Sept. 11, 1928. 1,683,716

L. ESPENSCHIED

ANTENNA FOR RADIOTELEGRAPHY

Filed Sept. 3, 1921 3 Sheets-Sheet 1

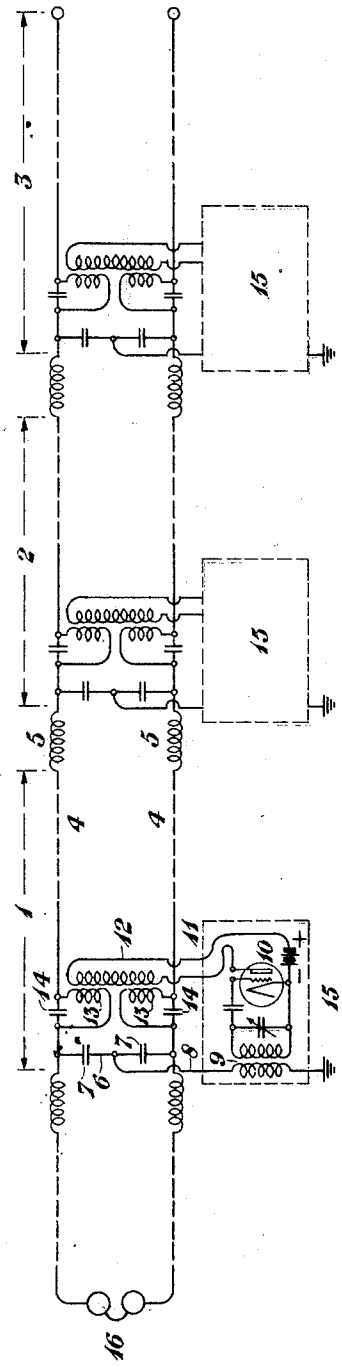


Fig. 1

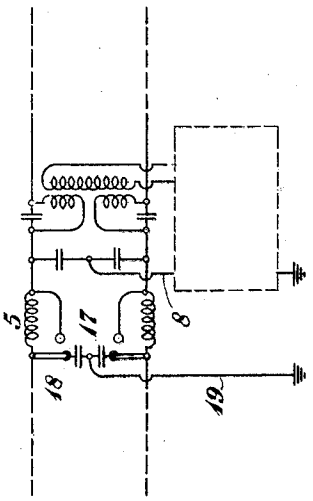


Fig. 2

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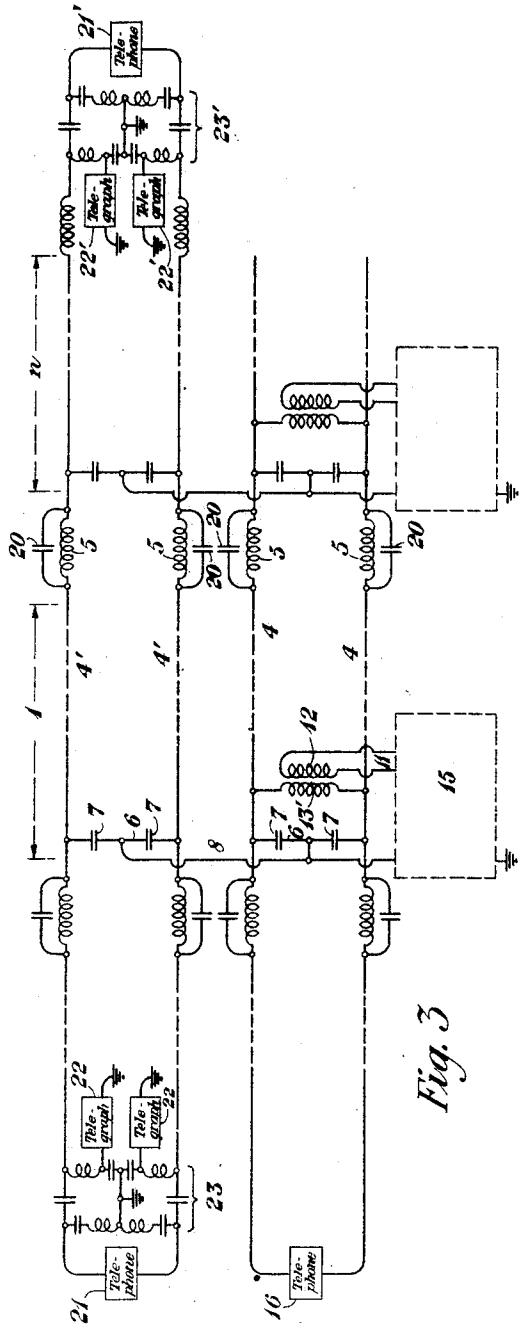


