Aug. 15, 1939. L. WALTER 2,169,377

ANTENNA

Filed Dec. 21, 1937

Fig. 1

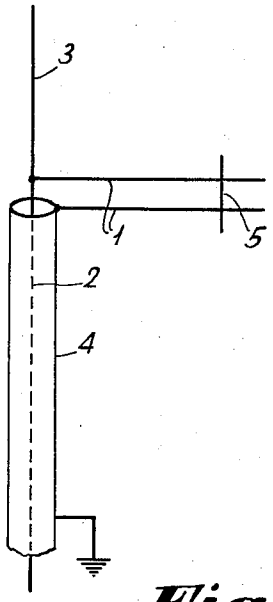


Fig. 2

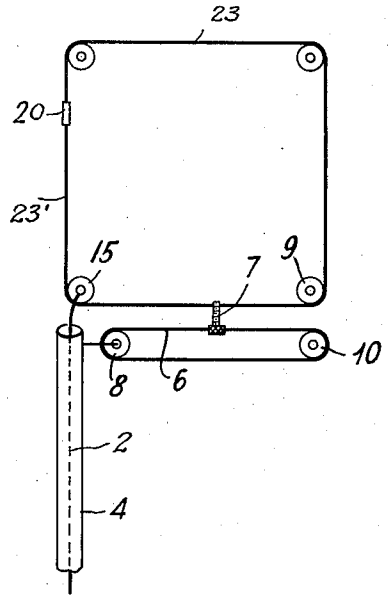


Fig. 3

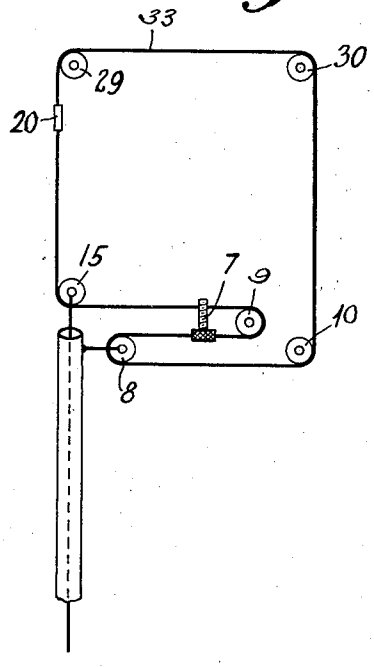


Fig. 4

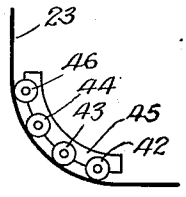
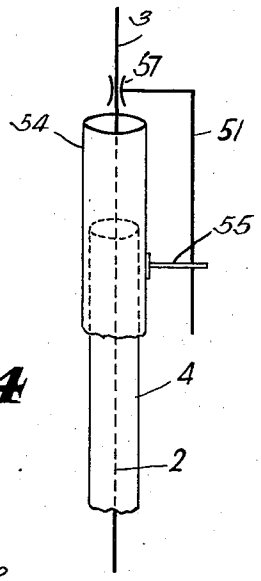


Fig. 5



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12 Claims. (Cl. 250—33)

The invention relates to an arrangement for matching a linear antenna, variable in length, with a feed line. It is known in order to match an antenna with an energy line, to place a reactance in parallel at a suitably chosen place of the line, said reactance together with the line section leading up to the antenna representing with the antenna a resistance which is equal to the wave resistance of the line, so that matching is obtained and standing waves do not appear. This arrangement, however, has drawbacks when using concentric feed lines since it is difficult then to connect at any desired place a parallel reactance and, furthermore, it is in the first place practically impossible to render the line tap variable for wave changing. An object of the present invention is to render possible the matching of an antenna with a line more especially with a concentric line for any desired wave length. In accordance with the invention the antenna length is variable and is chosen such that the effective antenna resistance at the base of the antenna is equal to the wave resistance of the feed line. Then the antenna is matched in regard to the effective resistance. However, there appears an additional wattless antenna resistance which, in accordance with the invention, will be compensated by a variable reactance placed in parallel to the output of the cable. This reactance preferably has the form of a Lecher wire provided with a movable short circuit strap.

