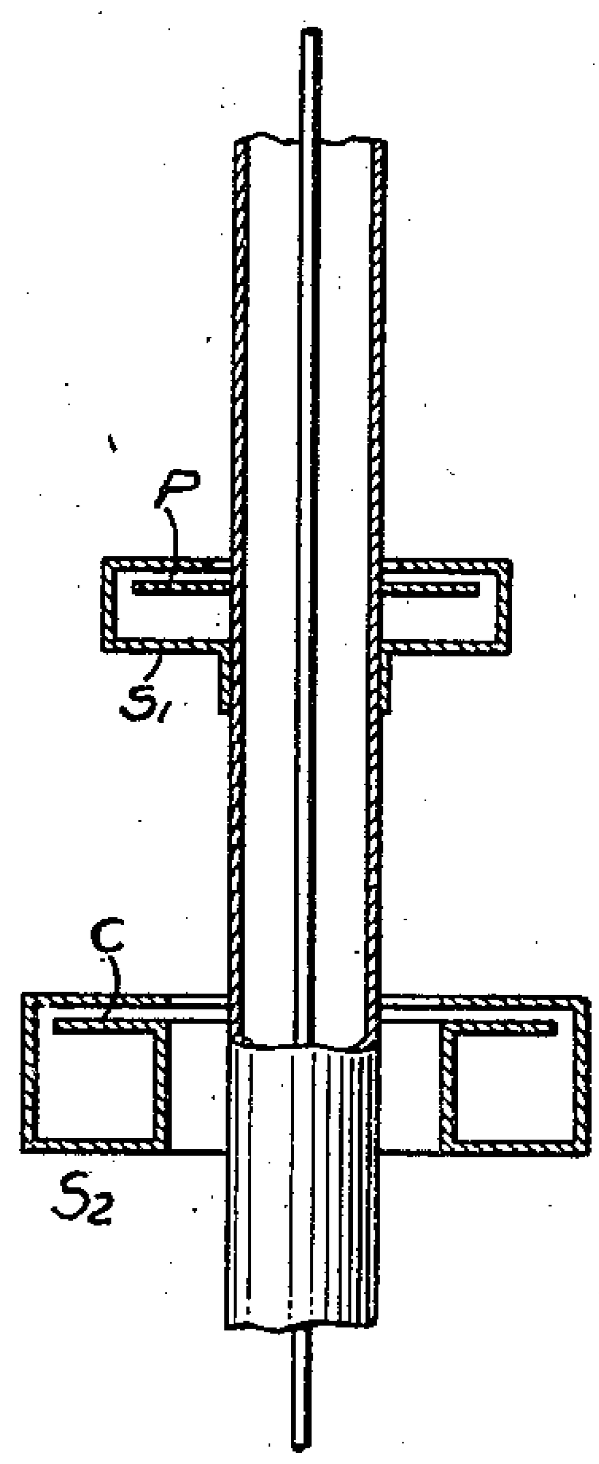


Fig. 3

