Aug. 6, 1929. E. F. W. ALEXANDERSON 1,723,908

IGNITION SYSTEM

Filed June 14, 1926

Fig. 1.

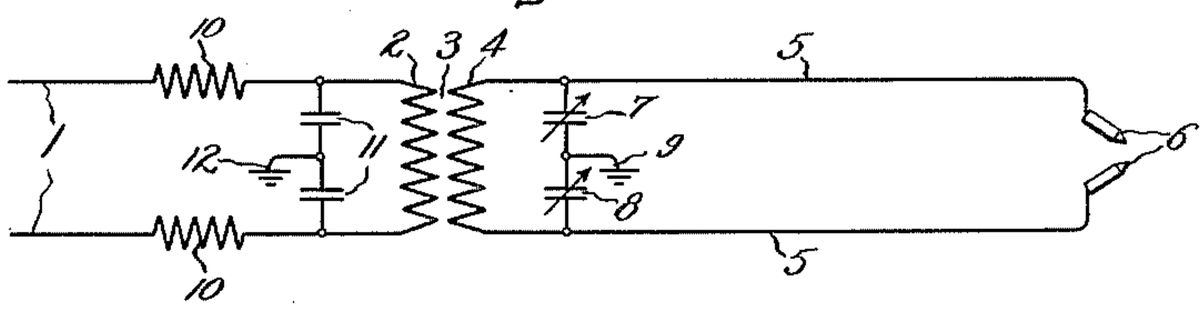


Fig. 4.

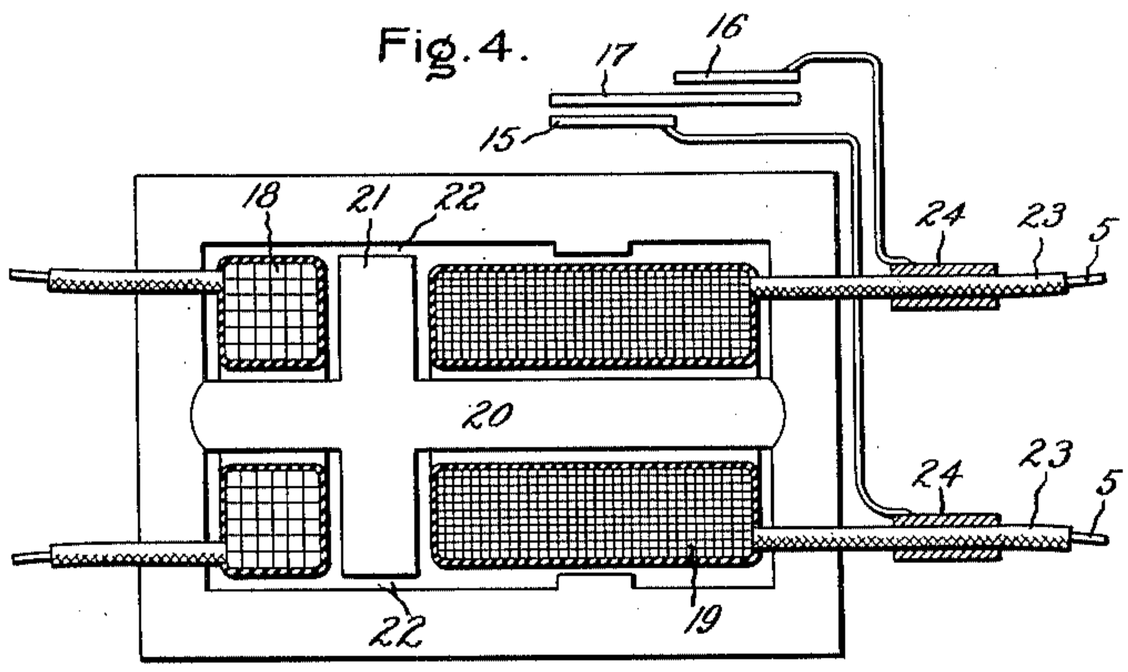


Fig. 3.

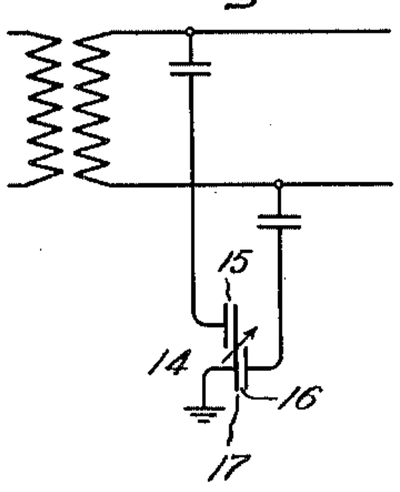
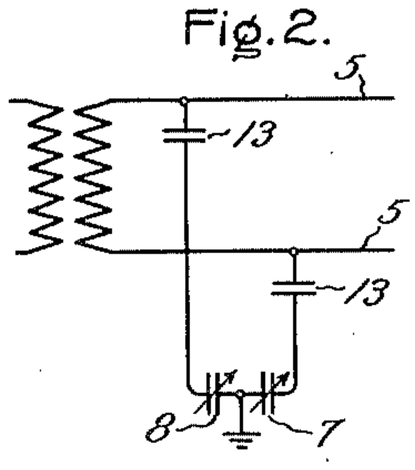


Fig. 2.



