J. HÄRDÉN.

WIRELESS TELEGRAPHY.

APPLICATION FILED OCT. 10, 1904.

1,011,777. Patented Dec. 12, 1911.

FIG. 1

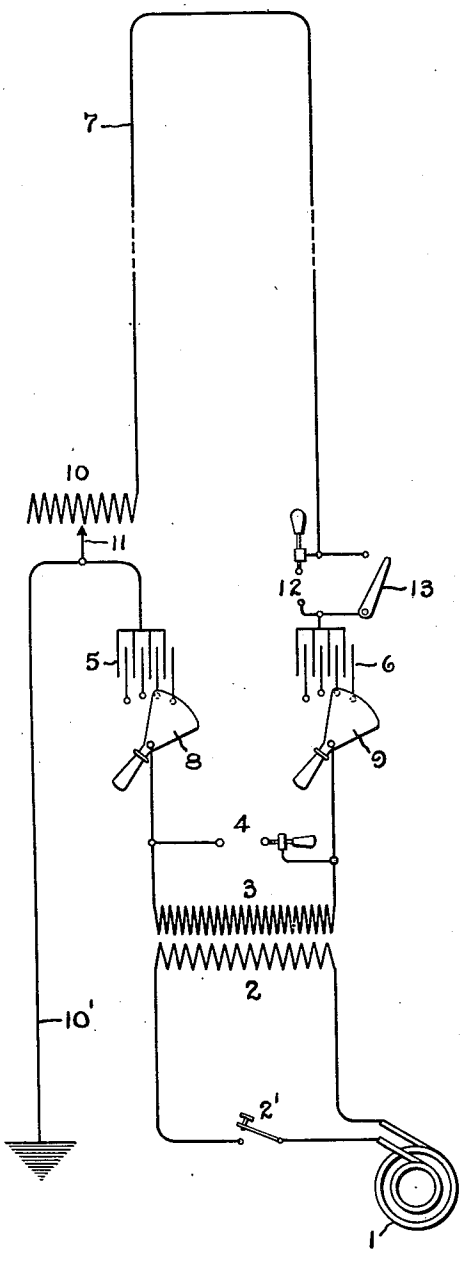
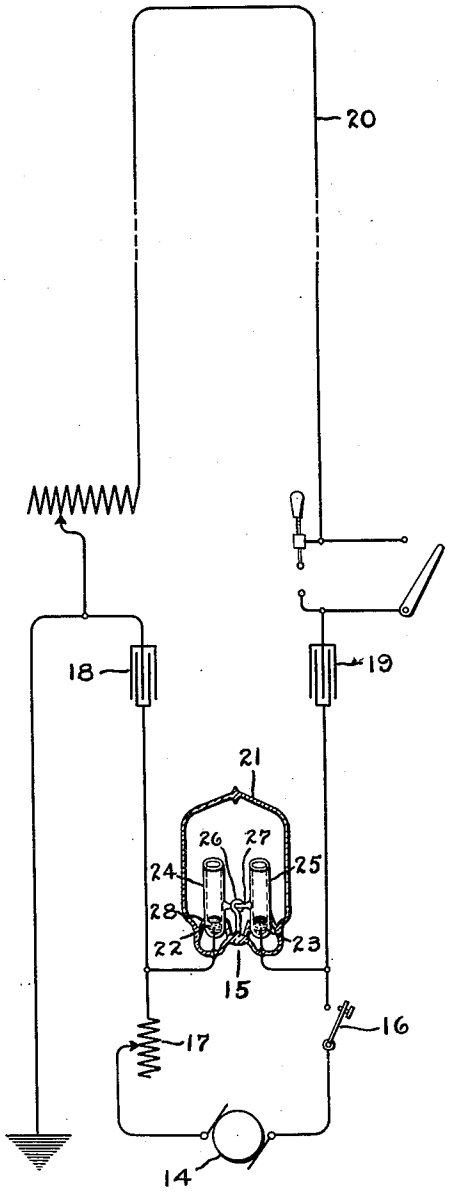


FIG. 2



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WIRELESS TELEGRAPHY.

1,011,777. Specification of Letters Patent. Patented Dec. 12, 1911.

Application filed October 10, 1904. Serial No. 227,784.

To all whom it may concern:

Be it known that I, JOHANNES HÄRDÉN, a subject of the King of Sweden and Norway, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Wireless Telegraphy, of which the following is a specification.

