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F. BRAUN & R. H. RENDAHL.

APPARATUS FOR INCREASING THE DISCHARGE ENERGY OF ELECTRICAL VIBRATION SYSTEMS.

APPLICATION FILED APR. 22, 1904.

Fig.1.

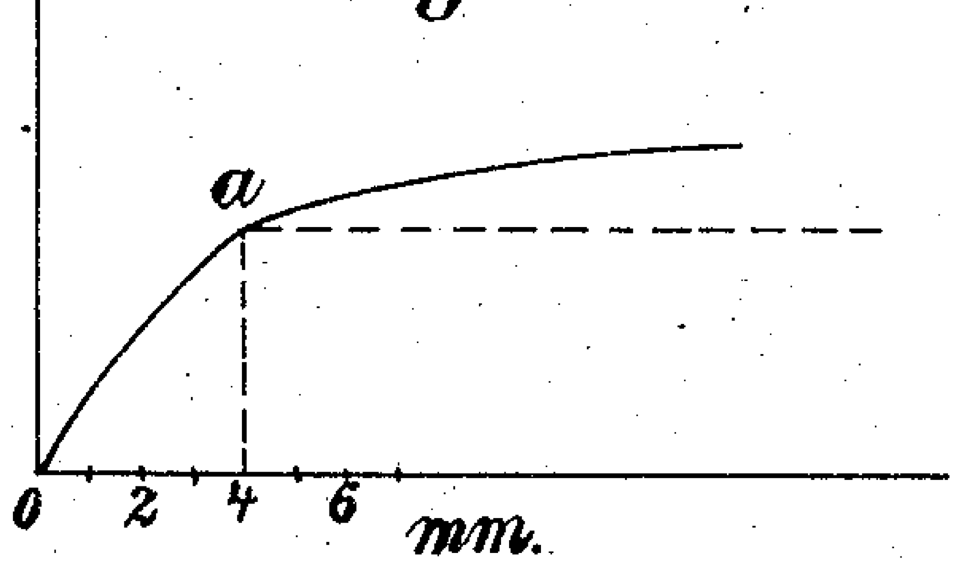


Fig 2.

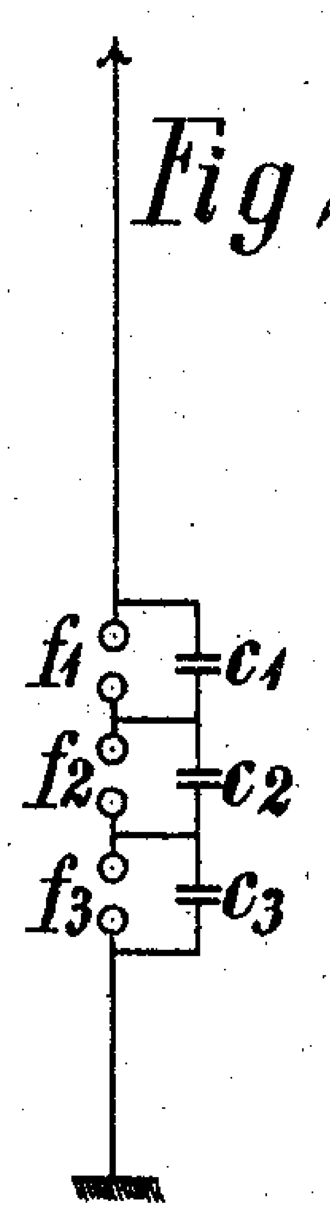


Fig.3.

