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E. L. OVINGTON.

ELECTRIC SPARK GAP OR INTERRUPTER.

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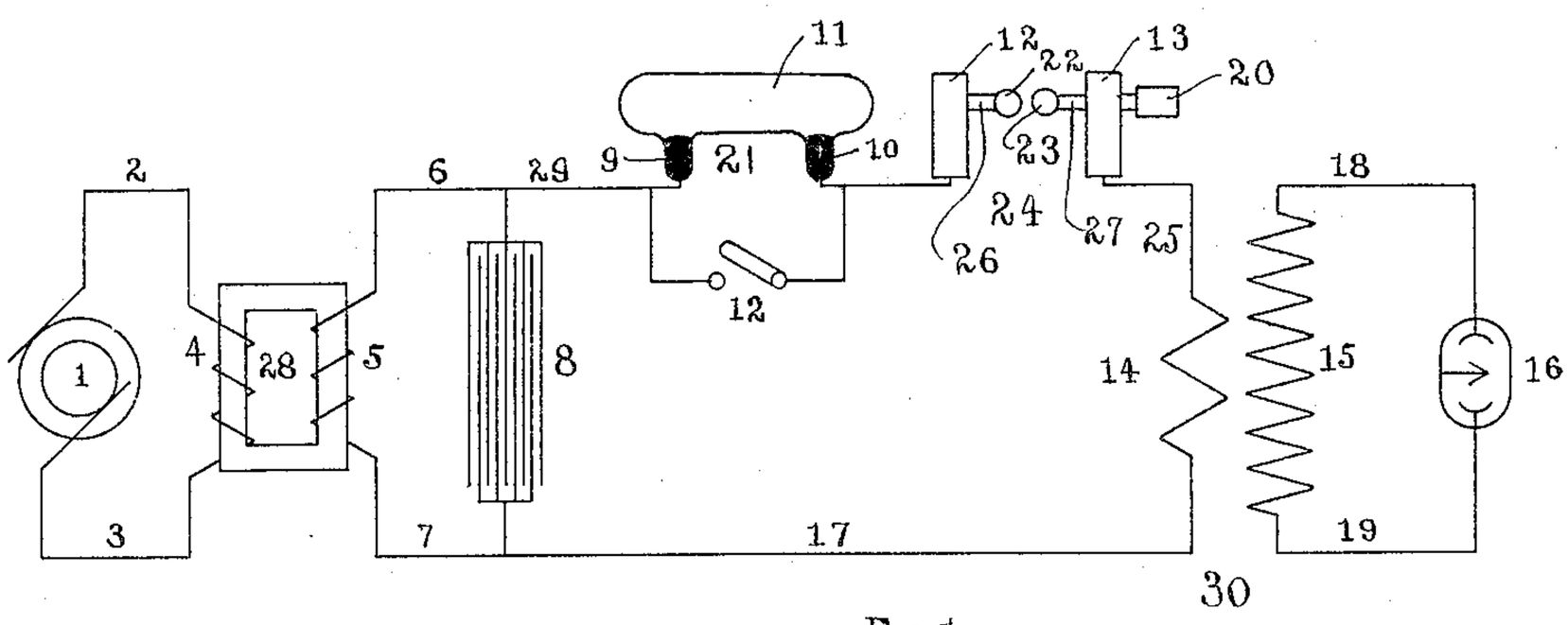

FIG. 1.