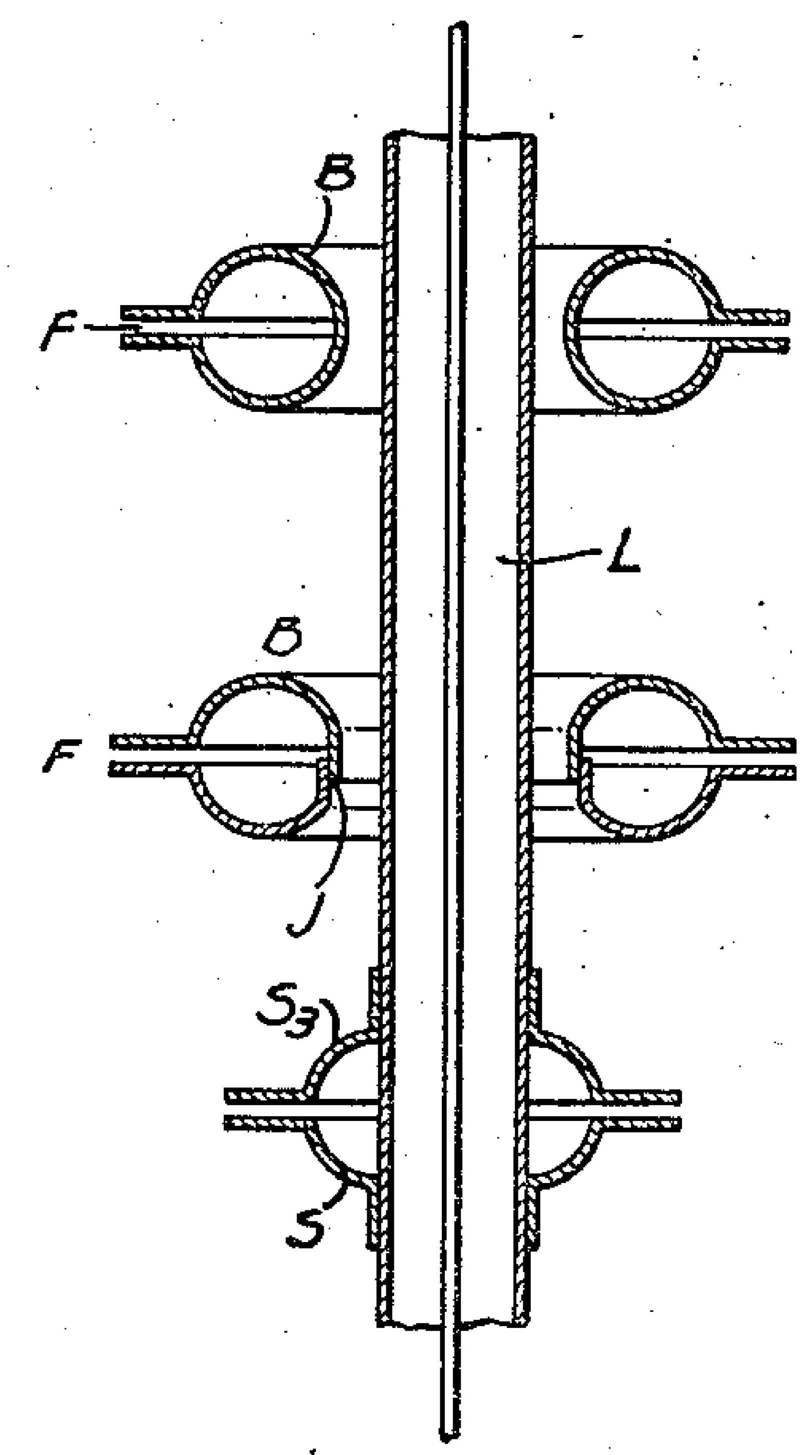


Fig. 4

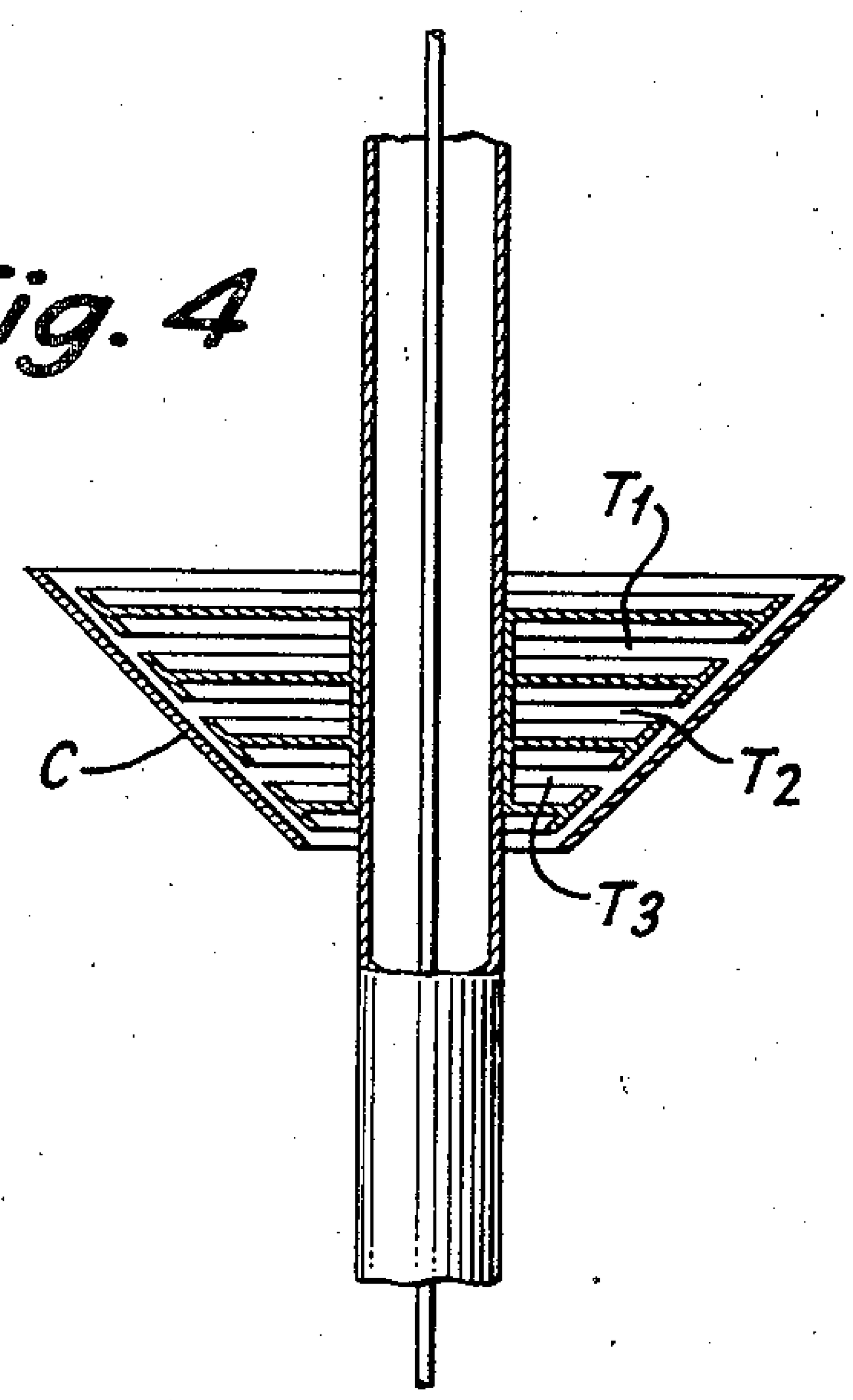
