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SPARK GAP FOR RADIOTONE WIRELESS TELEGRAPH SYSTEMS.

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**1,171,598.** Patented Feb. 15, 1916.

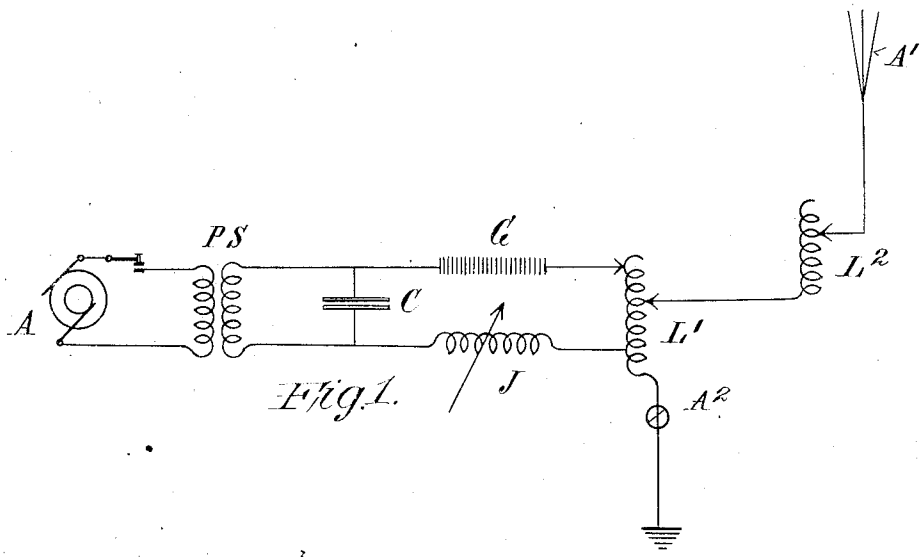



Fig. 1.

Fig. 2.

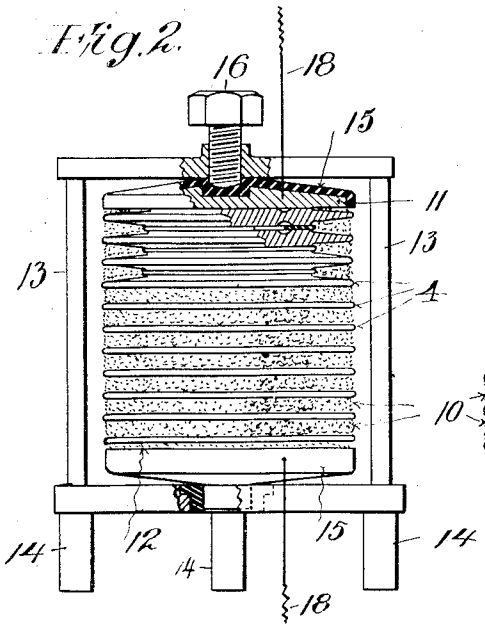
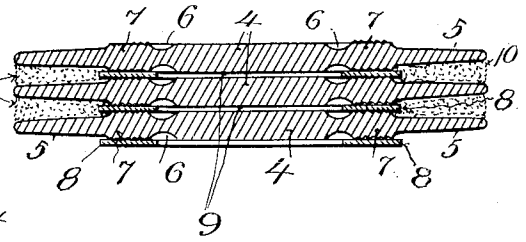



Fig. 3.




Witnesses:
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Inventor
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# UNITED STATES PATENT OFFICE.

LEE DE FOREST, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO RADIO TELEPHONE & TELEGRAPH COMPANY, A CORPORATION OF DELAWARE.

## SPARK-GAP FOR RADIOTONE WIRELESS-TELEGRAPH SYSTEMS.

1,171,598. Specification of Letters Patent. Patented Feb. 15, 1916.

Application filed March 10, 1910. Serial No. 548,485.

*To all whom it may concern:*

Be it known that I, LEE DE FOREST, a citizen of the United States, residing in the city, county, and State of New York, have made a certain new and useful Invention in Spark-Gaps for Radiotone Wireless-Telegraph Systems, of which the following is a specification.

This invention relates to apparatus for producing powerful electrical oscillations for use in the transmission of wireless signals.

The object of the invention is to provide a simple and efficient construction of spark gap for use in connection with wireless apparatus of the nature referred to.