It appears possible to compensate the wattless antenna resistance at the matching of the effective resistance by means of a compensating reactance connected in series with the antenna. But this has the drawback that the additional reactance has the entire high-frequency potential and also that the antenna, as regards direct current, is separated from the grounded outer conductor of the lead-in so that therefore flash-over is possible initiated by atmospheric discharges. On the contrary, according to my invention, the antenna is maintained at ground potential as regards direct potential by means of the parallel reactance, so that atmospheric discharges can pass by without being obstructed. Furthermore, the short circuit strap of the reactance has as such no high-frequency potential.

Figure 1 shows the principal idea of the invention while Figures 2, 3, 4 and 5 illustrate modifications thereof. In Fig. 1, 4 is the outer conductor of the feed line whose inner conductor 2 is directly connected with the antenna 3. There is placed in parallel to the output of the line the Lecher wire 1 whose short circuit strap 5 is displaceable. For each wave length the length of the antenna and at the same time the position of the short circuit strap 5 are so adjusted that matching is obtained such as can be readily done by controlling the voltage appearing at the line 2, 4. The structure of the variable antenna can be chosen at will, thus the antenna may have the shape of a rod and may be adapted for insertion into the inner conductor of the feed line.

The length of the radiator and the length of the short circuited parallel wire line have for complete matching a very definite proportion depending primarily on the wave resistance of the feed line. Therefore, the adjustment device for the length of the antenna and the device for moving the short circuit strap may be mechanically coupled so that for any desired wave length the matching can be carried out by a single operation.

An especially advantageous mode of execution of the invention is shown in Fig. 2. Herein, the antenna consists of a closed wire rope 23 interrupted by an insulator 20 and guided on rollers. By turning one of the rollers the piece 23' between roller 15 and insulator 20 acting as the actual radiator can be so set that the effective resistance of this piece at the roller 15 is equal to the wave resistance of the lead-in section 2, 4 whose inner conductor 2 is connected to the roller 15. Parallel to the lower horizontal part of the wire rope loop a conductor 6 is connected to the outer conductor 4 of the feed line and likewise forms a closed loop which may be guided over two rollers 8 and 10. Between said conductor 6 and the horizontal part of the antenna arrangement a short circuit strap 7 is arranged. This short circuit strap may in the simplest case be manually moved or it may be mechanically joined with the one part of the wire loop 6, so that it will be displaced when turning roller 8 for instance. As already stated above, the radiator is formed by the wire piece between roller 15 and insulator 20 and the variable parallel reactance by the short circuited double line passing from roller 15 across the short circuit strap 7 to the roller 8. By turning roller 15, the length of the radiator can be set, and by turning the roller 8 the parallel reactance can be adjusted. However, it will be preferable to turn the rollers 9 and 10 as both are at ground potential.

Fig. 3 shows an arrangement similar to that of Fig. 2 but here the matching is brought about by turning a single roller. In this arrangement the antenna, as well as the short circuit line, are formed by a single wire rope 33 closed in itself and which is placed around the rollers 15, 29, 30, 10, 8, 9. The conductor section between roller 15

and insulator 20 again serves as radiator while the conductor section between roller 15, short circuit strap 7 and roller 8 represents the parallel reactance. For example, if the insulator 20 is moved upwards lengthening the antenna the short circuit strap 7 mechanically connected with the conductor section between the rollers 8 and 9 moves to the right so that the Lecher wire line will likewise be lengthened. The arrangement, according to Fig. 3, is especially suited for remote control of the antenna. The matching can in this arrangement, however, not be maintained with such a high degree of accuracy as in the arrangement shown in Fig. 2 since the ratio between the variation in antenna length and variation in length of the short circuit lead is not exactly a linear one such as is necessary in Fig. 3. Therefore, in order that the matching, by means of a single operation, can be accomplished with any desired degree of accuracy the drives of the two rollers 9 and 10 in Fig. 2 may be coupled with each other by mechanical means such as a cam disk whereby the desired displacement of the short circuit strap 7 corresponds exactly with the displacement of the insulator 2. The arrangement of Fig. 2 is particularly suited for a wide wave range while the arrangement of Fig. 3 will be of advantage in case of shorter wave ranges since then the ratio between the variations in the antenna length and parallel reactance are linear to a sufficient extent.