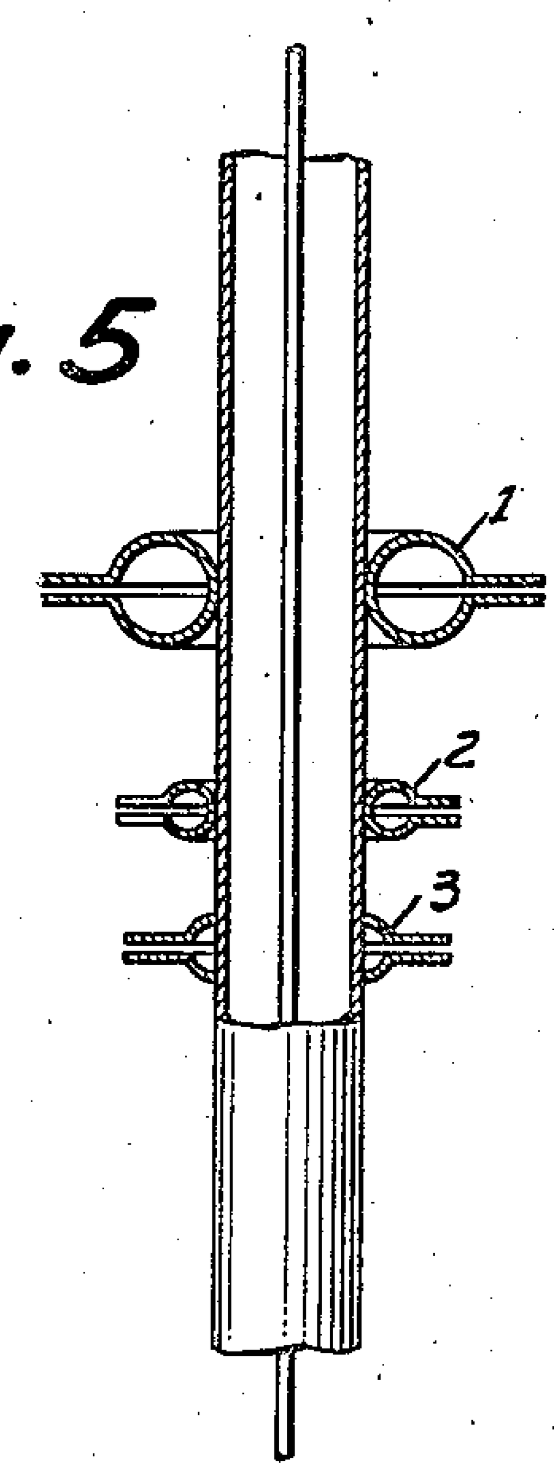


