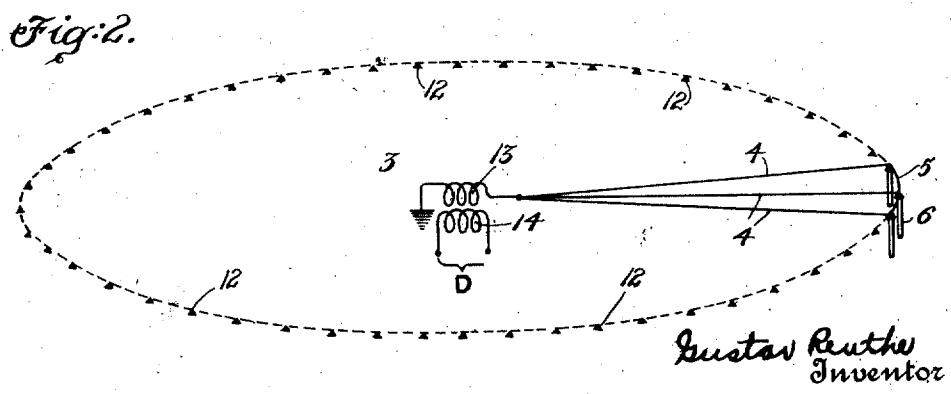
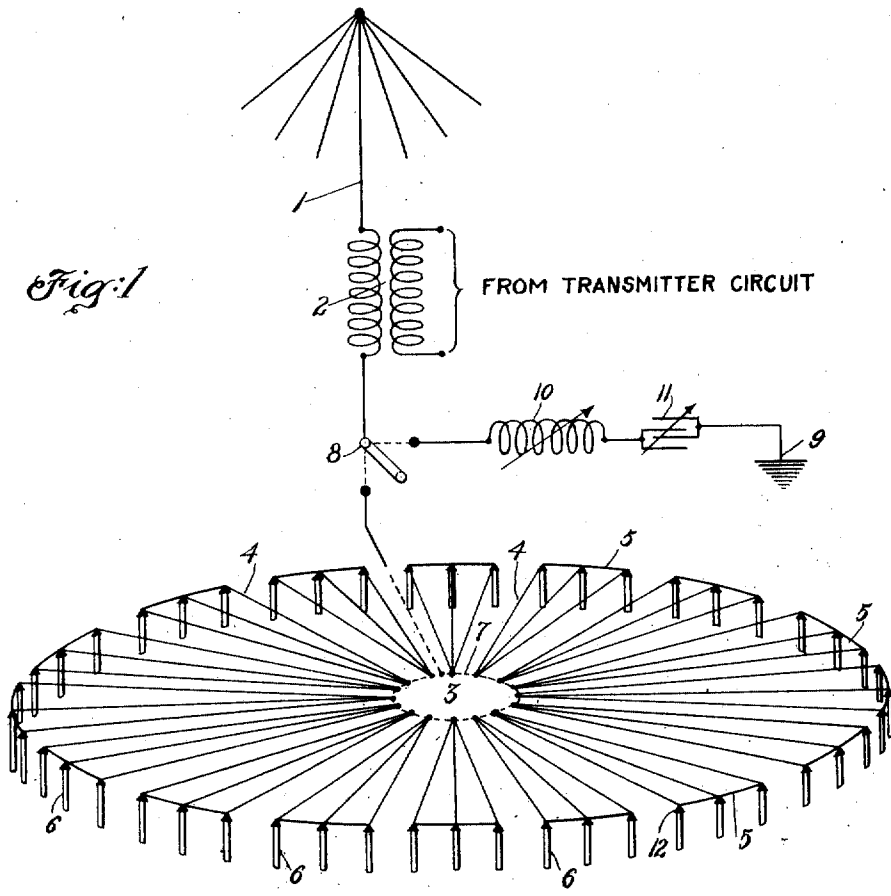


G. REUTHE.
 ANTENNA FOR RADIOTELEGRAPH STATIONS.
 APPLICATION FILED APR. 29, 1916.

1,214,591.

Patented Feb. 6, 1917.
 3 SHEETS—SHEET 1.



Gustav Reuthe
 Inventor

By his Attorney *[Signature]*

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Fig. 6.

