D. McF. MOORE.

WIRELESS TELEGRAPH APPARATUS.

APPLICATION FILED MAY 8, 1906.

1,010,669.

Patented Dec. 5, 1911.

2 SHEETS—SHEET 1.

Fig. 1.

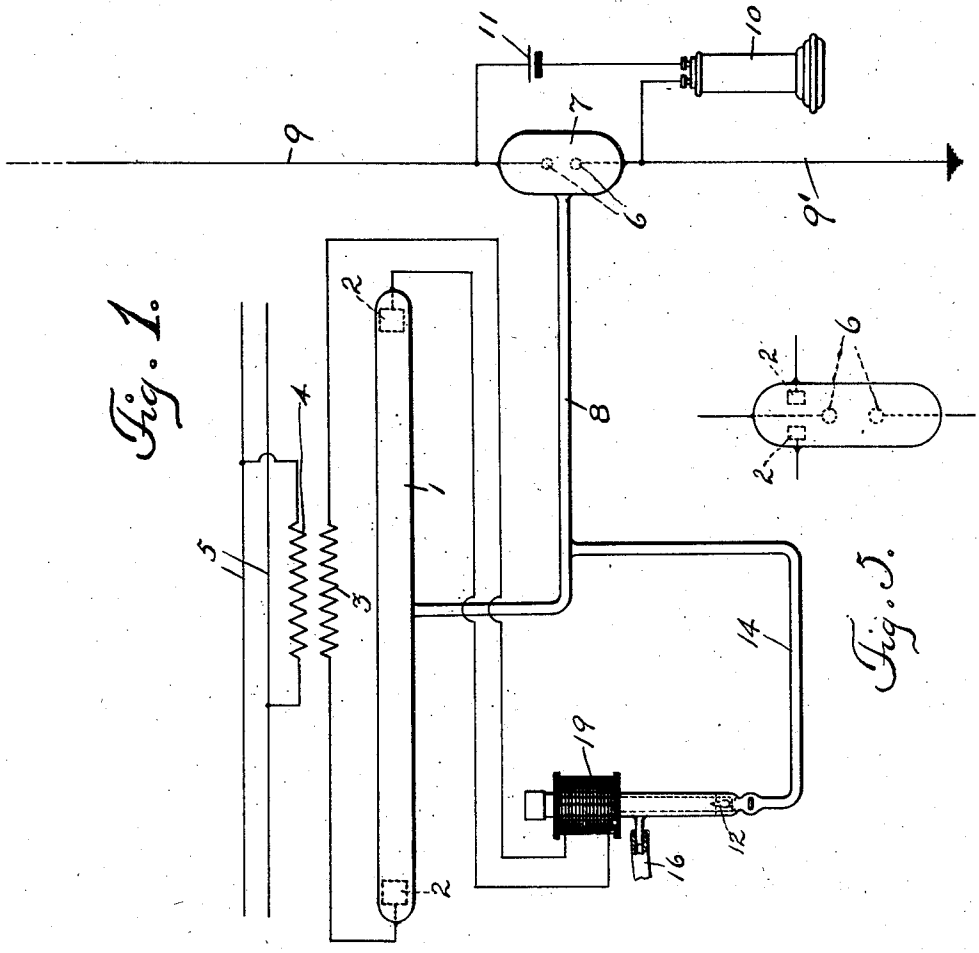
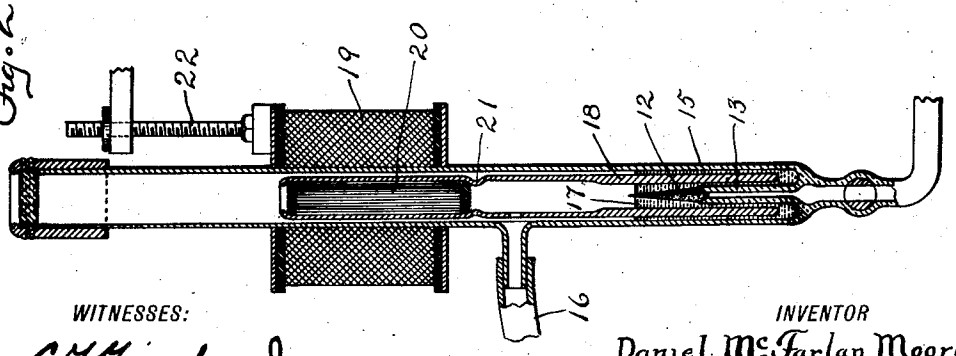


Fig. 3.

Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 3.

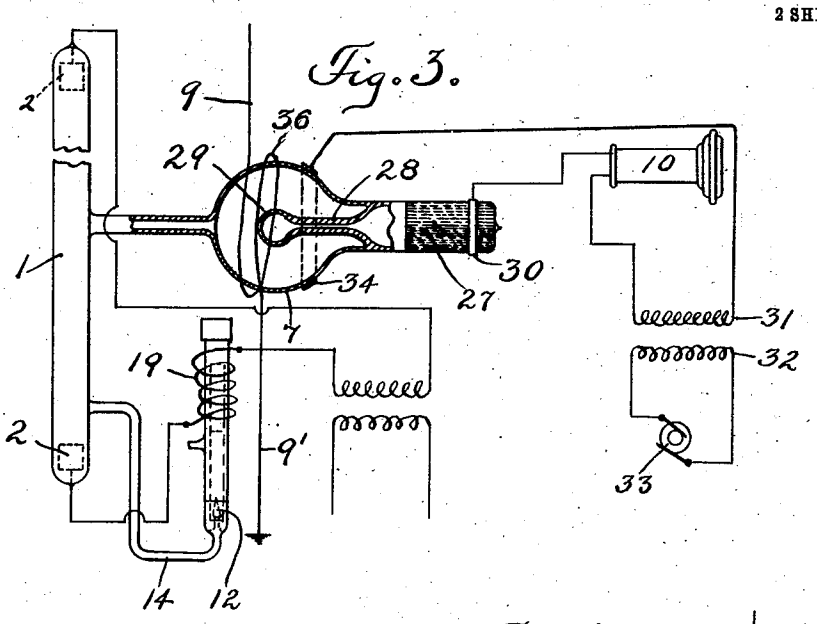
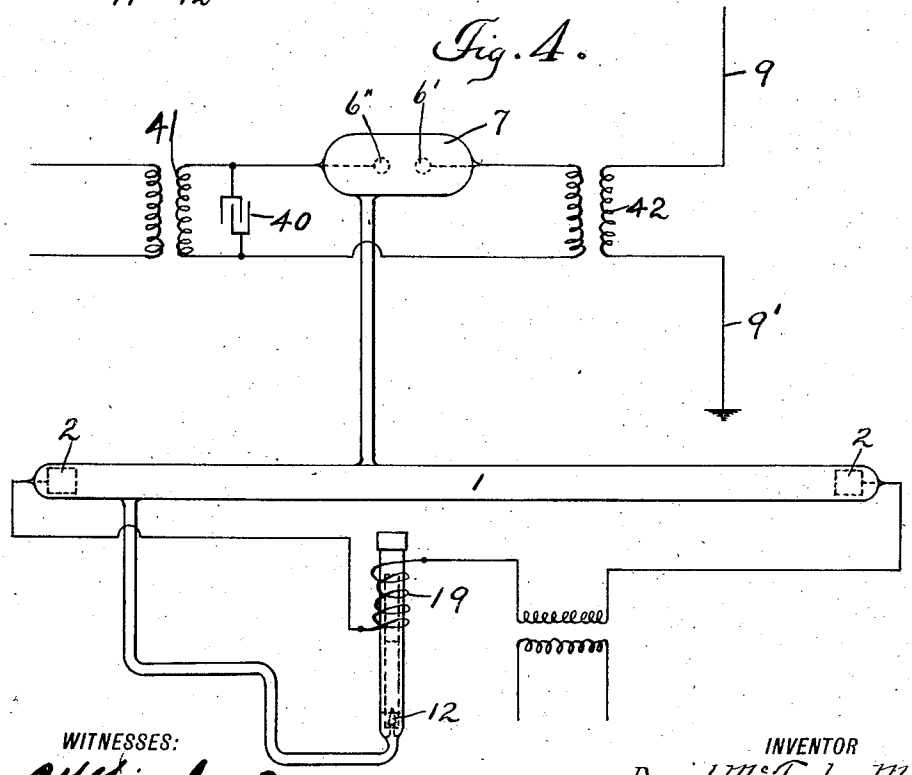


Fig. 4.