Fig. 5



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TRANSMISSION LINE

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2 Claims. (Cl. 178—44)

To suppress the so-called shell waves traveling along the outer conductor of shielded radio frequency lines or cables the use of "stopper pots" or traps has been suggested in the prior art. These essentially consist of a metallic cylinder of $\lambda/4$ length surrounding the outer conductor and unilaterally connected with it. Where relatively long waves are dealt with the geometric dimensions of these traps turn mostly out to be so large that constructional difficulties arise. It is, moreover, desirable in many instances to insure an excluder or suppressor action only at a single point and to alter the line as little as possible otherwise. To the said end, according to the invention, a concentrated or lumped capacity is used with the trap, with the result that the other dimensions of the excluding structure are diminished to such an extent that the geometric proportions of the excluding trap become far less than $\lambda/4$, indeed, they can be reduced practically to any desired extent.

There are quite a number of different ways and means adapted to carry the basic idea of the invention into effect, and some of these shall be hereinafter described by reference to the appended drawing in which Figure 1 shows an exemplified embodiment of the invention, while Figures 2 to 5 illustrate modifications of the form of the invention shown in Figure 1.

Figure 1 shows a coaxial line L. The inner conductor thereof terminates in an antenna A. In order to avoid waves travelling along the shell or outer conductor, a trap is provided at a distance of $\lambda/4$ below the end of the outer conductor as indicated at T. This trap essentially comprises a concentrated or lumped capacity C and a small cup-shaped part S. By shifting the said part S having a capacitive flange, it is possible to tune the trap. This arrangement still carries current on the top face of the upper capacity flange from the line (arrow), and this current is suppressed to zero value only at the entrance end of the trap, that is to say, on the outer edge. If, also, this current is to be suppressed, and if a current anti-loop or node is to be established directly at the conductor, then the arrangement shown in Figure 2 will prove of greater advantage in which the input of the trap circuit is arranged directly on the conductor surface or in such a way that no currents of the kind mentioned in connection with Figure 1 are able to arise. The upper trap circuit in Figure 2 is constituted by a shell portion S_1 connected at its lower edge to the conductor and having a narrow gap between its upper edge and the conductor. Within the trap S_1 is arranged a plate P which, together with the upper wall of the trap, forms a capacity sufficient to tune the trap to the wave which it is desired to suppress. A lower trap S_2 in Figure 2 is similar to the upper trap S_1 just described, with the exception that it is entirely physically separated from the conductor. An annular space between the trap S_2 and the conductor is provided, its thickness being small compared to the operating wavelength.

Figure 3 shows at the same time various ways of designing the suppressor pots or traps comprising lumped capacity. The upper pot or trap consists of an annular hollow body or chamber B which is fitted with capacity flanges F and which either is shifted directly on the line L or which surrounds the line while being spaced apart therefrom a distance that is small compared with the wavelength. The trap is, in the latter case, entirely separated from the transmission line and is readily shifted therefrom. The traps in the the upper portion of Figure 3 amount to substantially a single turn toroid having a flange shaped concentrated capacity for tuning. If this circuit is to be made tunable, then recourse may be had to the embodiment of a trap shown further below. In this embodiment the ring comprises two parts being shiftable in each other. The toroidal chamber B is arranged with a slidable joint J on its inner side opposite the capacity flanges F. It will be readily apparent that this particular modification may be tuned to various operating frequencies by sliding the joint J to decrease or increase the space between flanges F which also decreases or increases the interior circumferential length of the trap. The trap shown at the bottom of Figure 3, finally, is merely a symmetrical modification of the trap of Figure 1. The lower portion of the trap, identified by reference character S, is exactly the same as described with reference to Figure 1. The upper portion S_3 is a second flanged cup arranged with the flange facing the flange of the cup-shaped trap S. This modification may conveniently be tuned to the frequency to be suppressed by sliding the two portions thereof further apart or closer together as may be necessary.