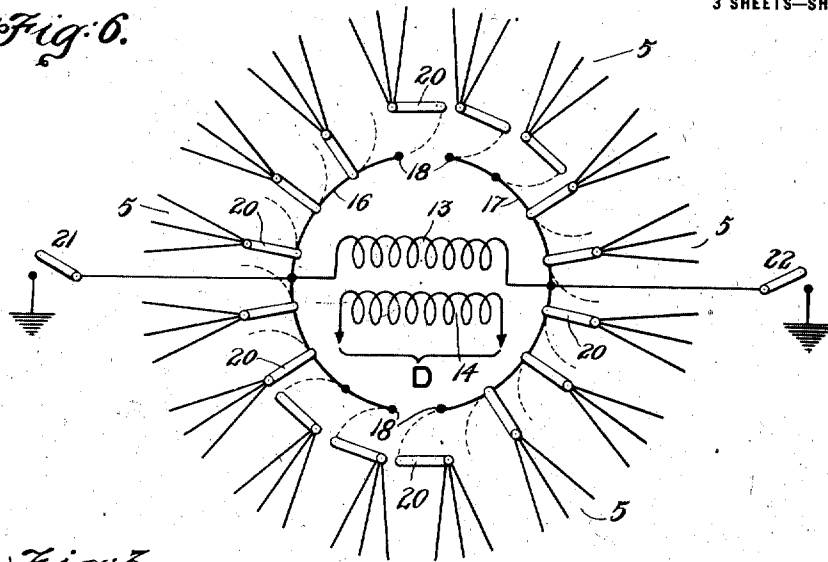


Fig. 3.

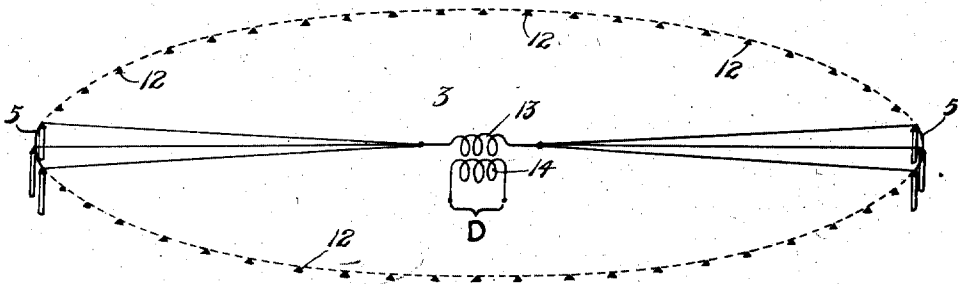


Fig. 4.

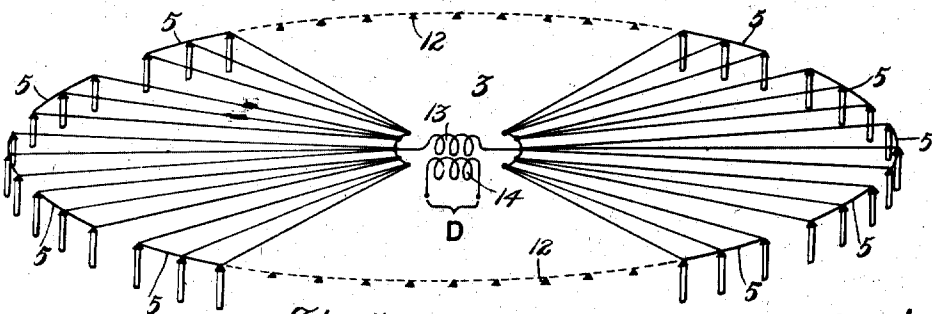
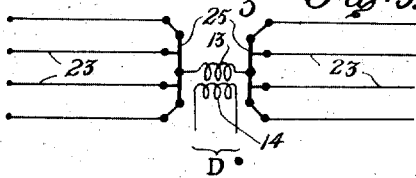


Fig. 5.



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 3 SHEETS—SHEET 3.