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UNITED STATES PATENT OFFICE.

ERNST F. W. ALEXANDERSON, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

IGNITION SYSTEM.

Application filed June 14, 1926. Serial No. 115,769.

My present invention relates to ignition systems of the general type in which a gas or vapor is ignited by means of an arc or spark discharge passing across a discharge gap.

It is well known that when a discharge takes place across a gap between two electrodes, high frequency oscillations will be produced in the circuit connected to the electrodes, the frequency of the oscillations being dependent upon the constants of the circuit. Much trouble has been experienced with such systems in the past because of the fact that the high frequency currents produced in this way have interfered with radio reception in the near neighborhood, or even at some distance from the point at which the discharge takes place due to the high frequency currents being supplied to the distribution circuit by means of which current is supplied to the discharge gap.

Such systems usually include a step-up transformer connected to a comparatively low potential alternating distribution system. Unless means is taken to prevent it, the high frequency currents may be supplied through the transformer to the distribution system and distributed over a considerable area to such an extent as to interfere with the operation of radio receivers. This type of interference may be due to radiation of high frequency energy from the distribution system, or to inductive effects which may be present when the radio receiver is located near a conductor of the distribution system. Disturbance may also be caused by radiation of high frequency energy from the high potential conductors connecting the transformer and the discharge gap. The object of my invention is to provide a system in which both forms of disturbance with radio reception may be prevented.

The first form of disturbance may be largely minimized by providing suitable chokes or filters in the low tension distribution system closely adjacent the transformer. The second form of disturbance is somewhat more difficult to avoid. If the leads connecting the high potential windings of the transformer and the discharge gap are closely adjacent one another and parallel it would appear that radiation from the two leads would be neutralized since the current at any instant is flowing in opposite directions in the two leads. I have found, however, that in actual practice it is very difficult to provide a system in which this theoretical condition is obtained. If the capacities between the two conductors and ground are unequal then a greater amount of radiation will take place from one than the other and complete neutralization will not be obtained.

In carrying my invention into effect, I provide means whereby the capacities to ground of two conductors may be balanced in such a way that radiation of high frequency energy will be prevented.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation will best be understood by reference to the following specification taken in connection with the accompanying drawing in which Fig. 1 shows diagrammatically a circuit arrangement which may be used in carrying my invention into effect; Figs. 2 and 3 show modifications in the circuit arrangement; and Fig. 4 is a partially diagrammatic view of a transformer which is specially suitable for use in connection with my invention together with a portion of the circuit connections which may be employed therewith.

I have indicated in Fig. 1 low tension supply conductors 1 for supplying current to the primary 2 of a step-up transformer 3. The secondary winding 4 of this transformer is connected by the leads 5 to the electrodes 6 of a discharge gap. Variable condensers 7 and 8 are connected between each of the supply conductors 5 and ground at 9. By adjusting the relative capacities of condensers 7 and 8 I have found that the system may be balanced in such a way that substantially no radiation of high frequency energy from the conductors 5 will be produced. I have found in fact that the system may be so adjusted that a very sensitive radio receiving set may be operated within a few feet of the conductors 5 without any disturbance whatever.

Choke coils 10 are preferably provided in the low tension circuit to prevent any high frequency currents which are transmitted through the transformer from flowing out

over the low tension distribution system. Shunt condensers 11 connected to ground at 12, serve to bypass any high frequency current which may be transmitted through the transformer.

It will be evident that the paths through condensers 7 and 8 to ground, serve to balance and render electrically symmetrical the ignition circuit 5, 5, 6, so that the high-frequency pulsations radiated from one side of the said circuit are exactly balanced and neutralized by the pulsations radiated from the other side of the spark-gap or ignition circuit. The term "electrically symmetrical" is employed to designate a condition of circuit in which each side thereof has precisely the same electrical characteristics. Under this condition, it is apparent that the phases of the high-frequency oscillations radiated from opposite sides of the line, as stated hereinbefore, would be displaced from one another 180° and as such, would be completely balanced or neutralized in so far as disturbing effects on neighboring radio sets and other delicately responsive impulse receiving apparatus, are concerned. In practice, it generally happens that the electrical characteristics of each side of the circuit 1, 10, 10 connected back to the source of energy to ground, is so greatly unequal and out of balance, which may be caused, for example, by faulty design of the generator, as to render it virtually impossible for condensers 7 and 8, preferably of a commercial size and type, to restore and maintain an over-all symmetry of the entire circuit 1, 10, 5, 6, 5, 10, 1. In that event, it may be necessary to separate, as far as possible, the source of energy portion of the circuit from the spark-gap or load portion and this may be conveniently accomplished by interpositioning a transformer between the respective portions of the circuit. The same transformer which provides the step-up voltage may also serve to isolate the two portions of the circuit to a sufficient degree whereby the secondary circuit may be rendered substantially symmetrical irrespective of the electrical constants of the primary circuit. When a transformer or other circuit-separating member is employed, the condensers 7 and 8 are called upon to balance and produce electrical symmetry only in the secondary circuit, 5, 5, 6, although it is to be understood that the separation of the circuits is merely an expedient method of obtaining the proper balance of circuit characteristics without the necessity of employing unusually large balancing elements and if desired, I may obtain symmetry of the entire circuit 1, 10, 5, 6, 5, 10, 1 by suitable means. From the foregoing, it will also be evident, that even if the potential of the source of energy is sufficiently high, as not to require a voltage step-up device, which, however, is contrary to the usual practice, it may still be desirable to employ a transformer of unity transformation in order to obtain the separation of circuits referred to hereinbefore and conversely, if balancing means of effective design be employed, it may be expedient to dispense entirely with the transformer under conditions of a high potential source of energy. It is apparent that the condensers 7 and 8 do not constitute a filtering arrangement in the sense of frequency discrimination and thus they do not perform the same function as the elements 11, 11 of the primary circuit but instead, lend reactive characteristics to each side of the circuit to the end that the high frequency radiating portions of the ignition system may be rendered symmetrical; obviously the condensers 7 and 8 may or may not be adjusted to the same value of reactance.