Fig. 3

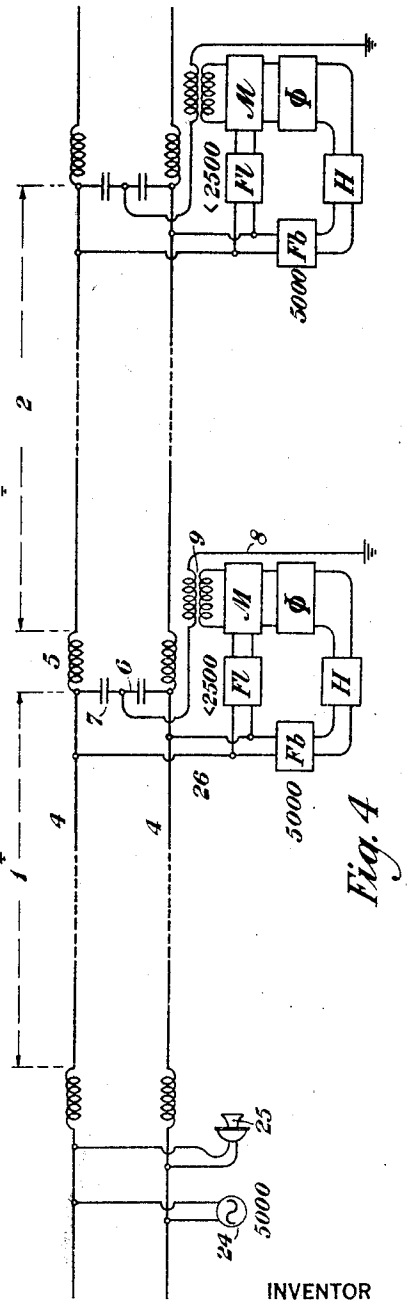


Fig. 4

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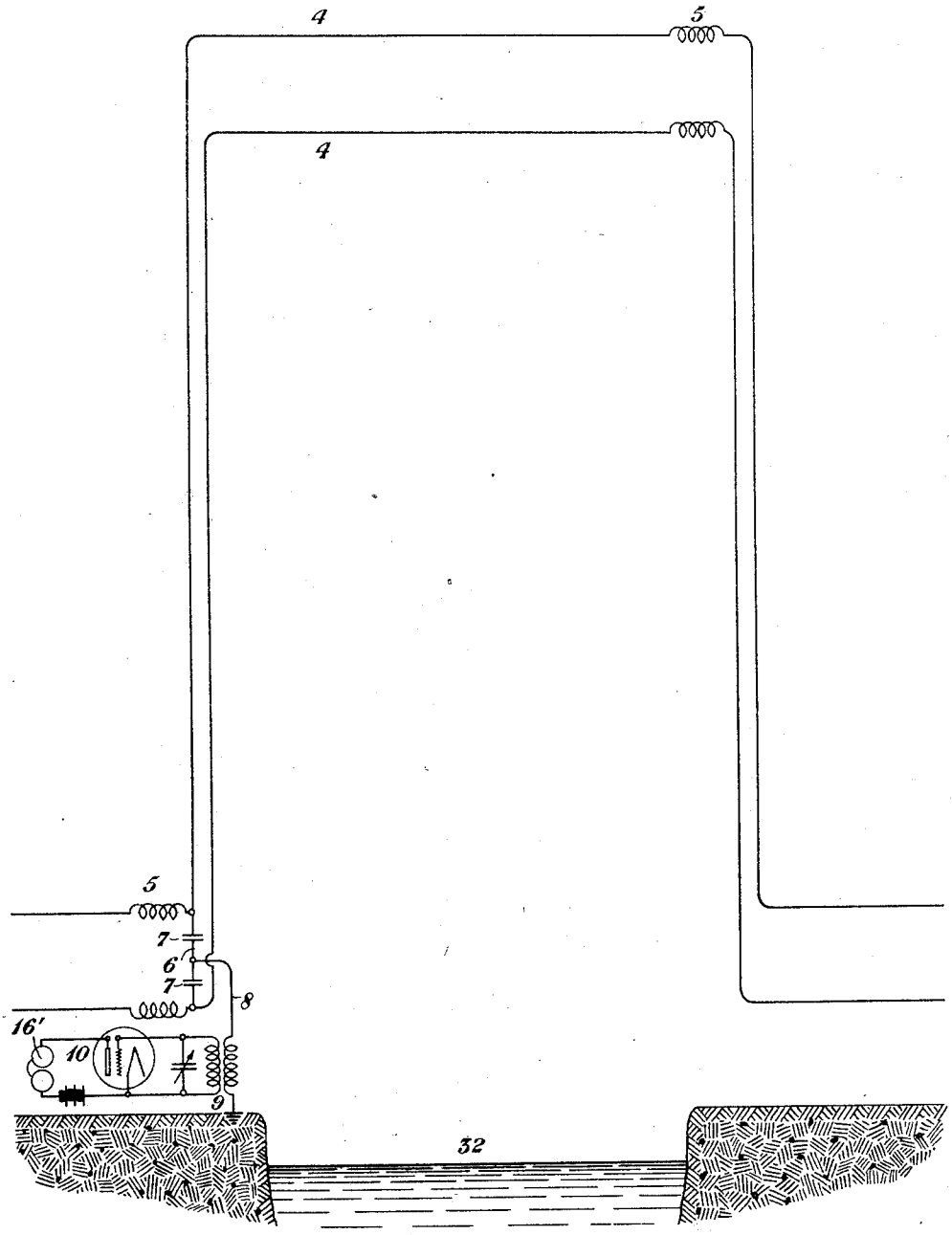