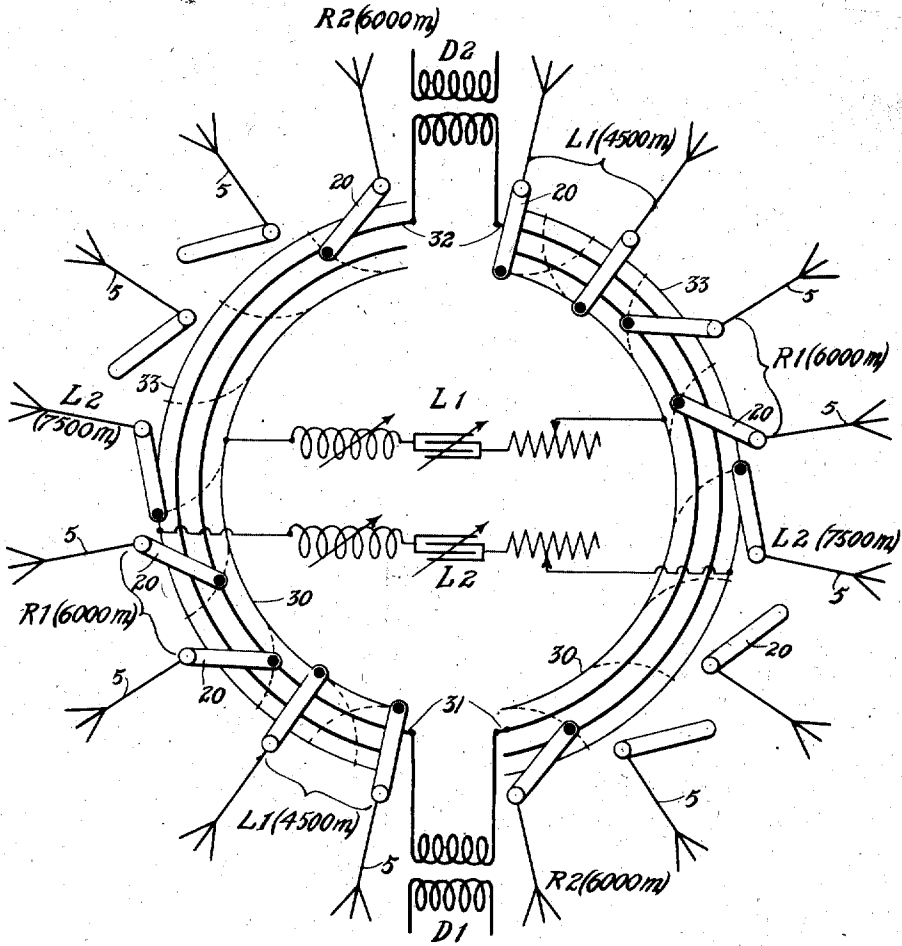


Fig. 7.

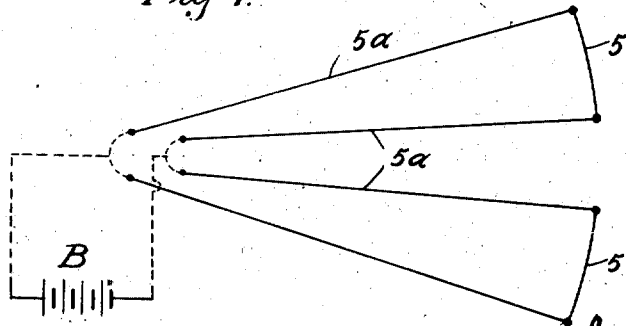


Fig. 8.

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 By his Attorneys
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UNITED STATES PATENT OFFICE.

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ANTENNA FOR RADIOTELEGRAPH-STATIONS.

1,214,591.

Specification of Letters Patent.

Patented Feb. 6, 1917.

Application filed April 29, 1916. Serial No. 94,351.

To all whom it may concern:

Be it known that I, GUSTAV REUTHE, a subject of the German Emperor, residing at Sayville, county of Suffolk, Long Island, State of New York, have invented certain new and useful Improvements in Antennæ for Radiotelegraph-Stations, of which the following is a full and clear description, illustrated in the accompanying drawings, the novel features of my invention being set forth more particularly in the annexed claims.

It is known that atmospheric disturbances manifesting themselves in the receiving systems of radio telegraph stations can be traced to two different causes.