The invention consists substantially in the construction, combination, location and arrangement of parts all as will be more fully hereinafter set forth, as shown in the accompanying drawing, and finally pointed out in the appended claim.

Referring to the accompanying drawing, Figure 1 is a view in diagram illustrating one arrangement of circuit connections with which a spark gap construction embodying the principles of my invention is well adapted for use. Fig. 2 is a view in elevation parts broken out and in section, showing a spark gap construction embodying the principles of my invention. Fig. 3 is a view in section showing a portion of the assembled electrode disks or plates composing the spark gap.

In the use of wireless apparatus, two lines of development have been pursued, one the spark system and the other the arc system of generating the waves to be radiated through space in the transmission of messages. Both these systems have their defects, among which, as regards the spark system may be mentioned the quick dampening of the radiated waves, and the consequent difficulties in close tuning, and in the case of the arc method the failure to secure efficient radiation of energy in proportion to the amount of energy required to effect the generation. Recent experimenters have proposed an intermediate system which has come to be known as the "singing spark method" wherein slowly damped waves are generated and radiated, thereby enabling tuning and interference difficulties to be eliminated, while at the same time permitting the attainment of great efficiency in the radiated energy, as compared with, or in proportion to, the energy consumed in effecting the generation thereof. In the singing spark method a great number of spark gaps are arranged in series with each other, and in the use of the apparatus shock excitation is accomplished and the sparks are quickly quenched thereby resulting in the generation and radiation of powerful slowly damped waves, which are heard in the receiving station or receiving instrument in the form of a high clear note capable of being easily heard and distinguished and by the use of which messages are easily received and accurately read. In the use of apparatus of this nature, however, great difficulties have been encountered. The spark in passing through the air gaps, from one to another of the plurality of electrode, tends to concentrate at one point on the surface of one or another of the electrode plates or disks thereby forming incrustations or projections in one or both surfaces of adjacent electrodes, the formation of which incrustations or projecting, mounds, pits, or the like, tending to still further concentrate the location of the sparks, with the result that irregularities in the action of the apparatus are encountered which greatly impair its usefulness and efficiency and necessitating frequent removals of the electrodes in order to clean or polish anew the surfaces thereof. Even with the use of flat surfaces, disks or plates, these difficulties were encountered and proved to be a serious obstacle to the attainment of satisfactory practical results, and threatened to seriously interfere with the attainment of practical success. It was proposed to obviate largely the troubles arising from the concentration of the sparks at one point on the surfaces of the electrodes by interposing mica washers as insulators between adjacent electrodes. This expedient I have found in practice to be inefficient, and unsuccessful in remedying the defect because of the fact that in the attainment of the best results exclusion of air from the space between the surfaces of the electrodes where the spark is to occur is essential and necessary, and that it is impossible to attain air tightness successfully and practically by the use of mica washers in this relation.

In carrying out my invention, and in order to attain the practical and successful exclusion of air from the spark gap I propose, in accordance with the principles of my inven-

tion, to interpose between the electrodes composing the spark gap of the singing spark system, suitable means and material to efficiently exclude the air from the gap. For this purpose I have found that the use of a resilient organic material, such for instance as a washer of fabric, suitably varnished or impregnated is efficient for the purpose. Any suitable or convenient material having a resiliency and capable of a desirable degree of compression when the plates or electrodes composing the spark gap are pressed tightly together in assembled relation, with the resilient washers interposed therebetween, may be employed. In my practical work I have found that varnished or impregnated linen used in this relation well answers the desired purposes. I have also found that when electrodes are used which are in the form of superimposed disks or plates, a filling of paraffin, beeswax or similar materials, or suitable mixtures thereof, applied between the rims or in the spaces between the peripheral edges of the plates or disks also produces excellent results in attaining the desired exclusion of air from the spark gap. It is obvious that the substance or material employed, whether in the nature of a washer interposed between the adjacent surfaces of the electrodes, or in the nature of filling material interposed or inserted between the rims or peripheries of the plates or disks forming the spark gap, must be of such nature and characteristics as to secure insulation and to resist the puncturing action of the current employed to generate the sparks, since the puncture of the interposed washers or air excluding filling would result in the formation of oxids of metals employed in the material of the electrodes or other formations of projections or incrustations in the surfaces of the electrodes thereby causing the sparks to concentrate at the point where such incrustations are formed and hence disturbing and deranging the proper and orderly operation of the device, and consequently causing a failure of a quick quenching of the spark which is necessary in order to obtain a clear musical note.