Fig. 5

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UNITED STATES PATENT OFFICE.

LLOYD ESPENSCHIED, OF QUEENS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

ANTENNA FOR RADIOTELEGRAPHY.

Application filed September 3, 1921. Serial No. 498,186.

The principal object of my invention is to provide a new and improved system of antenna units for radio receiving or transmitting. Another object of my invention is to utilize an open-wire transmission line, or a portion thereof, for a radio antenna. Another object of my invention is to sectionalize an open-wire transmission line without impairing its transmitting properties and to utilize the sections as units in a multiple antenna system. Still another object of my invention is to provide a system of antenna units with individual high frequency apparatus, combining them in proper effective relation with a low frequency central station. These and other objects of my invention will become apparent upon consideration of a few specific examples which I have shown in the accompanying drawings, and which I will now proceed to describe. It will be understood that the invention is defined in the appended claims, and in the following description I am referring to specific examples of practice thereunder.

In the drawings, Figure 1 is a diagram of a system of antennæ comprising sections of a transmission line; Fig. 2 is a diagram showing a modification; Fig. 3 is a diagram showing a plurality of transmission lines sectionalized for antenna purposes and adapted to serve at the same time as low frequency signaling conductors; Fig. 4 is a diagram showing a radio transmitting system comprising a sectionalized transmission line; Fig. 5 is a diagram showing the portion of a transmission line at an elevated river crossing utilized as a receiving antenna.

The two conductors 4 of the transmission line shown in Fig. 1 have respective interposed inductance coils 5 of comparatively low impedance for audio frequencies, but of high impedance to radio frequencies. Thus the transmission line is divided into the sections indicated by the numerals 1, 2 and 3. Across one end of each section is a bridge 6 with two condensers 7 in series and a branch 8 from a point between them going through the primary of transformer 9 to ground. The secondary of the transformer 9 is connected in the usual way to the grid of the vacuum tube detector 10 whose output or plate circuit 11 comprises the primary winding 12 of the transformer whose secondaries 13 are respectively in series with the conductors 4, each shunted by a condenser 14. As much of the receiving apparatus just described as is enclosed by the dotted rectangle is designated by the reference numeral 15.

At one end of the transmission line is a telephone receiver 16.

Each transmission line section, such as 1, together with the ground connection 8 at its end, constitutes a radio receiving antenna. The inductances 5 prevent leakage of the high frequency currents from this section into an adjoining section, so that, with respect to radio frequencies, the several antennæ function quite independently of one another.

The low- or audio-frequency currents in the output circuit of the detector 10 are applied through the transformer 12—13, and since the inductances 5 are of low impedance for such frequencies, these currents flow to the telephone receiver 16, where their effect is cumulative from the multiple antenna sections.

It will be understood that the condensers 7 and 14 are of low impedance to the radio frequency currents, and hence facilitate the flow of those currents through the primary of the transformer 9. On the other hand, these condensers are of high impedance to the audio frequency currents which accordingly flow principally along the length of the transmission line conductors 4.