The first cause is the electro-magnetic effect of electric discharges in the atmosphere at long distance. These discharges by what might be termed "impulse effects," disturb the antenna so as to oscillate with its natural period, which oscillations then in turn manifest themselves in the detector circuit. The effect of such long distance atmospheric discharges is the greater the higher the receiving antenna is and the smaller its damping. For this reason high antennæ (for instance of the umbrella-T- or L-type) which contain a large self induction in circuit and which are particularly suitable for sending, are very unsuited for receiving, whereas on the other hand low horizontal antennæ not suited very well for transmitting on account of their small height above the ground, and on account of their high damping, are very well suited for receiving because they offer great advantages with regard to lessening atmospheric disturbances. The second cause is static charges which the antenna receives through the electric field in the atmosphere. So long as this field and thus the charges which the antenna receives remain constant, they have no effect upon the detector system. They will, however, influence the detector immediately when the electric field in the atmosphere varies. Then currents are induced in the antenna, which similar to distant atmospheric discharges cause the antenna to swing with its own period and thus to disturb the detector system. With regard to these two causes, the combination covered by the U. S. Patent No. 1,082,221

granted to Georg von Arco on December 23rd, 1913, which comprises a comparatively high transmitting antenna and a comparatively low horizontal receiving antenna is particularly favorable, provided however that during receiving the transmitting antenna is detuned against the frequency of the arriving waves. Thus in case of distant atmospheric discharges the oscillations of natural period produced thereby do not affect the horizontal antenna and the detector system coupled therewith, because during receiving the transmitting antenna is detuned against the horizontal antenna and the detector system. The horizontal antenna is very little directly influenced by the atmospheric disturbances because in the first place, such antennæ are very little sensitive against atmospheric disturbances anyhow on account of their small height and their strong damping, and also because a great amount of the energy of the electro-magnetic field causing the disturbance is absorbed already by the transmitting antenna. In case of static charges, on the other hand, this combination is particularly favorable because with regard to the electric field in the atmosphere the transmitting antenna has, what may be termed, a "screening action" upon the horizontal antenna below, similarly to the effect produced by Faraday's cage. This screening effect will be the more complete, the larger the area of the transmitting antenna. It will be particularly complete in case the transmitting antenna is of the umbrella or tent type, though of course my invention also covers L- or T- types of antennæ, in which this effect is also present to some extent.

In technically developing this system, it has been proven to be of great advantage to use a transmitting antenna having a counterpoise and to divide the counterpoise into individual sectors which can be separated electrically from each other.

My invention is shown in the annexed drawings, in which,

Figure 1 shows the entire antenna arrangement with the counterpoise; Fig. 2 is a modification showing the counterpoise alone in a form in which one single sector is used for receiving; Fig. 3 is a modification showing a form of the counterpoise

in which two opposite sectors are used for receiving; Fig. 4 is a modification showing several oppositely disposed sectors of the counterpoise joined together for receiving and in order to obtain a different wave length; Fig. 5 is a plan view of a further modification of the counterpoise; Fig. 6 is a detail illustration of the form in which the individual sectors of the counterpoise may be thrown into circuit; Fig. 7 is a modification of Fig. 6; Fig. 8 shows the antenna wires arranged for heating.

Referring now to Fig. 1, 1 is the vertical antenna preferably an umbrella antenna to which the transmitter circuit (not shown here) may be coupled by means of coupling coils 2. 3 is the counterpoise used as a horizontal antenna as will be described hereinafter. It consists of a considerable number of radially extending wires 4 so as to cover an approximately circular area, a suitable number of adjoining wires (in this case, three) being connected into groups so as to form an even number of sectors 5 as shown. The wires of each group are connected together at their outer ends and supported a short distance above ground by posts 6 from which the wires are insulated. For sending, this horizontal antenna is used as the counterpoise for the vertical antenna and in this instance, all its sectors are connected at their inner ends as shown by the dotted line 7 and then connected to the vertical antenna by means of switch 8. For receiving, the vertical antenna is disconnected from the horizontal antenna by a switch 8 and thrown in circuit with a ground connection 9 which may or may not contain an inductance 10 and a capacity 11. If desired, during the receiving the vertical antenna may not be connected to the ground.