In the art of signaling by waves it is customary to provide the sending apparatus with an aerial conductor or wire and to impress upon said conductor an electromotive force of exceedingly high frequency. This high frequency potential sets up high frequency currents in the aerial wire which, from their inherent nature, give up their energy to the surrounding space in the form of vibratory energy or etheral vibrations and these vibrations are in turn reconverted into electrical vibrations at the receiving station. In such systems the power of the sending apparatus and the sensibility of the receiving apparatus are dependent to a great extent on the relation between the natural period of vibration of the aerial conductors and the frequency of the oscillating current used in the system. Thus if the aerial at the sending station has a natural period of vibration of the same frequency as the impressed oscillation or a harmonic of such frequency it will convert the energy of the oscillating charge into ethereal vibrations with an efficiency much higher than that attainable when this resonance of the aerial does not exist. To conveniently secure resonance of the sending aerial I provide an adjustable condenser and an adjustable inductance in series with it. To determine the exact adjustment of these regulators for a condition of resonance I use a small adjustable spark gap in the aerial wire. The discharge across this test spark gap will be a maximum when resonance of the circuit has been attained.

In wireless telegraphy apparatus, it has heretofore been customary to provide the sending and receiving apparatus with aerial conductors consisting of a single wire or of a group of wires connected together at one end, but in my improved apparatus I make use of a substantially closed loop of one or more turns and thereby secure a marked improvement in the power and sensibility of the apparatus.

My invention also relates to an improved apparatus for producing a spark discharge, and to certain other details of construction and arrangement which are more particularly set forth in the appended claims.

When a single aerial wire is used at the sending station each discharge of energy from the wire takes place in an exceedingly short time and in consequence there is transmitted through the ether a quantity of energy high in potential or intensity but of very short duration. The result is that when this energy reaches the coherer its effect thereon is of such short duration that the coherer and parts allied therewith sometimes do not have time to operate before the entire flow of energy has taken place.

By the use of aerials in the form of loops I am able to spread each discharge over a considerable time interval and thus give the coherer sufficient time to act. This increase in the time interval is probably due to surging of the current in the aerial loops after the original charging oscillations, caused by the spark discharge, have ceased; the surging being due in part to the resonant condition of the circuits and in part to oscillations of the magnetic flux threading the loops. This magnetic flux serves in a sense as a reservoir to store up part of the energy of the spark discharge which is later given out in rhythmic oscillations on the aerial thus converting into useful ethereal vibrations the magnetic energy set up by the current from the original spark discharge.

In the drawing, Figure 1 represents one form of sending apparatus with my improved form of aerial conductor; Fig. 2 is a modification of a sending apparatus in which a direct-current generator is used as the source of energy and in which the rapid oscillations are obtained by means of a mercury vapor spark gap operating in conjunction with condensers.

Energy for the excitation of the aerial may be derived from any suitable source such as an induction coil or an alternating current dynamo but I prefer to use the arrangement shown in Fig. 2 in which a direct current dynamo is used to charge condensers which in turn discharge through a rarefied atmosphere. This latter arrangement gives a higher efficiency and also a higher speed of operation than I have been able to attain with other sources of energy.

When an alternating current dynamo is

used I prefer the arrangement shown in Fig. 1. The dynamo 1, driven in any convenient manner, supplies power to the primary or low pressure side 2 of a transformer, the secondary 3 or high pressure side of which supplies energy to the sending apparatus. A key 2′ serves to close the dynamo circuit at proper intervals for transmitting signals of the Morse code. The alternator may operate at commercial frequencies as for instance 60 cycles per second and at a potential of 110 volts. A frequency of 60 cycles is of course too low to be effective in setting up ethereal vibrations and to secure the desired high frequency I preferbly employ an adjustable spark gap 4 located between the terminals of the high potential coil 3 of the step up transformer. Condensers 5 and 6 are located in the conductors connecting the spark gap 4 with the aerial loop 7. These condensers are rendered adjustable in capacity by the segmental switches 8 and 9 which serve to increase or decrease the number of condenser plates in circuit. A reactance coil 10 connects one end of the aerial loop 7 to ground through the ground conductor 10′ and a movable contact 11 serves to vary the proportion of reactance coil 10 between the aerial loop and the local circuit which includes the condensers 5 and 6. The other side of the loop 7 is connected to the local condenser circuit through the test spark gap 12. In adjusting the aerial loop to the condition of resonance the reactance coil 10 and the condensers 5 and 6 are adjusted until a maximum discharge is obtained across spark gap 12 in which condition the effective vibratory length of the aerial loop is equal to one quarter wave length of the impressed vibrations and the conversion of electrical energy into ethereal vibrations is most efficient. Not only is this true but with the line in this condition the flow of current in the aerial is at its maximum and hence the magnetic effect set up thereby is also at its maximum. This magnetic effect consists of a flux at right angles to the plane of the loop which flux reverses at each reversal of the current in the aerial and serves to prolong the period during which ethereal vibrations are given off from the aerial and which also ultimately gives up a large part of its magnetic energy as electrical energy in the form of current oscillations in the aerial loop after the original spark discharge has ceased. After the condition of resonance has once been obtained the spark gap 12 is adjusted so that no discharge takes place at this point when the apparatus is in actual use for transmitting messages. This may be accomplished by shunting the spark gap by a switch 13.