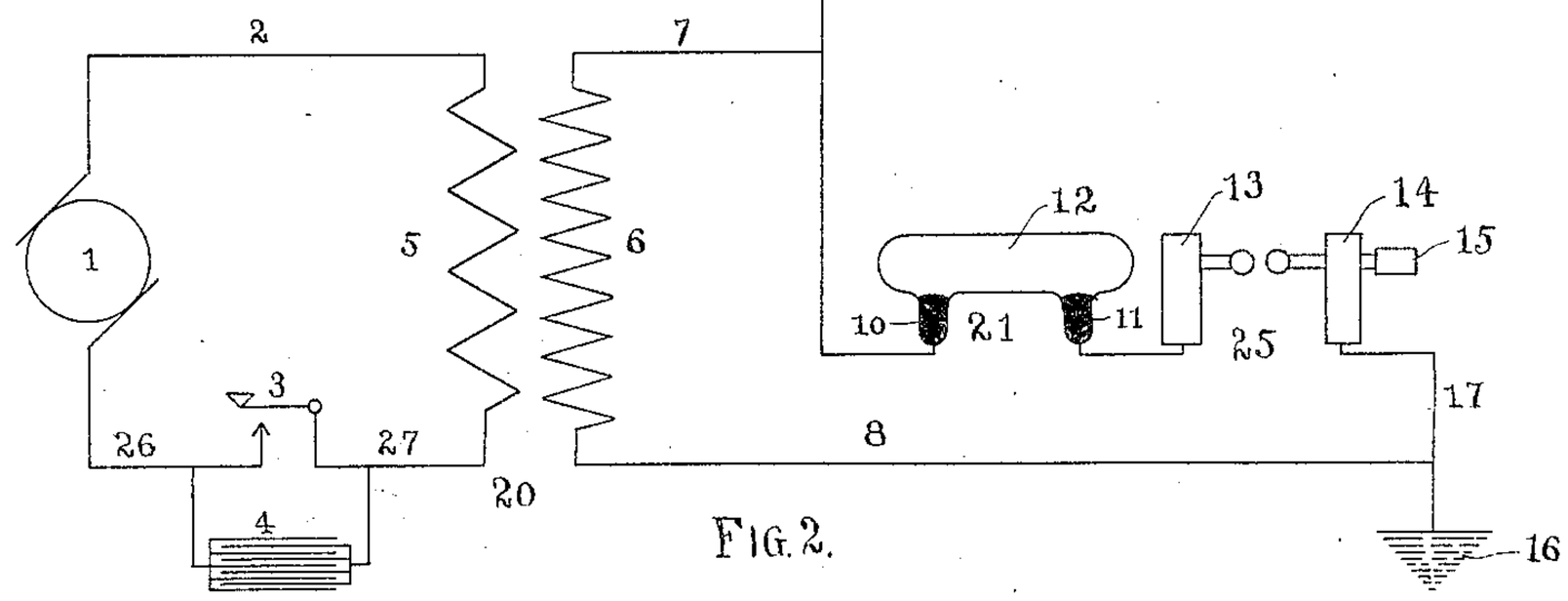

FIG. 2.

Witnesses
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UNITED STATES PATENT OFFICE.

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ELECTRIC SPARK-GAP OR INTERRUPTER.

SPECIFICATION forming part of Letters Patent No. 790,975, dated May 30, 1905.

Application filed February 11, 1905. Serial No. 245,299.

To all whom it may concern:

Be it known that I, EARLE L. OVINGTON, a citizen of the United States, and a resident of Boston, in the Commonwealth of Massachusetts, have invented certain new and useful Improvements in Electric Spark-Gaps or Interrupters, of which the following is a specification.

The invention which forms the subject of my present application relates to that class of electrical apparatus employed to generate currents of high frequency by disruptively discharging a condenser under suitable conditions.

The object of my invention is to provide a more efficient and satisfactory spark-gap or interrupter than has heretofore been employed in connection with apparatus of this class. I accomplish this object by combining and using in a novel manner two well-known forms of spark-gaps or current-interrupters, the combination being more efficient and flexible than either interrupter would be if used alone. Each interrupter when used alone has certain marked disadvantages, which limit its application in high-frequency apparatus. On account of the different nature of the interrupters, based, as they are, on entirely different fundamental principles, these disadvantages are characteristic of each particular form of interrupter, a difficulty met with in the operation of one not being apparent when employing the other. I have discovered that by combining the two forms as outlined in this invention an interrupter is obtained which not only possesses none of the disadvantages above referred to, but which has certain desirable features peculiar to itself.

The ideal spark-gap or current-interrupter for use in high-frequency circuits should possess the following characteristics:

First. A comparatively high and constant initial resistance before the disruptive discharge has occurred. This allows the condenser to charge to a high and well-defined potential on each current-wave.

Second. An extremely low resistance immediately after the occurrence of the disruptive discharge. The heating losses, and the consequent damping of the oscillatory current surging across the gap, are proportional to the resistance of same. A low resistance means small heating losses, and consequently an oscillatory current which vibrates persistently.

Third. The continuance of the condition of low resistance until the electric stress at the surface of the electrodes is reduced to a small percentage of its initial value. This allows the oscillations of the current to slowly die out or decay in a natural manner and not be prematurely interrupted by the opening of the circuit, due to the untimely rise in resistance of the gap.