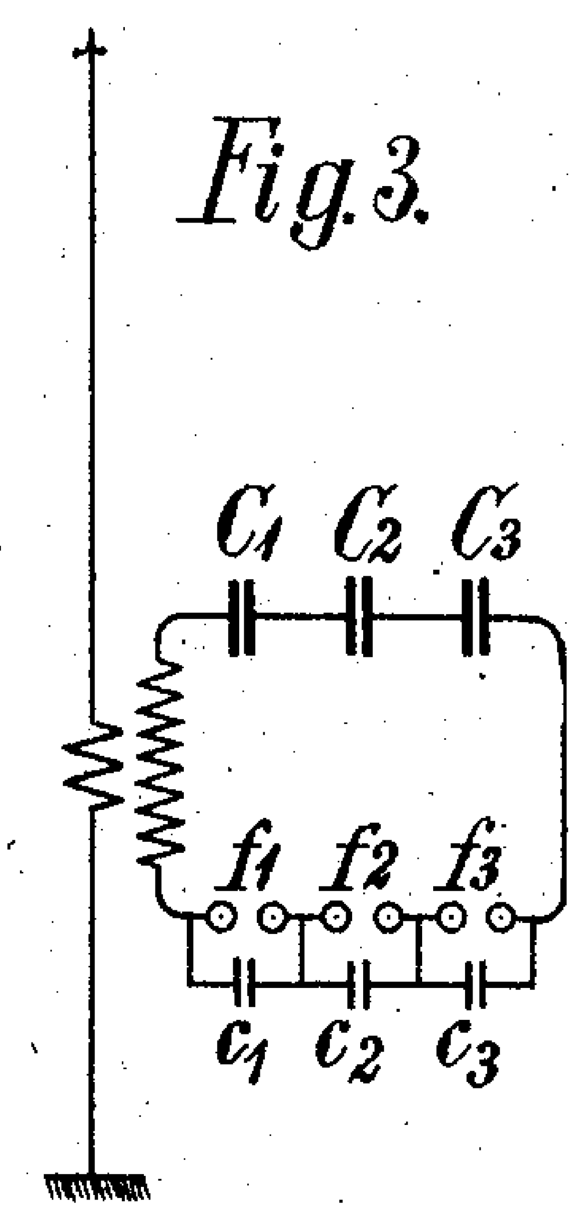


Fig.4.

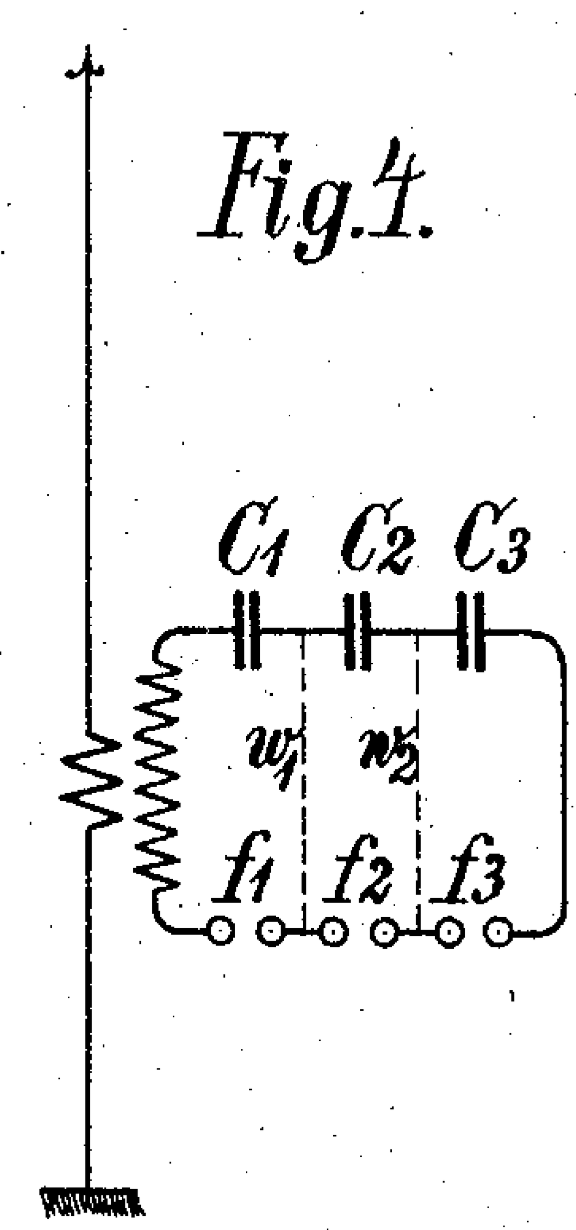


Fig.5.

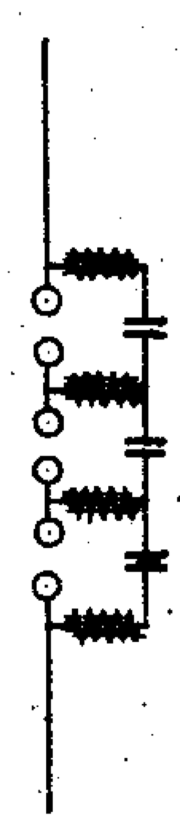
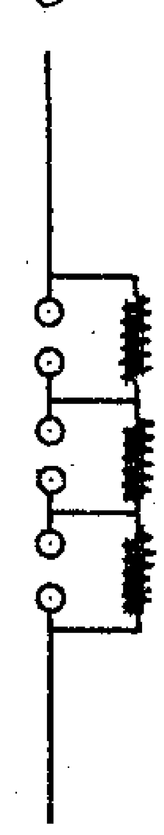


Fig.6.



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UNITED STATES PATENT OFFICE.

FERDINAND BRAUN, OF STRASSBURG, AND RAGNAR HÅKAN RENDAHL, OF BERLIN, GERMANY.