During receiving the horizontal antenna 3 may be used in several different ways which are illustrated in Figs. 2 to 4. In all these figures it should be assumed that of course all the radially extending wires 4 are in place though they may not be all connected. The wires are indicated by the black insulators 12 which are mounted on top of posts 6, the posts being omitted in the illustrations. Referring now particularly to Fig. 2, this modification shows the use of only one single sector for receiving. The inner end of the sector is connected to the transformer coil 13, the other end of which is connected to ground. This coil is coupled with the coil 14 which leads to the detector circuit arrangement not shown here, but merely marked with D in Figs. 2-5. The vertical antenna, which is not shown in Fig. 2, being disconnected from the horizontal antenna is of course considerably detuned thereby and if it is connected to the ground at 9 as described before, its detuning may still be materially increased by the capacity 11 and the

inductance 10, so that if it is excited by atmospheric disturbances, it will not only not interfere with the receiving by means of the single sector 5 of the low horizontal antenna, but have the screening effect previously referred to. All the remaining sectors of the low horizontal antenna are disconnected from the receiving circuit and from each other.

The modification shown in Fig. 3 in which the vertical antenna (as also in Fig. 4) is assumed to be similarly arranged but not illustrated, shows two oppositely disposed sectors 5 of the low horizontal antenna 3 connected at their inner ends to the respective ends of coupling coil 13 of the receiving arrangement. The remaining sectors are disconnected and the vertical antenna which is also disconnected may be arranged at that time as described before.

In Fig. 4 a number of diametrically, oppositely disposed sectors 5 are connected in groups and these opposite groups are connected to the two opposite ends of the coil 13 of the receiving arrangement. In the case of Figs. 3 and 4, the antenna assumes the form of a symmetrical, low horizontal antenna which in itself in combination with other features is known in the art, for instance in the U. S. Patent No. 979,144, to Fessenden, though the manner in which I apply such a symmetrical antenna is different from the way in which it is employed in the patent above referred to. In particular one of the purposes of the arrangements covered by the present invention, that is to say, to screen during receiving the low horizontal antenna from atmospheric disturbances by a large, high vertical transmitting antenna which is detuned, has not been sought nor accomplished to my knowledge by any of the arrangements of a low horizontal antenna disclosed in the prior art.

In the practical commercial use the antenna arrangements described hereinbefore have the great advantage that it is not necessary to erect a special, low horizontal antenna aside from the counterpoise which is used in electrical connection with the vertical antenna for transmitting, a use of the counterpoise which so far as I am aware, is also new in the art.

Arrangements of the form using the vertical antenna with the counterpoise and a special low horizontal antenna to which the counterpoise can be connected at will, are for instance shown in Patent No. 1,082,221 of December 23rd, 1913, to Georg von Arco, but it should be noted that in none of the forms shown in that patent, the novel combination described hereinbefore is used. In that patent aside from the low horizontal antenna, a special counterpoise is necessary which in case of large stations, for

which my invention is particularly suited, involves considerable expense through the additional wires and causes great inconvenience through the addition of a low horizontal antenna to the counterpoise, which latter naturally should cover as large an area as possible. Moreover, by using the low horizontal antenna in the preferred forms shown in Figs. 2 to 4, where any numbers of sectors may be connected to the receiving arrangement so that any desired compass direction may be covered, the great advantage is obtained that in case of receiving from several differently located stations, those portions of the low horizontal antenna which coincide with the direction of the received waves and by which, as is known, a particularly favorable effect is obtained, may always be connected for receiving. Moreover an arrangement such as I have shown renders it possible to vary the capacity of the low horizontal antenna for receiving in wide limits by using only a few or many sectors as is shown in Figs. 3 and 4, so that the antenna can receive at quite a variety of wave lengths.

In case a station operates principally with only one other station so that the messages are received practically only from one direction at all times, the low horizontal antenna might be given such form, that it extends principally only in two opposite compass directions. This form is shown in Fig. 5, wherein 13 and 14 represents again diagrammatically the receiving circuit to which that antenna is connected. The vertical antenna is disposed similarly as referred to in the remaining figures, but also here omitted from the drawings. In the preferred opposite compass directions a number of parallel wires 23 extend from the receiver, their inner ends being connected to bus bars 25; 25 between which the primary coil 13 of the receiver is connected. As many of the parallel wires 23 as desired may be connected to the bus bars so as to vary the wave length of the low horizontal antenna.