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WIRELESS-TELEGRAPH APPARATUS.

1,010,669. Specification of Letters Patent. Patented Dec. 5, 1911.

Application filed May 8, 1906. Serial No. 315,725.

To all whom it may concern:

Be it known that I, DANIEL McFARLAN MOORE, a citizen of the United States, and a resident of Newark, in the county of Essex and State of New Jersey, with post-office address 52 Lawrence street, have invented certain new and useful Improvements in Wireless-Telegraph Apparatus, of which the following is a specification.

My invention relates to that class of devices known as vacuum tubes when used under conditions where an electric current passes intermittently only through the tube and its object is to provide means whereby the gas tension or density within the tube may be kept constant by devices responsive to variations in the density and hence electric resistance of the contained gas.

My invention is particularly useful in wireless telegraph receiving and transmitting apparatus.

The first part of my invention is applicable generally to vacuum tubes used in wireless telegraph apparatus or to X-ray tubes, vacuum oscillographs and in fact to vacuum tubes used under any conditions or in any situations wherein the working or useful current employed passes only through the gas intermittently and cannot be, therefore, employed as a means for regulating the degree of vacuum.

The first part of my invention consists broadly in the combination with a vacuum tube connected into a circuit through which electric current passes only intermittently, of independent means automatically responsive to changes in the gas tension within the tube for feeding gas to said tube and comprising essentially a gas feed device and regulating or operating devices responsive to changes in the resistance, of a circuit including gas which partakes of the tension of the gas in said tube, as hereinafter more particularly described. In carrying out this part of my invention, I prefer to employ regulating or feed adjusting devices the same as described in my original application for patent filed Aug. 21st, 1905, S. N. 275,003 and since patented by Letters Patent No. 820,364, dated May 8, 1906, wherein I describe a gas feed valve which feeds gas to a vacuum tube and which is operated by a magnet responsive to changes in the resistance of the vacuum.

In carrying out my invention, the path for the regulating current includes a body of gas which partakes of the tension of the gas or body of gas through which the intermittently flowing current passes for which purpose I may employ a supplemental receiver connected by a tube with the main tube. However, the use of a separate tube as a separate structure is not essential, it being only necessary that the regulating current should pass through the gas by a path or in a circuit independent of that through which a current flows only intermittently.

My invention consists also in the use of a vacuum tube as a detector of electromagnetic waves and in its preferred form, this part of my invention involves the use of a vacuum tube having sealed or internal electrodes which are connected into the receiving circuit, by which the electric waves or vibrations are received as in wireless telegraphing.

My broad invention as applied to apparatus for generating or producing electric waves or vibrations by the oscillatory discharge comprises a spark gap consisting essentially of electrodes maintained in fixed relation to one another and separated in a vacuous space in which, by preference, the vacuum is maintained by automatically feeding gas in such manner as to maintain a constant degree of vacuum. The gas fed into the tube is derived from a source or body of gas which is normally at greater tension or density than that within the tube and is admitted in determinate regulated amounts through a feed device such, for instance, as a valve whose action is automatically governed by changes in the gaseous tension or condition within the tube.

For the purpose of setting forth my invention, I will describe some applications of the same to wireless telegraph apparatus.

In a receiver for wireless telegraphs, my invention is particularly useful since the vacuum may be regulated to any degree of nicety and may be maintained practically in any desired condition, thereby making it

possible to detect the presence of the slightest current.

As applied to a wireless telegraph transmitting apparatus, it is particularly useful because by regulating the degree of vacuum, the length of the emitted waves may be exactly determined, thus making the invention especially useful under conditions where the principle of syntonizing is employed. Moreover, when once adjusted, the wave lengths and oscillations may be maintained at a regular and constant rate. Further, by the use of a spark gap of the kind described, waves of greater carrying power may be produced.