APPARATUS FOR INCREASING THE DISCHARGE ENERGY OF ELECTRICAL-VIBRATION SYSTEMS.

SPECIFICATION forming part of Letters Patent No. 790,250, dated May 16, 1905.

Application filed April 22, 1904. Serial No. 204,352.

To all whom it may concern:

Be it known that we, FERDINAND BRAUN, doctor of philosophy and professor, a subject of the German Emperor, residing at Strassburg, Alsace, Germany, and RAGNAR HÅKAN RENDAHL, engineer, a subject of the King of Sweden and Norway, residing at 13 Hollmannstrasse, Berlin, S. W., Germany, have invented a certain new and useful Improvement in Apparatus for Increasing the Discharge Energy of Electrical-Vibration Systems, of which the following is a full, clear, and exact description.

This invention relates to wireless signaling systems, and particularly to the transmitting apparatus thereof.

It relates especially to such transmitting apparatus in which more separate spark-gaps are contained in the oscillating system.

More particularly it relates to a disposition of means with relation to the spark-gaps by which the charge-potential is distributed adequate to the length of the spark-gaps, whereby the exciting energy is increased or the damping of the oscillating system is diminished.

It is well known that the exciting energy of the oscillating system can be increased by increasing the discharge-potential by enlarging the spark-gap; but in this way the limit is very soon reached. With the increase of the spark-gap the resistance of the same increases too quickly and out of proportion, thus resulting in great waste of stored energy in the spark itself. If the curve be taken in which the lengths of the sparks be entered as abscissæ and the potentials as ordinates, it is found that a curve results dependent on the actual construction each time of the spark-gap and essentially on the radius of curvature of the sparking pole, which curve, with a given length of spark, shows a critical point. The curve shown in the diagram Figure 1 indicates it at four millimeters. The point is indicated by *a*. This means that with an enlargement of the spark-gap beyond four millimeters the potential at the poles of the spark-gap no longer increases proportionately to the spark-gap, but more slowly. Measurements of resistance at the same spark-gap have also shown that the curve for this does not possess such a flaw, but that the resistance of the spark-gap always grows proportionately with the enlargement. From this it follows that it is impossible without great waste of energy (apart from the condition which is always assumed for the maximum ohmic resistance of vibration-circuits) to essentially enlarge the discharge energy by increasing the spark-gap. On the other hand, it is necessary to work only with such spark-gaps as lie beneath or little above the critical sparking length. This spark-gap may be termed the "unit" spark-gap. Now if while observing these proportions a simple spark-gap which is larger than is admissible according to the curve shown in Fig. 1 be divided into two separate spark-gaps connected in series which do not separately exceed the allowable limit a total potential is in general obtained by measurements which is smaller than the sum of the separate potentials to be expected. The cause of this is to be found in the distribution of the total potential over the separate spark-gaps not taking place without further action to the extent demanded by the separate spark-gaps on account of their sparking length. The following means remove this drawback.

Reference is had to the accompanying drawings, in which—

Fig. 1 is a diagram already referred to. Fig. 2 is a diagrammatic view of a simple transmitter for wireless telegraphy. Fig. 3 is a diagrammatic view of transmitter in combination with a closed exciting-circuit. Fig. 4 shows a modification of Fig. 3. Figs. 5 and 6 are views of spark-gaps in combination with different means for distributing the charge-potential.

In Fig. 2, which represents an open vibration system, (so-called "Hertz" system) the unit spark-gaps f' f^2 f^3 are supplied with potentials corresponding with their sparking tension by means of a parallel arrangement of condensers c' c^2 c^3 to each of the different spark-gaps. These condensers have comparatively a very small capacity. Generally about one hundred centimeters suffice, The size of the condensers is such that the potentials arising in them are proportionate to those of the sparking lengths to which each separate spark-gap is to be charged. As the spark-gaps are of equal length, the condensers are therefore uniform. By means of this sparking and potential distribution it is possible to bring into play extraordinarily high discharge-potentials, and therefore considerably increased discharge energy, in any suitable vibration systems—for instance, also in a so-called "open" or Hertzian vibration system, as here shown—without diminishing the degree of effectiveness.

In the transmitter shown in Fig. 3 the aerial wire is excited by a closed oscillating circuit, which contains the condensers C' C^2 C^3 and several spark-gaps f' f^2 f^3. In this case the total potential of the three serial spark-gaps is distributed in a correct manner also by means of condensers c' c^2 c^3. On account of their extraordinarily small capacity the energy which is self-accumulated in these is so small that it may be neglected as compared with that accumulated in C' C^2 C^3. It also follows from the small size of the condensers c' c^2 c^3 that their own inherent vibrations over the spark-gaps f' f^2 f^3 are different in size from the fundamental vibration of the exciting-circuit, and therefore do not influence the inherent number of vibrations of the main circuit. In order, however, to entirely remove any possibility of this, ohmic resistances or coils of higher self-induction may be inserted in the intermediate wires from the spark-gap to the potential-distributers, as shown in Fig. 5, which insertions are admissible for the slower charging vibration of the source of high potential, but not for the rapid discharging vibrations. The suitable distribution of the charge-potential over the spark-gaps may also be obtained by means of the larger condensers C' C^2 C^3, contained in the oscillating circuit, as shown in Fig. 4.