The structural details of the arrangements shown in Figs. 2 and 3 depend on the respective exterior conditions of the length of the antenna. It is necessary that the roller 15, being at a high-frequency potential, does not present too high a capacity with respect to ground since, otherwise, an inconvenient length of the Lecher wire 15, 7, 8 will be necessary, or the linear relationship between the length of the antenna and that of the Lecher wire may cause too great a disturbance. Therefore, it will be advisable to utilize in place of individual rollers or wheels a corresponding arrangement in accordance with Fig. 4 whose manual part 43 consists of insulating material and whose individual rollers 42, 43, 44, 46 are as small as possible. In this arrangement the curvature of the wire rope 23 and, hence, the mechanical stress is very much lower. Without this a very large wheel would be required and thus a very large capacity would result.

A further example embodying the idea of the invention is shown in Fig. 5. The length of the rod-shaped antenna 3 is in this modification rendered variable in that the end of the outer conductor 4 of the concentric energy line is arranged to be movable by means of a tubular piece 4 so that the effective radiator protruding from the energy line is variable in length. The antenna conductor 3 is rigidly connected with the inner conductor 2 of the energy line. In conjunction with the tubular piece 54 conductingly connected with the grounded cable shell 4, a conductor 51 is movably arranged and conductingly connected at the upper end with the antenna 3 said conductor 51 extending parallel to the tubular piece 54. A short circuit strap 55 is movably disposed between the tubular piece 54 and the conductor 51, so that, as in the other figures, a Lecher wire that can be tuned is connected in parallel to the output of the cable, said Lecher wire serving for compensating the wattless resistance of the antenna. As a further modification the conductor 51 may also consist of a tube concentrically surrounding the tubular part 54, said tube being connected with its upper end to the antenna conductor by means of a gliding contact member 57. The short circuit strap 55 may be moved in a slot in the outer tube. Also, in this arrangement which will be considered primarily for antenna arrangement mounted on the top of towers, the displacement of the short circuit strap 55 may be mechanically coupled in any desired manner with the variation in the length of the antenna. The length of the tube between the upper edge of the outer conductor 4 and the upper edge of the displaceable tube 54 can be readily adapted for tapping with the aid of a slot in item 54. This facilitates the tuning since the means serving for the tapping, in other words, the tubular piece 54 and the slide 55, are situated near each other. The provision of three longitudinal slots in the tube 3 affords a convenient support on the end of the tube 4. Then a single water-tight connection between 1 and 4 will be sufficient.

In all arrangements of the Figures 1, 2, 3, 5 the places of contact should preferably be heated in the winter time to prevent deposit of ice. This may simply be done during the pauses in operation by means of a heating current flowing through the cable train, short circuit line and outer conductor.

I claim:

1. An antenna arrangement comprising an antenna conductor having a variable length radiating portion, a transmission line having one element connected to one end of said antenna conductor and means for matching said antenna to said transmission line comprising a Lecher line connected to the end of said transmission line and means for varying the length of said Lecher line as the radiating length of said antenna conductor is varied.

2. An antenna arrangement comprising an antenna conductor having a variable length radiating portion, a concentric cable transmission line having its center conductor connected to one end of said antenna conductor and means for matching said antenna to said transmission line comprising a Lecher line connected to the end of said transmission line and means for varying the length of said Lecher line as the radiating length of said antenna conductor is varied.

3. An antenna arrangement comprising an antenna conductor having a variable length radiating portion, a transmission line having one element connected to one end of said antenna conductor and means for matching said antenna to said transmission line comprising a Lecher line connected to the end of said transmission line and means for simultaneously varying the length of said Lecher line as the radiating length of said antenna conductor is varied.

4. An antenna arrangement comprising an antenna conductor having a variable length radiating portion, a concentric cable transmission line having one element connected to one end of said antenna conductor and means for matching said antenna to said transmission line comprising a Lecher line connected to the end of said transmission line and means for simultaneously varying the length of said Lecher line as the radiating length of said antenna conductor is varied.

5. An antenna arrangement comprising a flexible conductor having its ends joined together by an insulator and passing around the plurality of rollers, one of said rollers being connected to a conductor at the end of a transmission line whereby the portion of said conductor between said

one roller and said insulator constitutes the radiating element of said antenna and a variable length Lecher line connected across said transmission line, one of the wires of said Lecher line being composed of the section of said flexible conductor adjacent the radiating portion thereof and said one roller.