In the accompanying drawings: Figure 1 represents diagrammatically one way in which my invention may be carried out in a wireless telegraph receiving apparatus. Fig. 2 is an enlarged vertical section through a preferred form of automatic valve for feeding the gas to the vacuum tube receiver or detector. Fig. 3 illustrates the application of my invention to a modified form of vacuum tube detector. Fig. 4 illustrates diagrammatically the application of my invention to apparatus for generating electromagnetic waves. Fig. 5 illustrates a modification in the disposition of the electrodes used in regulating the vacuum.

Referring to Fig. 1, 7 indicates a vacuum tube having electrodes 6 sealed within it and included in the receiving circuit which receives the electromagnetic waves or vibrations to be detected. Such circuit is typified by the antenna 9 and the ground connection 9'. The visual or audible indicator of the waves is connected to the circuit in any way so as to respond to the effect of the passage of the detached waves across the gap between the internal electrodes 6. As typical of such an indicator, I show a telephone 10 connected across the circuit of the detector proper through a battery 11 or other source of energy. By maintaining a vacuum in the receiver 7 at a proper tension, an instrument exceedingly sensitive to the passage of received electromagnetic waves may be secured. As a means for maintaining a constant degree of vacuum, I propose to employ some means for feeding gas to said tube from a body or source of gas of greater density than that normally maintained within the tube, the action of the feed devices being made responsive to changes in the gas tension within the receiver 7 in any desired way. Preferably, I use the changes of electric resistance of the contained gas as a means for controlling the action of the feed devices, for which purpose I employ a regulating electric circuit, a portion of which includes a body of gas partaking of the gas tension or density within receiver 7. This may be accomplished by connecting the receiver 7 through a tube 8 with a second or supplemental receiver or bulb 1, having a pair of electrodes 2 from one to the other of which the current continually flows through the interposed gas. Preferably, tube 8 should be made short so that the change of tension in bulb 7 may be immediately felt in the tube 1. Obviously, however, it is not necessary to use another tube 1 and it will be possible to employ supplemental electrodes 2 sealed in the receiver 7 itself as indicated in Fig. 5.

The gas admitted to the tube or bulb 7 to repair or restore the vacuum may be admitted through a feed tube 14 from any body of air or gas normally of greater density than that in the bulb 7. This admission may be controlled by a valve of any desired construction, operated by an electromagnet 19, which may be in the circuit of the electrodes 2 as shown, said electrodes being supplied continually with energy from the secondary 3 of an induction coil or other source. The primary of such induction coil, indicated at 4, is connected to the constant potential mains 5 or to any other desired source of energy. Obviously, electromagnet 19 might be in any circuit which would feel the changes of resistance in the gas between electrodes 2.

The construction of valve may be any desired. By preference I employ the valve construction described in my prior application before referred to and specifically described and claimed in my application filed as a division of the before mentioned application on the 16th of April, 1906, S. N. 311,816 and since patented by Patent No. 855,801, dated June 4, 1907. Such construction of valve embodies the following devices: 12 is a mass of porous material preferably consisting of rather dense arc light carbon. The denser the carbon, the less the length of the mass 12 through which the gas is required to pass. The mass 12 is seated as a stopper in the end of a tube 13 joined to tube 14, communicating with tube 8 and located in a chamber 15, preferably of glass, forming a valve chamber with which tube 16, which communicates with a source of air or gas supply, connects. In the chamber 15 is a body of liquid such as mercury surrounding the mass of porous material 12 and leaving the upper terminal of the same exposed or adapted to be exposed by a slight change of level of the liquid 17 brought about in any desired way, as for instance, by the operation of a plunger or liquid displacer 18 immersed in the liquid. Displacer 18 consists of a tube of glass having an opening in its side to admit the air or gas to the space above the tip of the carbon 12. By moving the displacer, the tip of the mass 12 may be more or less exposed, or by a suit-

able adjustment may be alternately disposed and sunk beneath the level of the liquid so as to vary the extent of the porous surfaces through which gas under pressure may leak into and through the mass 12. It is preferred to taper the point of the tip for the purpose of securing a marked change in the extent of exposure for a small change in the level of the liquid. Inasmuch as the plunger works in the same body of liquid in which the tip of the valve proper is located and is exposed to the same pressure of incoming air or gas, it is obvious that any changes in such pressure will not affect the height of the liquid so as to disturb the adjustment of the valve, and the same will, therefore, work in a uniform manner in response to the action of the magnet and irrespective of variations in the pressure of the body of gas constituting the source of supply.