To simplify the connection of the several sectors to the receiving arrangement, as shown in Figs. 2-5, it is of course necessary to provide suitable switches by which this can be accomplished. That this can be done in a number of different ways to suit the particular requirements of the installation is obvious. I have shown in Fig. 6 more or less diagrammatically as an example one way in which this can be accomplished. This figure only shows the central portion of the sectors 5. The receiving coil 13 is connected at each end to the bus bars 16 and 17, these bars being shown in this particular case semi-circular for convenience. These bars have contacts 18, each bar a number equal to one-half of the numbers of sectors which the horizontal antenna con-

tains. For instance, in the modification Fig. 1, the antenna contains 16 sectors so that each bar has 8 contacts. The inner end of each sector terminates in a switch 20 which can be thrown onto its corresponding contact 18 so that this sector is thereby connected to the corresponding bar. Thus any number of sectors may be quickly thrown into or out of circuit and the most suitable group of sectors for receiving may be quickly determined. In order to use this switch arrangement for the form shown in Fig. 2, each bar 16, 17 is provided with a switch 21, 22 respectively by which the respective bar may be grounded as shown. This arrangement can be further modified so as to render the horizontal antenna capable of multiple receiving as well as also capable of protecting by means of some of its sectors, other sectors which may be used at the time for directional receiving. This modification is shown in Fig. 7. In principle of arrangement it is similar to that shown in Fig. 6, except that instead of one circle of bus-bars, four circles of two bars each are concentrically arranged, and the switches 20 are placed so that their points may wipe transversely over all four circles of bars so that they can make contact with any of the circles desired. The showing in Fig. 7 is of course somewhat diagrammatical and it is obvious to anyone skilled in the art that in a station in actual practical use the detail arrangement of the switches and bars may be made somewhat more convenient. In this figure the two heavy marked circles of bars 31 and 32 each comprise two substantially half circles which are connected with the detector circuit D_1 and D_2 in a manner similar to that shown in Fig. 6 at 13, 14. The two other thin lined circular pairs of bars 30 and 33 are provided for connecting some of the antenna sectors desired with local circuits L_1 , L_2 , the purpose of which will be explained presently.

So far as the directional receiving by means of two oppositely disposed antenna sectors is concerned, which has been described hereinbefore, I have found that it is possible to simultaneously receive from two different directions, even at the same wave length, with two different receiving circuits. Of course such multiple receiving is most effective when the two directions are substantially at right angles to each other or nearly so because then in case of receiving on the same wave length there will be the least interference. On the other hand it is also possible to simultaneously receive by means of two pairs of oppositely disposed sectors from substantially the same direction at different wave lengths. Of course it naturally follows that also from two different directions simultaneous messages can be received at the same time at different wave

lengths. Now the arrangement shown in Fig. 7 enables me to carry out this multiple receiving. I have assumed in this figure the case where I desire to receive simultaneously at the same wave length from two different directions which are substantially at right angles to each other and I have therefore connected two adjacent oppositely disposed pairs of antenna sectors 5 together by means of their respective switches 20 and thrown them on to the two respective halves of bus-bars 31. This may form receiving circuit R_1 which is connected with the detector circuit D_1 . Another oppositely disposed pair of single sectors 5 may be connected by their respective switches 20 to the pair of bars 32 which is connected with the detector circuit D_2 . This may form the receiving circuit R_2 . The antenna sectors connected to the respective circuits as will be seen are substantially at right angles to each other. Both may be tuned to the wave length of 6,000 m. as indicated.

I found by actual practical experience at a large wireless station that in this way messages can be very conveniently and clearly received simultaneously at the same wave length or of course also at different wave lengths.