The selectivity of the traps described is substantially greater than that of the stopper systems of $\lambda/4$ known in the art inasmuch as inductance and capacity no longer are uniformly distributed, in fact, merely a capacity is practically involved which, even with slightest changes occasions a substantial change in the tuning. By resorting to suitable screw construction, it is an easy matter to insure the desired accuracy of tuning. If an entire frequency band or a number of frequencies are to be excluded rather than a single frequency, then a plurality of traps tuned to different waves may be mounted in sequence. This is illustrated by way of example in Figures 4 and 5. The embodiment, Figure 4, comprises a joint and common capacity plate C which conjointly with the various traps T_1, T_2, T_3 allows to build a geometrically reduced trap or stopper systems designed for three frequencies. It will be obvious that also in this embodiment the drawback described by reference to Figure 1 can be avoided by choosing a suitable form of construction along the lines of embodiment Figure 3, if the excluder action is to be installed directly on the conductor. Figure 5 utilizes the type of trap construction shown in Figure 3 so that no further explanation is required, the traps 1, 2 and 3 being of different sizes so that each suppresses a different frequency.

The tuning and the properties of the trap or pot circuits may be acted upon and regulated at will by filling the same with materials possessing convenient dielectric constants, permeability, and conducting powers. In fact, a medium inhering adequate loss may here serve at the same time to directly attenuate and suppress the wave to be eliminated. In an embodiment of this kind, for instance, a hemp rope may be wrapped or braided with wires in such a way that two semi-cylindrical cups placed opposite each other are formed. This rope being tuned to resonance by its diameter may be wrapped around the conductor to be rid of radio frequency waves thus resulting in an arrangement resembling that shown on top in Figure 3, though with this distinction that a substantial ohmic drop is occasioned. A further modification involves a lumped capacity connected across the ends of a toroidal coil surrounding the transmission line. The toroidal coil may be conveniently constructed by lacing a conductor around a wooden ring adapted to be placed over the transmission line.

The invention is not confined to the purpose of eliminating or suppressing what has briefly been called "shell" waves, in fact, it can be used also to suppress waves of definite frequency on any kind of conductor at all. From other constructions known in the prior art it distinguishes itself especially by its extremely reduced geometrical proportions.

We claim:

1. A wave trap mounted about a conductor and spaced from the outer surface thereof to suppress the traveling along the conductor of waves of a particular high frequency comprising, an annular shell formed of two co-extensive cylindrical portions of different diameters the smaller of which is larger than and spaced from the outer surface of said conductor, a first annular plate connecting said cylindrical portions at one end, a second annular plate similar to said first annular plate and positioned at the opposite end of said cylindrical portions and connected to the larger of said cylindrical portions, said second annular plate being spaced at its inner periphery from the adjacent end of the smaller of said cylindrical portions, and an annular condenser plate within said shell connected at its inner periphery to the end of the smaller of said cylindrical portions adjacent said second annular plate and spaced parallel to and in predetermined relationship with respect to said second annular plate, whereby said condenser plate and said second annular plate constitute a condenser of predetermined characteristics, said shell having radial and axial dimensions whereby the trap is tuned to the desired frequency.

2. A wave trap to suppress the traveling along a conductor path of waves of a particular high frequency wherein the conductor path is along a cylindrical conductor, the combination with said conductor of, an annular shell mounted about said conductor and formed by a cylindrical member spaced from said conductor and a pair of parallel annular plates attached at their outer peripheries to said cylindrical member, one of said annular plates being attached at its inner periphery to the conductor and the other of said annular plates being spaced at its inner periphery from said conductor to form a slit, and an annular condenser plate within said shell mounted at its inner periphery upon said conductor adjacent said slit and positioned in coacting relationship with respect to the annular plate forming said slit whereby a condenser is formed of predetermined characteristics, said shell having radial and axial dimensions whereby the trap is tuned to the desired frequency.

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