The displacer 18 may be operated by means of an electromagnet 19, the laminated core of which, indicated at 20, is held in a tubular extension of the tubular displacer 18 by a contraction 21. An adjustment of the vertical position of the displacer to determine the extent to which the tip of the mass 12 shall be normally exposed above the level of the liquid may be secured by adjusting the position of the coil 19 of the electromagnet vertically on the tube 15 by means of a screw 22. Mercury is preferred because it forms an effective air seal and does not clog the pores of the porous material 12.

The connection to the body of gas which is fed to the tube is indicated at 16 and such gas being admitted to the chamber 15 passes to the space within the plunger through openings in the tubular extension of said plunger as shown so as to reach the tip of the plug or mass 12.

In the operation of the apparatus, the tension of the gas between electrodes 2 is substantially that of the gas in the bulb 7 and if such tension decreases for any reason so as to interfere with the proper and most delicate operation of said receiver, the resistance between the electrodes 2 will change and the electromagnet 19 will operate the valve so as to admit more gas and thereby restore the gas tension in 7 to normal. Obviously the tension in 7 which is normally maintained may be such that a decrease will produce either an increase or decrease of electric resistance of the gas since, as is well known, there is a critical tension at which the resistance is least and at higher tensions a diminution of the adjusted tension will increase the resistance while at lower tensions than such critical tension, a decrease of tension will lower the resistance. As will be obvious, therefore, the manner in which the plunger is actuated by the magnet 19 would depend upon the tension or degree of tension to be maintained in the tube or bulb 7, and in the one case, namely, where the decrease of tension raises the resistance, the magnet should be arranged to allow the plunger to rise by decrease in its own power, while in the other case, that is to say, where the tension is maintained at such degree that an increase lowers the resistance of the gas, said magnet should act to raise the plunger. These, however, are details which do not affect the general principle of my invention and the construction of the feeding devices, and manner of regulating the same may be indefinitely varied without departing from my invention.

As will be obvious, by the use of my invention, it is possible to use any kind of gas in the receiver and to keep the tension of the same regulated to any desired degree. It thus also becomes practicable to regulate the sensitiveness of the tube when used as a receiver for a wireless telegraph apparatus.

In Fig. 3 I show another construction of detector for electromagnetic waves embodying my invention. The bulb 7 of glass or other material has a neck 27 provided with a tube 28 sealed in the neck and terminating in a small glass sphere 29. On the exterior of the neck is a coating of some conducting material, as for instance, graphite encircling which is a band 30 to which connection is made to any generator, as for instance, the secondary 31 of a potential raising transformer having its primary 32 connected to a very high frequency alternating current generator 33. The space comprising the neck, tube and sphere constitute an independent compartment or space which contains a moderately rarefied and highly conducting gas. The globe or bulb 7 itself is exhausted to a very high degree and preferably has an exterior band 34 connected to that terminal of the secondary 31 opposite the terminal which is connected to the band 30 so as to complete a circuit for the high tension and high frequency currents. The currents act inductively through the coating 27 upon the gas inclosed in the neck in which it acts by induction upon the gas contained in the bulb 7 and thence inductively to the band 34 to complete the circuit. In the bulb 7 a brush discharge or effect will be observed, which brush is exceedingly sensitive to magnetic influence or to an electric disturbance or influence of any character to which it may be subjected and will change its position in response to the action of that influence or disturbance. On the exterior of the bulb is a conductor 36 which is connected into the receiving circuit by which the electromagnetic waves are received for action upon the detector. Such receiving circuit is here typified as the receiving antenna 9 and ground connection 9′ of a wire-

less telegraph apparatus. Normally the brush will occupy a particular position or zone in the bulb, but upon the reception of the electromagnetic waves in the circuit 9, 9′, its position will be disturbed and thereby the condition of any indicator, visual, audible or of other character in the circuit of said brush and the generating coil 31, will be affected. Such an indicating instrument may be an audible instrument like the telephone 10, here shown as connected directly into the circuit of the brush. In normal operation the telephone will give forth the sound characteristic of the high tension and high frequency currents flowing from the coil 31 and through the band 34, but a sensible difference in their loudness will be observed by displacement of the brush by the action of the received electromagnetic waves.