Fourth. The ability of almost instantly reaching the condition of high resistance the moment the electric stress at the surface of the electrodes reaches a certain small percentage of its original value. This prevents the discharge of the condenser occurring at some point below the potential fixed by the initial high resistance of the interrupter, and hence allows the condenser to become fully charged before discharging. It also prevents the low-frequency current of the charging source from flowing across the gap and preventing clear and distinct oscillations of the current.

Fifth. A means of varying the initial high resistance of the interrupter, and consequently to control the potential to which the condenser is charged. This is important, since the energy of discharge of a condenser of constant capacity varies as the square of the potential to which it is charged. Variation of the discharge potential of the condenser provides, therefore, a method of regulating the energy of each wave-train and also furnishes a method of governing the number of times the condenser is charged per unit time, assuming the charging energy to be constant.

The mercury interrupter possesses in a marked degree the first, second, and fourth characteristics above mentioned. It is decidedly lacking in the third, since it recovers its original high resistance at the slightest diminution of the electric stress at the surface of its electrodes. It is entirely lacking in the

fifth characteristic, since the potential at which the disruptive discharge occurs is fixed during the construction of the interrupter and is a function of the degree of vacuum of same.

The ordinary spark-gap, comprising conducting-electrodes separated by an intervening dielectric, possesses to only a limited degree the first and fourth character of the ideal gap. This is due to the tendency of the dielectric to become more or less permanently ionized, making its point of initial high resistance uncertain and its ability of rapidly regaining this point precarious. The ordinary gap does possess, however, the third and fifth characteristics in a marked manner. Now these two features are exactly what is lacking in the mercury interrupter. Thus it is evident that the desirable characters which one interrupter lacks the other possesses, and vice versa.

I have made the discovery that if the two interrupters be used together in series with each other, a combined interrupter is produced which possesses to a great extent all of the above-enumerated desirable characteristics which go to make up the ideal current-interrupter or spark-gap for use in apparatus of the class we are considering.

I have confirmed my theory by experiments ard have found that by using the combined interrupters in the manner contained in this specification I produce a device which yields results superior to anything heretofore produced.

Referring to the accompanying drawings, Figure 1 represents one manner in which my invention may be used in connection with high-frequency apparatus for therapeutic and other use, while Fig. 2 shows its application to a simple form of wireless-telegraph transmitter.

I would state that as all of the apparatus herein shown is or may be of well-known construction I have indicated such well-known parts therefore by conventional representations. As a mercury interrupter I have shown in a conventional manner a common form of mercury-vapor gap, such as used in connection with apparatus of this class. My invention applies equally well, however, to any interrupter employing mercury as its electrodes, although its use is particularly advantageous when used in conjunction with a mercury-vapor gap, as described.

Referring to Fig. 1, 1 is a source of energy here shown as an alternating-current generator. The primary 4 of a transformer 28 is connected with 1 by means of conductors 2 and 3. The secondary 5 of transformer 28 is connected by conductors 6 and 7 with the opposite sides of condenser 8. A conductor 29 connects one side of the condenser 8 with the mercury-vapor gap 21. As shown, this gap is a vessel 11, usually made of glass, which has been exhausted to a high vacuum. Platinum leading-in wires have been sealed into this vessel and the same covered with mercury 9 and 10, as shown. The other side of the vapor-gap (marked 10) is connected with one terminal of the air spark-gap 24. In the drawings I have shown this as a support 12, a rod 26 bearing a sphere 22. A somewhat similar arrangement forms the other terminal of this gap, except that the rod 27 slides in the support 13, thus enabling the distance between the spheres 22 and 23 to be adjusted. An insulating-handle 20 provides a safe method of adjusting this gap. The support 13 is connected by conductor 25 with the primary 14 of a disruptive-discharge transformer 30. The other side of the primary 14 of transformer 30 is connected by conductor 17 with the condenser 8, as shown. A translating device, here shown as an X-ray tube 16, is connected by conductors 18 and 19 with the secondary 15 of the disruptive-discharge transformer 30. As shown in the drawings, a switch 12 is so arranged that the mercury gap may be cut out of circuit at will. This provides a means of utilizing the air gap 24 separately, if desired. A similar switch could be placed so that the vapor gap 21 could be used singly, if it was found advisable.

