April 18, 1933. A. A. LEONARD 1,904,149

MEANS FOR ELIMINATING THE EFFECTS ON RADIO CIRCUITS OF SPARKING IN THE IGNITION SYSTEM OF AN INTERNAL COMBUSTION ENGINE

Filed Jan. 3, 1929

Fig. 1,

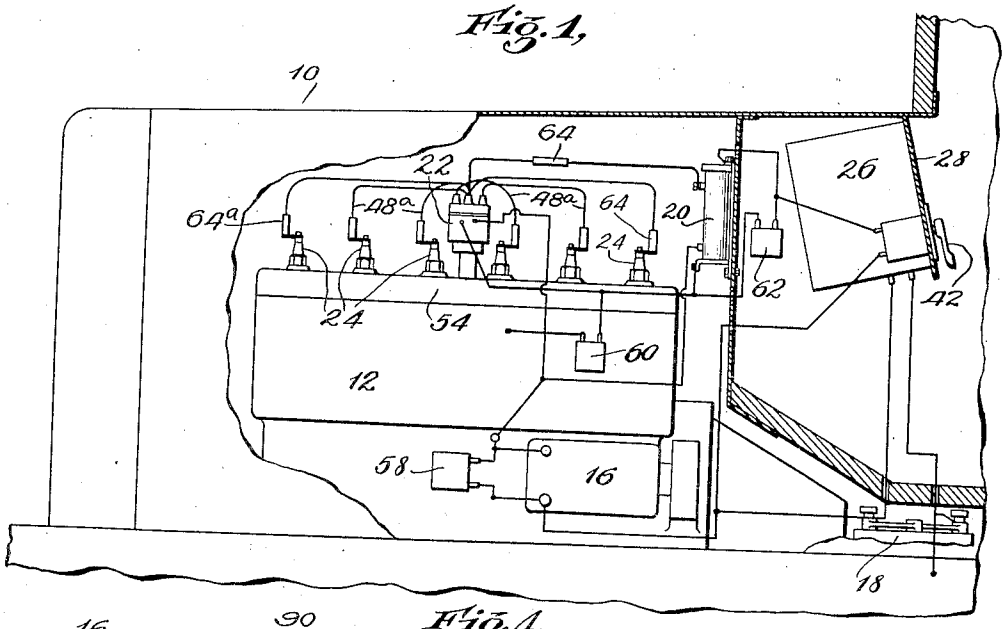


Fig. 4,

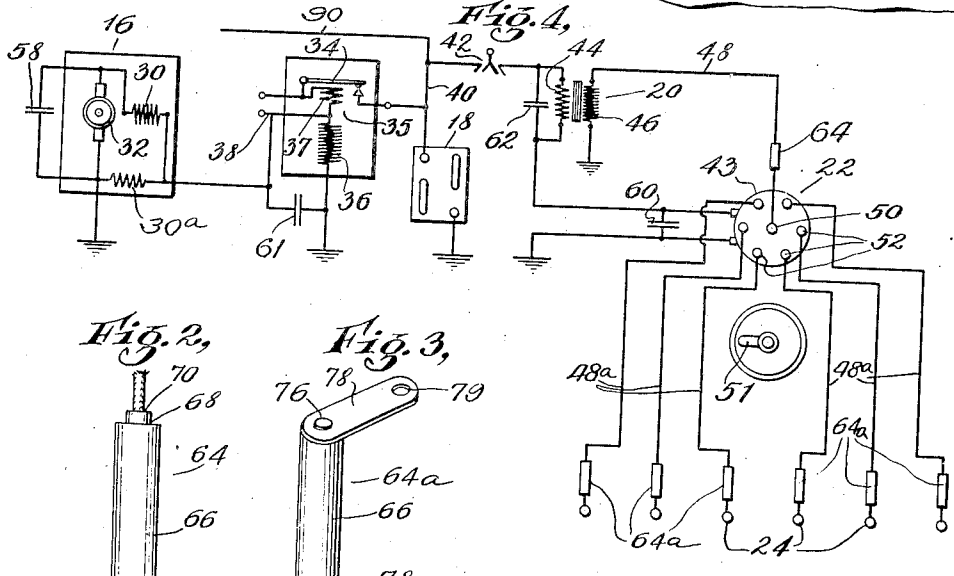


Fig. 2,

Fig. 3,

INVENTOR.
ANTHON A. LEONARD

BY Myron Feinstein
ATTORNEYS.

Patented Apr. 18, 1933

1,904,149

UNITED STATES PATENT OFFICE

ANTHON A. LEONARD, OF FOREST HILLS, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO TRANSITONE AUTOMOBILE RADIO CORPORATION, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF DELAWARE

MEANS FOR ELIMINATING THE EFFECTS ON RADIO CIRCUITS OF SPARKING IN THE IGNITION SYSTEM OF AN INTERNAL COMBUSTION ENGINE

Application filed January 3, 1929. Serial No. 330,035.

The present invention relates in general to means for eliminating the effect on radio circuits of sparking, and more particularly to means for suppressing the production of high frequency oscillations engendered by sparking in the usual electrical circuits of a motor vehicle or the like, so that the operation of a radio apparatus carried by said vehicle will not be interfered with.