Obviously the indicating instrument might be connected in other ways to the circuit so as to respond to any change in position of the brush consequent upon the action of the electromagnetic waves operating on the brush through the presence of conductor 36. The degree of vacuum in the bulb 7 necessary to stability of action and adjustment is maintained in the manner already described by the automatic feed of a gas into said bulb from a body of gas maintained at greater density than that of the vacuum. Obviously, devices of the same character might be used for maintaining the desired degree of gaseous tension in the neck 27 and tube 28. The automatic feed is shown as being produced by the action of an automatic magnetic feed employing a valve in the manner already set forth in connection with Fig. 1.

In Fig. 4 I show my invention as embodied in a standard arrangement of devices for generating electromagnetic waves by oscillatory discharge of a condenser across a spark gap. The generated waves are shown as being utilized through the antenna and ground connection of an ordinary wireless telegraph, but obviously might be employed in other ways. The bulb or globe 7 of glass has sealed in it proper discharge points or balls 6′, which are set at a proper distance apart to allow the discharge of the condenser 40 to take place disruptively through the tenuous gas separating the electrodes or balls 6′. The charging of the condenser is effected by the usual transformer 41 connected to any source of alternating current, and the effects of the oscillatory discharge may be transferred through transformer 42 for impression upon the circuit 9, 9′ in the usual way. The vacuum in the tube 7 may be maintained at the adjusted tension by the operation of the automatic gas feed devices already described, and since the resistance across the spark gap may be thus maintained at any desired degree, a regular and reliable effect may be obtained in the production of the electromagnetic waves due to an oscillatory discharge. Moreover, the vacuum may be maintained at such degree as to facilitate the discharge and thereby give rise to greatly increased effects. It also becomes possible by varying the vacuum, which may be accomplished through adjustment of the feed, as already explained, to vary the wave length of the waves produced and to vary the pitch or tone which is a valuable feature adapting my invention particularly to use in syntonic systems of wireless or space telegraphy or telephony.

In some cases the vacuum tube containing the gas through which the electric discharge takes place may have electrodes of such character that the operation of the tube produces an increase of the gaseous tension therein.

What I claim as my invention is:

1. In a wireless telegraph, a vacuum tube receiver and a circuit independent of the receiving circuit and made up in part of gas or vapor varying in tension with that in the receiving circuit and an automatic valve for admitting gas to said receiver to maintain the condition of the vacuum.

2. An electric wave detector consisting of a vacuum tube the tenuous gas in which provides a circuit responsive to the received electromagnetic waves, and an indicating instrument connected thereto, a gas tension regulating circuit and electrodes separated from one another in said gas and forming a path for a continually flowing current in said regulating circuit as and for the purpose described.

3. The combination of an electric wave detector comprising a vacuum tube whose gas forms a part of an electric circuit, with a regulating circuit independent of that for the electric waves and means responsive to variations in the resistance of the gas or vapor in said regulating circuit for automatically feeding gas to said tube to keep the gas tension and resistance of the tube constant, as and for the purpose described.

4. The combination with a vacuum tube whose gas or vapor forms a path for an intermittently flowing electric current, of a regulating circuit including the gas or vapor and forming the path for a continually flowing electric current and means responsive to changes in the resistance of the gas in the regulating circuit for automatically feeding gas to the tube.

5. The combination with a vacuum tube through which electric current flows intermittently, of feed devices for feeding gas

or vapor to said tube and a regulating magnet responsive to variations in a current flowing continually through a circuit independent of that for the intermittently flowing current and which includes a body of gas whose tension partakes of the tension of the gas in the gas path through which the current flows intermittently.

Signed at New York, in the county of New York and State of New York, this 30th day of March, A. D. 1906.

DANIEL McFARLAN MOORE.

Witnesses:
C. F. TISCHNER, Jr.,
LILLIAN BLOND.