Referring to Fig. 2, 1 is a source of electric energy, here shown as a direct-current generator. The primary 5 of a transformer or induction-coil 20 is connected with the source of energy 1 by the conductors 2, 26, and 27, and telegraphic key 3. A condenser 4 bridges this key, as is customary. One side of the secondary 6 of the transformer 20 is connected by conductor 7 with the antenna or elevated conductor 9, the other side of the secondary of the transformer being connected by conductor 8 with the ground connection 16. The vapor gap 21 and the air gap 25 are connected in series, as shown, between the elevated conductor 9 and the ground connection 16.

I do not mean to imply by the terms employed in describing my improvement that I limit myself to the use of any particular spark-gap which I place in series with the mercury interrupter. I have made the discovery that if any spark-gap other than one employing mercury in a vaccum as its electrodes be placed in series with the mercury interrupter a decided improvement will result. The good points of each gap seem to be preserved and the undesirable features eliminated, thus affording an ideal method of interrupting the currents in the discharge-circuits of a high-frequency apparatus.

The difficulties encountered in the use of the mercury interrupter alone are due to the fact that the electrodes of this gap are mercury in a vacuum. Certain phenomena, briefly described above and undesirable in connection with high-frequency apparatus,

are present when such an interrupter only is employed. I have made the discovery that the above undesirable phenomena are not present if in series with the mercury interrupter is placed a spark-gap or interrupter which does not employ as electrodes mercury in a vacuum.

It is a matter of common knowledge that two ordinary spark-gaps have been used in series connection with an object foreign to the spirit of my invention; but I believe myself to be the first to employ in combination a mercury interrupter and one which does not have as electrodes mercury in a vacuum, the object being to produce an interrupter which preserves the advantages and eliminates the disadvantages of each when used separately.

In referring to high-frequency circuits in this specification I not only include apparatus designed for therapeutic or other use, but that designed for use with wireless telegraphy as well. I include all forms of high-frequency apparatus employing the disruptive discharges of a condenser and an interrupter producing such disruptive discharge.

Throughout this specification I have used synonymously the words "spark-gap" or "gap" and "interrupter," although, strictly speaking, the mercury interrupter is not a spark-gap, since no actual spark occurs. By "mercury interrupter" I imply any form of interrupter which employs as its electrodes mercury, either in a vacuum or otherwise.

It is the peculiar and undesirable characteristics of the mercury when same is used as electrodes in an interrupter which my invention aims to eliminate.

Having thus explained the nature of my invention and described a manner of using same, although without attempting to set forth all of the ways in which it may be used, what I claim as new, and desire to secure by Letters Patent, is—

1. The interrupter herein described, comprising in combination a mercury interrupter, and a spark-gap or interrupter other than one employing mercury in a vacuum as its electrodes, same to be placed in series with said mercury interrupter, substantially as set forth.

2. The combination of a mercury interrupter and a spark-gap in series with same, said spark-gap or interrupter to be one in which mercury in a vacuum is not employed as electrodes, substantially as set forth.

3. The interrupter herein described, comprising in combination a mercury interrupter, and a spark-gap in series with same, said spark-gap consisting of conducting-electrodes separated by a dielectric, the thickness of the dielectric being variable, substantially as set forth.

4. The combination of a mercury interrupter and a spark-gap consisting of conducting-electrodes, the distance between which may be altered, said spark-gap being in series with the mercury interrupter, substantially as set forth.

5. The combination of a high-frequency apparatus employing the disruptive discharge of a condenser, an interrupter producing the disruptive discharge, said interrupter comprising a mercury interrupter, in series with which is placed a spark gap or interrupter not employing as electrodes, mercury in a vacuum, substantially as set forth.

6. The combination of a high-frequency apparatus employing the disruptive discharge of a condenser, an interrupter producing the disruptive discharge, said interrupter comprising a mercury interrupter in series with which is placed a spark-gap, said spark-gap consisting of conducting-electrodes separated by an intervening dielectric, the thickness of the dielectric being variable, substantially as set forth.

In testimony whereof I have affixed my signature in presence of two witnesses.

EARLE L. OVINGTON.

Witnesses:
WM. O. EDDY,
E. J. OVINGTON.