In the preamble of the specification I have pointed out that the vertical antenna exerts a "screening action" upon the horizontal antenna. I can now increase this screening action upon the sectors of the horizontal antenna which are used at the time for receiving by a certain arrangement of other sectors of the horizontal antenna, which run substantially in the same direction as those used for receiving, and which are preferably located on either side of the receiving sectors. I connect such "auxiliary" sectors as I may term them into local circuits containing inductance, capacity and resistance, such that two diametrically oppositely disposed sectors located respectively on one side of the receiving antenna sectors are connected to one local circuit tuned to a wave length below that at which signals are received; and diametrically oppositely disposed auxiliary sectors located respectively at the other side of the receiving sectors are connected to another local circuit tuned to a wave length above the one at which signals are received. In Fig. 7, the two auxiliary circuits including the auxiliary sectors are termed L_1 and L_2 and may be located on either side of the receiving antenna R_1 . L_1 may be tuned to 4,500 m. and L_2 may be turned to 7,500 m. Thus unless a disturbance arrives at exactly 6,000 m. wave length or closely thereto, its energy is at least partly consummated in the local circuits without detrimental effect upon the receiving sectors. This expedient may be particularly favorable where, during re-

ceiving, distant thunder showers occur substantially in the direction from which the signals are received. In such case aside from the vertical antenna the two auxiliary horizontal sectors assist greatly in keeping away the disturbance from the receiving circuit.

From the illustration in Fig. 7 it may also be seen that two adjacent pairs of opposite sectors may be thrown into two different receiving circuits, one tuned to one wave length, the other to another wave length and thus two kinds of signals may be simultaneously received from substantially the same direction.

While it is not shown in Fig. 7 for simplicity's sake, it is of course obvious to anyone skilled in the art that all the pairs of bus-bars may be provided with grounding switches such as are shown at 21 and 22 in Fig. 6 for the purposes referred to in the specification, and it is also obvious to anyone skilled in the art that by the arrangement shown in Fig. 7 a large number of combinations of sectors is possible according to the local conditions and those of receiving.

In cases, where the station is exposed to severe winter weather, especially ice storms, it is advisable to arrange the wires, of which the horizontal antenna sectors are formed, so that each sector or portions of it can be formed into a loop, which can be thrown in circuit with a strong source of alternating or direct current, when the antenna is not used for receiving or sending. Any destructive formation of ice on the wires can thus be easily melted off. An arrangement of the wires of two adjacent sectors is shown in Fig. 8 as an example. The two sections 5—5 are open at their inner ends so that their individual wires 5^a may be connected to the battery B or any other suitable source of direct or alternating current in any suitable manner, (in series or in parallel) as the occasion and the source of current may require. In Fig. 8 for example a multiple connection of two adjacent sectors is shown in dotted lines. Any other connection will be obvious to anyone skilled in the art. I have found in practice that for such purposes current of considerable intensity is required rather for a short time, than current of smaller intensity for a longer time, on account of the strong heat radiation of the wires. Therefore the division of the horizontal antenna into sectors for radiotelegraphic purposes affords at the same time a very convenient arrangement for thawing off ice coated wires because the individual sectors can be connected successively to the heating circuit, for which considerably less electric energy is required than would be necessary, were the horizontal antenna arranged as one integral net of wires commonly used heretofore. Up to the

present this latter arrangement appears to have stood in the way of successfully thawing off antenna wires.

I claim:

5 1. In a radio telegraph station the combination of a high vertical antenna for transmitting and a low horizontal antenna for receiving, said vertical antenna being connected electrically during transmission with
10 said horizontal antenna as a counterpoise, said horizontal antenna being disconnected from the vertical antenna during receiving.

15 2. In a radio telegraph station, the combination of a high vertical antenna for transmitting, and a low horizontal antenna for receiving, having a suitable number of sections, said vertical antenna being connected during transmitting with all of said sections as a counterpoise, said horizontal antenna
20 being disconnected from the vertical antenna during receiving and at least one of its sections being used as a low horizontal antenna for receiving.

25 3. In a radio telegraph station, the combination of a high vertical antenna for transmitting and a low horizontal antenna for receiving, said vertical antenna being connected electrically during transmitting with said horizontal antenna as a counterpoise,
30 said horizontal antenna being disconnected from the vertical antenna during receiving, and means for detuning the vertical antenna.

35 4. In a radio telegraph station, the combination of a high vertical antenna for transmitting, and a low horizontal antenna for receiving, having a suitable number of sections, said vertical antenna being connected during transmitting with all of said sections as a counterpoise, said horizontal antenna
40 being disconnected from the vertical antenna during receiving and at least one of its sections being used as a low horizontal antenna for receiving, and means for detuning the vertical antenna.