It would be a matter of considerable difficulty and disadvantage to try to carry the radio frequencies by wire to a considerable distance. For such frequencies, the dissipation of energy in wire conduction and the attenuation would be large. By my invention, the radio frequency currents are not carried from the respective antennæ in which they are set up, but at each such antenna they are detected, and their effect is converted into audio frequency currents which can readily be conveyed a considerable distance to a central station, there to energize a common indicator. It will be seen that I have utilized the same conductors which form the antennæ to serve as the conductors of the indicator circuit, and that I am able to place the indicator station at any convenient point more or less remote from some, or all, of the antennæ.

The antennæ system here disclosed has directional selectivity. Each unit is directive,

consisting, as it does, of a long horizontal overhead portion grounded at one end. By properly relating the section lengths to the wave lengths, the directional selectivity can be intensified. A desirable ratio is to make the length of each section one-quarter of a wave length.

For receiving purposes, the use of the sectionalized conductor, as here disclosed, will assist in reducing interference from high frequencies which might be induced in the open-wire lines from neighboring electrical systems. If the exposure of the line is beyond the portion that is sectionalized for antenna purposes, the end section coils will substantially prevent the high frequency disturbance from entering the antennæ. If the exposure is at a point close to one of the sections, then the disturbance will be principally confined to that antenna. In such a case, it might be desirable simply to omit the apparatus 15 for that antenna, in other words, not to attempt to utilize the corresponding section of the line as an antenna.

The inductance windings 5, which serve to divide the line into sections for radio frequencies, may be given the proper values, so that they will function as loading coils for the audio frequency currents in the line.

Fig. 2 illustrates a modification which may be introduced at the end of each section opposite to the receiving apparatus. At such a place the bridge 17 with two condensers is put across the line, and the ground connection 19 is made at a point between the condensers. These condensers offer a high impedance to audio frequency currents, and hence they do not alter the audio-transmitting properties of the line, but they offer low impedance to radio frequency currents, and hence each antenna unit becomes grounded at its distant end as well as through the receiving apparatus at the receiving apparatus end. Thus each antenna becomes a so-called earth antenna, and for maximum efficiency it becomes desirable to make the antenna length equal to a half wave length, or an integer multiple of a half wave length. If this condition is satisfied, the sectionalizing coils 5 can be omitted, which may be done by shunting them by throwing the switches 18 in Fig. 2. Thereupon the ground conductor 8 serves as the ground connection for both ends of the two antenna sections adjacent thereto. In this case the whole arangement takes the form of an open-wire line well grounded through the receiving apparatus with respect to high frequency currents, but only very slightly with respect to audio frequencies, at points an integer multiple of a half wave length apart; with suitable high frequency radio apparatus in the ground leads.

Fig. 3 illustrates a system comprising a plurality of open-wire transmission circuits sectionalized for antenna purposes, one of these circuits being utilized as the indicator circuit for the antenna system, and the others serving for wire telephone and telegraph communication independently of the radio system.

In the case of Fig. 3, I have shown a condenser 20 in shunt to each inductance winding 5, making the combination anti-resonant to the radio frequency. The lowermost pair of conductors 4 serve as the indicator circuit for the radio system. In this case the output circuit 11 from the receiver 15 includes the primary winding 12 of the transformer whose secondary winding 13′ is bridged across the line. At 23 and 23′ I have shown the well-known combination of elements which serve to separate the telephone and telegraph channels for composite of the line. Thus, although the line 4′ is sectionalized and used as part of the antenna system, it is fully available for telephone communication between the telephones 21 and 21′, and each of its conductors can be used as a telegraph line between the two telegraph stations 22 at one end and the two stations 22′ at the other end.

Where a plurality of overhead lines are worked as an antenna system, as shown in Fig. 3, the sectionalizing apparatus 5, 20 should be introduced at registering points on all the lines, for, if any conductor of one section should lap past a conductor of the other section, the capacity effect between them might afford a leakage for high frequency current.