In the accompanying drawing I have shown an arrangement embodying the principles of my invention wherein the spark gap is composed of a plurality of metal disks 4, superimposed or piled the one upon another. In practice I employ copper disks. Each disk is provided with a rim or peripheral portion 5 of less thickness than the body portion of such disk, and each disk is provided with a circular groove or channel 6 in each face thereof, the portions 7 of the disks encompassing the circular channels or grooves 6, constituting bearing portions of the disks when stacked or piled upon each other. It is between these portions 7 of the disks that I interpose washers or thin flat rings 8 of resilient or compressible material of suitable character to render the spaces 9 between the opposed faces of adjacent disks air tight. The thin flat washers or rings 8 may be as above indicated of any suitable or desired resilient yielding or compressible material, and while my invention as defined in the claim is not to be limited or restricted thereto, I have found varnished fabric suitable for the purpose. The space 9 between the opposed faces of adjacent disks when superposed upon each other, which faces comprise those portions of the disks encompassed by the circular grooves or channels 6, should be very slight. In practice the sparking takes place in the spaces 9 and between the opposed surfaces of the disks in these portions thereof encompassed by the circular grooves or channels 6.

I have been enabled to secure excellent results by employing 20 or 30 more or less of these gaps, 9 in series. The interposition of the soft yielding compressible washers or thin rings 8, as above described enables me to attain a substantially air tight spark gap arrangement thereby securing excellent and rapid spark quenching and avoiding the formation of incrustations at any point in the surfaces of the plates between which sparking occurs, and the formation of which points tend to concentrate the spark discharges thereon, thereby deranging the operation and proper functioning of the apparatus. I have also indicated a filler material 10 of beeswax, paraffin or similar compounds or mixtures thereof interposed between the peripheral rims or portions 5 of the disks as a means for also excluding air from the spark gaps.

In Fig. 2 I have shown an arrangement which I have found simple and efficient for assembling the disks for practical operation, wherein the disks 4 are held between heads 11, 12, mounted in the top and bottom of a frame work 13 which if desired may be supported upon insulating legs 14. The heads 11, 12 should be completely insulated as indicated at 15 from the frame 13. A screw 16 acting upon one of said heads, as head 11 for instance, serves to tightly clamp the plates or disks together in assembled relation. The leads 18 of the circuit connections are respectively connected to the heads 11, 12. By this specific structure I am enabled to economically manufacture the various parts comprising the spark gap and to efficiently and quickly assemble the same. It is obvious, however that in its broadest scope as defined in the claim my invention is not to be limited or restricted to the specific details of construction and arrangement.

In Fig. 1 I have shown a circuit arrangement suitably adapted for the purposes of my invention. In this view of the drawing reference sign A is the generator. In prac-

tice I prefer to employ an alternating current generator and I have found such a generator of 110 volts 480 cycles as sufficient for my purposes, though in these respects my invention is not to be limited or restricted. The circuit of the generator is, in the instance illustrated coupled through the primary and secondary coils P, S, of a transformer to a circuit in which the spark gap indicated at G is shunted by capacity indicated as a condenser C and an inductance J, shown as variable. The oscillating circuit may be coupled in any suitable or well known manner to an antenna system. I have shown an antenna system comprising the antenna $A^1$, a loading coil $L^2$ to which the antenna is adjustably connected, and a coupling coil $L^1$ to which the loading coil is adjustably connected and to which the oscillating circuit is also adjustably connected. If desired a current measuring instrument such as a hot wire or other form of ammeter $A^2$ may be included in the circuit of the antenna system.

While I have shown one arrangement of circuit connection suitable for use in connection with a radiotone spark gap embodying the principles of my invention I do not desire to be limited or restricted to the particular circuit arrangements shown, as many others may be equally well adapted for use in this connection.

Having now set forth the object and nature of my invention and having explained the construction, arrangement and mode of operation thereof what I claim as new and useful and of my own invention and desire to secure by Letters Patent is,—

In an apparatus for producing powerful electrical oscillations, a plurality of metal disks forming electrodes, and superposed upon each other, and soft compressible varnish fabric interposed between adjacent disks to form an air tight space therebetween.

In testimony whereof I have hereunto set my hand in the presence of the subscribing witnesses, on this 24th day of February A. D., 1910.

LEE DE FOREST.

Witnesses:
C. C. HUNICHE,
S. E. DARBY.