In Fig. 2, I have shown the arrangement which I prefer to use when the energy is derived from a direct-current source. The direct-current dynamo 14, driven in any suitable manner, is connected to a vacuum spark gap apparatus 15 through a sending key 16 and a variable reactance 17. Adjustable condensers 18 and 19 are connected between the terminals of the spark gap and the sending aerial 20.

While I may use for the vacuum spark gap a mercury vapor lamp of ordinary construction I have found that such an arrangement is not entirely satisfactory as the lamp tube becomes coated on the inside with a dark deposit which in time forms a short circuit from one electrode to the other thus rendering the tube useless. This dark deposit I believe to be due to a partial decomposition or similar change of the glass surface produced by the action of the spark. I have made the important discovery that if the electrodes are inclosed in silica tubes this deposit does not form and I am able to use spark gaps of this improved construction for a long time without material depreciation. The vacuum chamber 21, which may be of glass or similar material, incloses the two mercury electrodes 22 and 23 and maintains a rarefied atmosphere about them. Silica tubes or cups 24 and 25 surround these mercury electrodes and protect the glass walls of the chamber 21 from the destructive action of the spark which passes between the two mercury electrodes. As it is impossible to satisfactorily fuse the silica cups to the glass vacuum chamber I support the cups by means of a glass standard 26 fused to the base of the vacuum chamber and provided at its top with a hook which engages a solid silica rod 27 joining the two silica tubes or cups 22, 23. Projections 28 on the inner walls of the vacuum chamber serve to further steady and support the silica cups.

I am aware that mercury vapor spark gaps have been used on alternating current circuits to produce an oscillating discharge, but a considerable increase in efficiency and rapidity of operation is obtained by using direct current. The aerial and its grounded reactance coil and test spark gap are similar to the corresponding parts in Fig. 1.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In a system of wireless telegraphy, the combination of a sending aerial in the form of a substantially closed loop traversed in series by oscillations, an inductive reactance in series therewith, a capacity reactance in series with said inductive reactance, a source of energy connected in series with said capacity and said series connected loop and a ground connection for said aerial between said inductive reactance and said capacity reactance.

2. In a system of wireless telegraphy, the

combination of an aerial in the form of a substantially closed loop, an adjustable inductive reactance in series therewith, a test spark gap in series therewith, means for short circuiting said spark gap, a second spark gap for setting up high frequency oscillations, and an adjustable capacity reactance connecting each side of said second spark gap to said aerial.

3. In a system of wireless telegraphy, the combination of a sending aerial in the form of a substantially closed loop, a capacity reactance in series therewith, a spark gap shunting said aerial and adapted to produce high frequency oscillations traversing said looped circuit in series, and a source of current connected across said spark gap and in series with said aerial.

4. A spark gap apparatus comprising a plurality of mercury electrodes between which a spark discharge may pass, means for maintaining a rarefied atmosphere about said electrodes and a silica cup surrounding one of said electrodes.

5. The combination with a source of energy, of a spark gap apparatus having a gas tight chamber, mercury electrodes in said chamber between which a spark may pass, and means inclosing said electrodes for protecting the walls of said chamber from the destructive action of said spark.

6. The combination with a source of direct current, of a vacuum spark gap apparatus having a gas tight chamber of glass, mercury electrodes in said chamber between which a spark may pass, and a silica tube inclosing each of said mercury electrodes to protect the inner surface of the glass from the destructive action of said spark.

7. In a system of wireless telegraphy, the combination of a source of direct current, a vacuum spark gap connected across said source, an aerial connected in series with said source and shunting said spark gap, and a plurality of condensers connected in series with said aerial and with said series connected source thereby constituting a looped series circuit traversed by oscillations.

8. The combination with a source of current, of a spark gap apparatus having a gas tight chamber, mercury electrodes in said chamber between which a spark may pass, and a silica cup inclosing each of said electrodes and separating it from the wall of said gas-tight chamber.

9. In a system of wireless telegraphy, the combination of a sending aerial in the form of a substantially closed loop traversed in series by oscillations, an inductive reactance in series therewith, a capacity reactance in series with said inductive reactance, a source of energy connected in series with said capacity reactance and in series with said aerial, a spark gap in shunt with said source and a ground connection for said aerial.

In witness whereof, I have hereunto set my hand this seventh day of October, 1904.

JOHANNES HÄRDÉN.

Witnesses:

EDWARD WILLIAMS, Jr.,

HELEN ORFORD.