45 5. In a radio telegraph station the combination of a high vertical antenna for transmitting and a low horizontal antenna for receiving, said horizontal antenna consisting of a suitable number of radially extending
50 wires forming an approximately circular area and being connected in suitable numbers in individual groups to form independent sectors of the circle, said vertical antenna being connected during transmission
55 with all of said sectors as a counterpoise, said horizontal antenna being disconnected from the vertical antenna during receiving, and at least one of its sectors being used as a low horizontal antenna for receiving.

60 6. In a radio telegraph station the combination of a high vertical antenna for transmitting and a low horizontal antenna for receiving, said horizontal antenna consisting of a suitable number of radially extending

wires forming an approximately circular 65 area and being connected in suitable numbers in individual groups to form independent sectors of the circle, said vertical antenna being connected during transmission with all of said sectors as a counterpoise, said horizontal antenna being disconnected from the
70 vertical antenna during receiving, and at least one of its sectors being used as a low horizontal antenna for receiving, and means for detuning the vertical antenna against the frequency of the arriving waves during receiving. 75

7. In a radio telegraph station the combination of a high umbrella type antenna for transmitting and a low horizontal antenna
80 for receiving, said horizontal antenna consisting of a suitable number of radially extending wires forming an approximately circular area and being connected in suitable numbers in individual groups to form independent sectors of the circle, said vertical
85 antenna being connected during transmission with all of said sectors as a counterpoise, said horizontal antenna being disconnected from the vertical antenna during receiving, and at least one of its sectors being used as a low horizontal antenna for receiving, and means for detuning the vertical antenna against the frequency of the arriving waves during receiving. 90

8. In a radio telegraph station the combination of a high vertical antenna for transmission and a low horizontal antenna for receiving, said horizontal antenna consisting of a suitable number of radially extending
100 wires forming an approximately circular area and being connected in suitable numbers in individual groups to form independent sectors of the circle, said vertical antenna being connected during transmission with all of said sectors as a counterpoise, said horizontal antenna being disconnected from the vertical antenna during receiving, and at least one of its sectors being used as a low horizontal antenna for receiving, said
105 vertical antenna having a ground connection and having suitable inductance and capacity in circuit therewith to detune the antenna against the frequency of the arriving waves during receiving. 110

9. In a radio telegraph station the combination of a high umbrella type antenna for transmitting and a low horizontal antenna for receiving, said horizontal antenna consisting of a suitable number of radially extending wires forming an approximately circular area and being connected in suitable numbers in individual groups to form independent sectors of the circle, said vertical antenna being connected during transmission with all of said sectors as a counterpoise, said horizontal antenna being disconnected from the vertical antenna during receiving. 115

120 125

ceiving, at least one pair of oppositely disposed sectors being connected as a low horizontal antenna for receiving, and means for detuning the high antenna against the frequency of the arriving waves during receiving.

10. In a radio telegraph station the combination of a high vertical antenna for transmitting and a low horizontal antenna for receiving, said horizontal antenna consisting of a suitable number of radially extending wires forming a circular area and being connected in suitable numbers in individual groups to form independent sectors of the circle, said vertical antenna being connected during transmission with all of said sectors as a counterpoise, said horizontal antenna being disconnected from the vertical antenna during receiving, each of said sectors having a suitable switch connection to permit the combination of any desired number of oppositely disposed sectors to vary the capacity of the low horizontal antenna and to render it directive for receiving, and means for detuning the vertical antenna against the frequency of the arriving waves during receiving.

11. In a radio telegraph station the combination of a high umbrella type antenna for transmitting and a low horizontal antenna consisting of a suitable number of radially extending wires forming an approximately circular area and being connected in suitable numbers in individual groups to form independent sectors of the circle, said vertical antenna being connected during transmission with all of said sectors as a counterpoise, said horizontal antenna being disconnected from the vertical antenna during receiving, at least one pair of oppositely disposed sectors being connected as a low horizontal antenna for receiving, local circuits containing inductance, capacity and resistance, means for connecting the pairs of opposite sectors adjacent to either side of the receiving sectors each to one of said local circuits, said local circuits being tuned respectively to a wave length above and below that of the receiving antenna for screening the receiving antenna from disturbance, and means for detuning the high antenna against the frequency of the arriving waves during receiving.

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