By means of large ohmic or inductive resistances w' and w^2 points between the condensers C' C^2 C^3 are connected with points between the spark-gaps f' f^2 f^3. Thereby before starting the discharge the potential differences between the condensers are transmitted to the electrodes of the spark-gaps, and therefore all of the separate spark-gaps act simultaneously at their discharge. The distribution of potential may also be attained, as easily seen, by utilizing self-induction coils which are connected with one another in series in place of the condensers c' c^2 c^3, parallel to each of the partial spark-gaps, as shown in Fig. 6. This method is, however, but little practicable. The secondary self-induction of the inductor or transformer charging the main condensers (condensers C' C^2 C^3, Fig. 3) is, in fact, always so calculated that it yields in conjunction with the capacities C' C^2 C^3 a number of inherent vibrations, which number is identical with the periods of the primary inductor or transformer current. Where self-induction coils are used as potential-distributers, the resultant self-induction of these is connected in parallel to that of the secondary inductor-coil, whereby the resonance of the transformer and the inductor is destroyed, while retaining the primary alternating-current frequency.

Means of more efficiency in place of the condensers c' c^2 c^3 may consist of large ohmic resistances, which, like the said condensers, may be arranged directly parallel with the respective spark-gaps.

It is without further comment clear that by the before-described means shunted to the separate spark-gaps all of the unit sparks act simultaneously in common circle at their discharge.

Having thus described our invention, the following is what we claim as new therein and desire to secure by Letters Patent:

1. An electrical oscillating system consisting of an oscillating circuit containing several spark-gaps and electrical means of good conductivity for the charge-potential and of small conductivity for the discharge vibrations shunted to the separate spark-gaps for distributing the charge-potential over the separate spark-gaps.

2. An electrical oscillating system consisting of an oscillating circuit containing several spark-gaps, capacities and means of small conductivity for the rapid discharge vibration shunted to the separate spark-gaps for distributing the charge-potential over the separate spark-gaps.

3. An electrical oscillating system consisting of an oscillating circuit containing several spark-gaps, and small capacities of small conductivity for the rapid discharge vibrations shunted to the separate spark-gaps for distributing the charge-potential over the separate spark-gaps.

4. An electrical oscillating system consisting of an oscillating circuit containing several spark-gaps, and high self-inductions of small conductivity for the rapid discharge vibrations shunted to the separate spark-gaps for distributing the charge-potential over the separate spark-gaps.

5. A transmitter for wireless telegraphy consisting of an aerial conductor containing several spark-gaps in series, and electrical means of good conductivity for the charge-potential and of small conductivity for the discharge vibrations shunted to the separate spark-gaps for distributing the charge potential of the aerial conductor over the separate spark-gaps.

6. A transmitter for wireless telegraphy consisting of an aerial conductor containing several spark-gaps in series, and small capacities of small conductivity for the dis-

charge vibrations of the aerial conductor shunted to the separate spark-gaps for distributing the charge-potential of the aerial conductor over the separate spark-gaps.

7. A transmitter for wireless telegraphy consisting of an aerial conductor in connection with a closed exciting-circuit containing several spark-gaps and means of good conductivity for the charge-potential and of small conductivity for the discharge vibrations of the closed exciting-circuit shunted to the separate spark-gaps.

8. A transmitter for wireless telegraphy consisting of an aerial conductor in connection with a closed exciting-circuit containing several spark-gaps, condensers and means of small conductivity for the discharge vibrations of the closed exciting-circuit shunted to the separate spark-gaps.

9. A transmitter for wireless telegraphy consisting of an aerial conductor in connection with a closed exciting-circuit containing several spark-gaps and small capacities of small conductibility for the discharge vibrations shunted to the separate spark-gaps.

10. In an electrical oscillating system, the combination of a plurality of separate spark-gaps in series, of means for charging each separate spark-gap with a potential corresponding to the spark tension of that spark-gap.

In witness whereof we hereunto subscribe our names this 12th day of March, A. D. 1904.

FERDINAND BRAUN.
RAGNAR HÅKAN RENDAHL.

Witnesses:
GUSTAV SCHWEISS,
D. BRANDER.