6. An antenna arrangement comprising a flexible conductor having its ends joined together by an insulator and passing around the plurality of rollers, one of said rollers being connected to a conductor at the end of a transmission line whereby the portion of said conductor between said one roller and said insulator constitutes the radiating element of said antenna and a variable length Lecher line connected across said transmission line, one of the wires of said Lecher line being composed of the section of said flexible conductor adjacent the radiating portion thereof and said one roller, the other wire of said Lecher line being connected to the other conductor of said transmission line and composed of a second flexible conductor closed upon itself and supported on a pair of rollers and a short circuiting strap connecting the two wires of said Lecher line.

7. An antenna arrangement comprising a flexible conductor having its ends joined together by an insulator and passing around the plurality of rollers, a concentric cable transmission line, one of said rollers being connected to the central conductor at the end of said transmission line whereby the portion of said conductor between said one roller and said insulator constitutes the radiating element of said antenna and a variable length Lecher line connected across said transmission line, one of the wires of said Lecher line being composed of the section of said flexible conductor adjacent the radiating portion thereof and said one roller, the other wire of said Lecher line being connected to the shell of said transmission line and composed of a second flexible conductor closed upon itself and supported on a pair of rollers and a short circuiting strap connecting the two wires of said Lecher line.

8. An antenna arrangement comprising a flexible conductor having its ends joined together by an insulator and passing around the plurality of rollers, one of said rollers being connected to a conductor at the end of a transmission line whereby the portion of said conductor between said one roller and said insulator constitutes the radiating element of said antenna and a variable length Lecher line connected across said transmission line, one of the wires of said Lecher line being composed of the section of said flexible conductor adjacent the radiating portion thereof and said one roller, the other wire of said Lecher line being connected to the other conductor of said transmission line and composed of a second flexible conductor closed upon itself and supported on a pair of rollers and a short circuiting strap contacting said first mentioned wire of said Lecher line and conductively supported on said flexible conductor.

9. An antenna arrangement comprising a flexible conductor having its ends joined together by an insulator and passing around the plurality of rollers, one of said rollers being connected to a conductor at the end of a transmission line whereby the portion of said conductor between said one roller and said insulator constitutes the radiating element of said antenna and a variable length Lecher line connected across said transmission line, one of the wires of said Lecher line being composed of the section of said flexible conductor adjacent the radiating portion thereof and said one roller, the other wire of said Lecher line being connected to the other conductor of said transmission line and composed of a second flexible conductor closed upon itself and supported on a pair of rollers and a short circuiting strap contacting said first mentioned wire of said Lecher line and conductively supported on said second flexible conductor, and means for so moving both of said conductors that as the effective length of said radiating element is increased the length of said Lecher line is likewise increased.

10. An antenna arrangment comprising a flexible conductor having its ends joined together by an insulator and passing around the plurality of rollers, one of said rollers being connected to a conductor at the end of a transmission line whereby the portion of said conductor between said one roller and said insulator constitutes the radiating element of said antenna and a variable length Lecher line connected across said transmission line, one of the wires of said Lecher line being composed of the section of said flexible conductor adjacent the radiating portion thereof and said one roller, the other wire of said Lecher line being connected to the other conductor of said transmission line and composed of a second flexible conductor closed upon itself and supported on a pair of rollers and a short circuiting strap connecting the two wires of said Lecher line, and means for simultaneously varying the length of said radiating portion and said Lecher line.

11. An antenna arrangement comprising a flexible conductor having its ends joined together by an insulator and passing around the plurality of rollers, one of said rollers being connected to a conductor at the end of a transmission line whereby the portion of said flexible conductor between said one roller and said insulator constitutes the radiating element of said antenna, another of said rollers being connected to another conductor of said transmission line, the portion of said flexible conductor between said one roller and said other roller forming a Lecher line and a short circuiting strap across said Lecher line and having one end rigidly connected to said conductor so that as the effective length of said radiating element is increased the length of said Lecher line is also increased.

12. An antenna arrangement comprising a flexible conductor having its ends joined together by an insulator and passing around the plurality of rollers, a concentric cable transmission line, one of said rollers being connected to the central conductor of said transmission line whereby the portion of said flexible conductor between said one roller and said insulator constitutes the radiating element of said antenna, another of said rollers being connected to the shell of said transmission line, the portion of said flexible conductor between said one roller and said other roller forming a Lecher line and a short circuiting strap across said Lecher line having one end connected to said conductor so that as the effective length of said radiating element is increased the length of said Lecher line is also increased.

LUDWIG WALTER.