In view of the difficulty of making variable condensers adapted to be connected directly to high tension lines 5, it may be desirable to employ specially constructed coupling condensers 13 between the conductors 5 and the variable condensers 7 and 8, as indicated in Fig. 2 of the drawing. Also since the desired adjustment is one of relative capacity between the two conductors 5 and ground, the condensers 7 and 8 may be combined, as shown in Fig. 3, in a single unit 14, comprising two fixed condenser electrodes 15 and 16, and one movable electrode 17, which is so arranged that it may be moved relatively to the fixed electrodes 15 and 16.

In Fig. 4, I have shown, a transformer which is especially adapted for use in connection with my invention. This comprises a low tension winding 18, and a high tension winding 19, both wound on the central core 20 of a shell type transformer. Between the two windings of the transformer is interposed a magnetic shunt 21. Short air gaps 22 are preferably provided between the ends of the shunt 21 and the outer legs of the transformer core, to prevent a short circuiting of the low frequency magnetic flux of the transformer. This shunt is effective in short circuiting a large portion of the high frequency flux, and as a result, the amount of high frequency energy transferred through the transformer to the low tension side is greatly reduced. The particular form of transformer used forms no part of my present invention, but is described and claimed in a copending application of Edward A. Wagner, Serial No. 115,790 filed June 14, 1926.

A convenient method of forming the coupling condensers 13 illustrated in Figs. 2 and 3 of the drawing, is shown in connection with Fig. 4. Each of the high tension leads 5 is surrounded by the usual insulating ma-

terial 23, and a metal sheath 24 is wound around the insulating conductor for a portion of its length, thus forming an electrode of the coupling condenser, the conductors themselves forming the other electrode. These conducting sheaths 24 are connected to fixed plates 15 and 16, of the variable condensers and a movable plate 17 is located in such a way that as it is moved the relative capacities of the two condensers may be varied.

While I have shown and described the preferred embodiments of my invention, it will be apparent that many modifications in the precise manner in which it is carried into effect may be made without departing from the scope thereof, as set forth in the appended claims.

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

1. The combination in an ignition system of a discharge gap, a step-up transformer for supplying a high potential to said gap to produce a discharge, and means for balancing the capacity to earth of the conductors connecting said transformer and said gap to prevent radiation of high frequency energy from said conductors.

2. The combination in an ignition system of a discharge gap, a step-up transformer for supplying a high potential to said gap to produce a discharge, a pair of conductors connecting said transformer and said gap, a pair of condensers connecting said conductors to ground, and means for adjusting the relative capacities of said condensers to prevent radiation of high frequency energy from said conductors.

3. The combination in an ignition system of a discharge gap, a step-up transformer for supplying a high potential to said gap to produce a discharge, a pair of insulated conductors connecting said transformer and said gap, a conducting sheath surrounding each of said insulated conductors for a portion of its length, a condenser connected between each of said conducting sheaths and ground, and means for varying the relative capacities of said condensers.

4. The combination in an ignition system of a discharge gap, a step-up transformer for supplying a high potential to said gap to produce a discharge, a pair of insulated conductors connecting said transformer and said gap, a conducting sheath surrounding each of said insulated conductors for a portion of its length, a condenser electrode connected to each of said conducting sheaths and an adjustable grounded condenser electrode in capacitative relation to both of said first mentioned condenser electrodes.

5. The combination in an ignition system of a discharge gap, an energizing circuit for producing a spark discharge across the gap whereby unbalanced high frequency energy normally would be radiated from one side of the circuit and means for equalizing the paths from both sides of said circuit to ground whereby the radiation of high frequency energy is prevented, said means comprising reactance elements.

In witness whereof, I have hereunto set my hand this 11th day of June, 1926.

ERNST F. W. ALEXANDERSON.