In Fig. 4 I have shown a transmission line sectionalized and combined with radio transmitting apparatus. The sectionalizing of the line 4 is accomplished in the same way as already described by means of the coils 5 and the bridge 6 is provided through the condensers 7 with the grounded branch 8 the same as in the earlier figures. A transmitter 25 and a generator 24 of frequency, say, 5,000 cycles per second, are put across the line at any conveniently located central station. To the frequency 5,000 and the voice frequencies introduced at the transmitter 25, the coils 5 offer low impedance, so that these frequencies flow to the branch circuits 26, but not through the condensers 7. The branch circuit 26 branches again to two filters, viz., F^1 and F^b. F^1 is a low-pass filter with its cut-off at 2,500. Thus it passes all the essential voice frequencies, but does not pass the 5,000 frequency. F^b is a band-pass filter with its critical frequencies set to pass the 5,000 frequency, but to exclude the voice frequencies. The 5,000 frequency transmitted by the filter F^b goes to the distorting tube harmonic generator H, which gives an output radio frequency current that goes to the modulator M through

the phase adjuster ϕ. In the modulator M the radio frequency current from the generator H is modulated by the voice frequency current transmitted through the filter F^1, and the modulated radio frequency current is impressed through the transformer 9 on the conductor 8 in series with the wires 4 of the respective antenna section.

It will be seen that each antenna 1 or 2 radiates as a unit. It is desirable that the radiation from the various antenna units shall have the proper phase relation. In this way a decided maximum of intensity in the particular direction may be obtained. This is the reason for the presence of the phase adjusters ϕ. The perfect synchronous relation of the radiation from all the antenna units is secured by supplying the 5,000 frequency current from a common source, so that the high frequency generators H are kept accurately in step.

By the term "terminal signaling apparatus", which is employed in certain of the following claims, I intend to cover generically either terminal transmitting apparatus or terminal receiving apparatus. In Figure 1, for example, terminal receiving apparatus has been shown as at Figure 16.

What is claimed is:

1. A transmission line sectionalized as to high frequency currents by interposed inductances and respective detecting means to co-operate with each section to utilize it as a radio antenna.

2. A transmission line sectionalized as to high frequency currents by interposed inductances, respective means to co-operate with each section to utilize it as a radio antenna, and a central low frequency station in co-operative relation with all said sections.

3. A transmission line sectionalized as to high frequency currents by interposed inductances, respective means to co-operate with each section to utilize it as a radio antenna, and a central station having a low frequency circuit connection over the said transmission line to each said means at the respective sections.

4. A transmission line, elements interposed at intervals therein to give high impedance to radio frequency currents, but low impedance to audio frequency currents, ground connections for the corresponding sections of the transmission line, elements in said ground connections offering low impedance to radio frequency currents and high impedance to audio frequency currents, radio apparatus associated with said ground connections, radio apparatus connected to said transmission line, and an audio frequency connection from each of said apparatus with said transmission line.

5. A series of antennæ conductively connected together for low frequency currents, reactance elements insulating them from one another for high frequency currents, respective high frequency radio apparatus in combination with said antennæ, and low frequency terminal signaling apparatus operatively associated with the entire series at one end thereof.

6. A series of antennæ conductively connected together for low frequency currents, but in effect insulated from one another for high frequency currents, respective detectors for said antennæ, a common low frequency indicator, a plurality of parallel transmission lines all sectionalized alike to high frequency currents by interposed inductances, means combined with each section to utilize all the conductors of the corresponding section as a radio antenna, a low frequency central station connected by one of said transmission lines with all of said means, and low frequency sending and receiving apparatus connected with the other transmission lines.

7. A plurality of antennæ, like units of radio frequency apparatus associated respectively therewith, a central station, and an audio frequency circuit connecting said station and said units of apparatus in serial order with said central station at one end of the series arrangement.

8. A transmission line sectionalized as to high frequency currents by interposed inductances, radio receiving apparatus associated with each section and comprising a respective detector, an output low frequency circuit for each said detector connected to the line, and a cooperating low frequency indicator on the line.

9. A transmission line with an elevated portion, inductances therein cutting off this portion from the remainder of the line with respect to radio frequencies but not low frequencies, and apparatus associated with said portion to utilize it as a radio antenna.

10. A transmission line sectionalized as to high frequency currents by interposed inductances, local means to co-operate with each section to utilize it as a respective radio antenna and terminal signaling means to co-operate with said local means.

11. A transmission line sectionalized as to high frequency currents by interposed inductances, respective high frequency means to co-operate with each section as an individual radio antenna and extended low frequency terminal signaling means to co-operate with all the sets of high frequency means.

In testimony whereof I have signed my name to this specification this 30th day of August, 1921.

LLOYD ESPENSCHIED.