In the use of radio apparatus mounted upon motor vehicles, it has been determined that, while the useful transient oscillations of fundamental frequency produced in the ignition system produce no material interference with the proper operation of the radio apparatus, the transient oscillations of comparatively much higher frequency caused by arcing or sparking in the various electrical circuits of the vehicle, such as the circuits associated with the ignition system, particularly in the high tension spark gap induction coil secondary circuit of the ignition system, seriously impair the efficiency and distort the reception of the radio apparatus.

The usual ignition system of motor vehicles includes a battery, a generator for supplying the requisite electrical energy to the battery, a cut-out device for bringing the generator into and out of circuit with the battery, which is usually controlled by the generated potential, an induction coil for transforming the battery E. M. F. into a high oscillatory E. M. F., an interrupter for periodically interrupting the flow of current in the primary of the induction coil, a plurality of spark plugs, and a distributor for connecting in proper sequence the spark plugs to the high tension secondary of the induction coil and usually including an auxiliary air gap through which the current from the high tension secondary is discharged.

The functions of these various elements of an ignition system are well known in the art. Imperfect commutation of the brushes of the generator, arcing of the cut-out, arcing of the primary interruptor, the sparks across the gaps of the spark plugs and across the auxiliary gap of the distributor, and the possible sparking at the contacts of the distributor, are causes of spurious oscillations of extremely high frequency in the various circuits associated with the elements of the ignition system, these oscillations starting at the moments of make and break of the sparks and their frequency and magnitude being largely governed by the distributed inductance and distributed capacity of the various wire conductors of the system, by the length of said conductors and their arrangement with relation to one another and to ground. These spurious oscillations, owing to the proximity of a radio apparatus carried on the vehicle, are normally received by such radio apparatus, thereby interfering with its proper operation.

The high frequency oscillations due to the spark producing elements of the distributor and spark plugs above mentioned are particularly disturbing to a radio apparatus located in the neighborhood, and the general object of the present invention is the substantial elimination of such disturbing oscillations. More particularly stated, it is an object of the invention to provide electrical means for eliminating such high frequency oscillations, which can be simply made and installed with ease and at little cost.

In accordance with the invention, resistance units having suitably low capacity and inductance are so disposed in the wire circuits leading from the induction coil secondary to the spark plugs, that the normally existing oscillations caused by sparking in the distributor and at the spark plugs are substantially completely suppressed. These resistance units are arranged in series with the spark producing elements of the distributor and of the spark plugs and in close prox-

imity thereto. Since the resistances so added to the secondary circuits of the ignition system are negligible as compared to the almost infinite resistance of the gaps in said resistance circuits, the initiation of the useful sparks will not be affected.

The present invention aims at creating perfect conditions in elimination of the disturbing effect of sparking on high frequency signal circuits, practical solutions of which will be described in conjunction with the accompanying drawing in which, for the purpose of describing the invention, a particular embodiment of the latter is shown adapted to the combination of an automobile and a radio receiver mounted thereon.

In the drawing:

Fig. 1 is a side elevation of a portion of an automobile, having a radio receiver mounted thereon, portions being broken away to illustrate the relative arrangement of the parts embodying the invention, some of said parts being shown diagrammatically; Fig. 2 is a side view, of a resistance unit, as arranged for use in a part of the circuit of the ignition system; Fig. 3 is a side view, showing a modification of the unit shown in Fig. 2; and Fig. 4 is a wiring diagram of the generator and ignition circuits of an automobile, illustrating the incorporation therein of the various means whereby the invention is effected.

Similar reference characters in the several figures indicate similiar parts.

Fig. 1 illustrates the front portion or hood 10 of an automobile, in which the engine 12 is mounted. The latter drives a generator 16, for providing the current necessary to charge a battery 18, and provide the necessary voltage for operating the lights, ignition system, and the other electrical accessories with which automobiles are now generally equipped.

A radio receiving set 26 is suitably mounted on the automobile, being preferably suspended adjacent, or upon, the dashboard 28 in a convenient location to afford the operator thereof ready access to the controls of said set for its proper operation. The radio set 26 is merely shown diagrammatically in side elevation, since the parts thereof, and its connections, do not enter into the particular inventive features set forth herein, except in so far as they are in electromagnetic relation to the ignition system by reason of their proximity.

In Fig. 4, there is illustrated diagrammatically a high tension ignition system, suitable for use with a multi-cylinder explosive hydro-carbon engine, the generator 16 and the battery 18. The circuit also includes a cut-out device 35 for automatically bringing the generator 16 into and out of circuit with the battery 18. The generator 16 has an armature 32 and series and shunt field windings 30 and 30*a* respectively. One terminal of the generator is connected to ground, ordinarily the metallic portions of the engine and vehicle frame, and the other terminal thereof is connected in circuit through the cut-out device 35 with the potential terminal of the battery 18, the other terminal of which is connected to ground. The cut-out device 35 comprises a switch 34 for making and breaking the circuit from the generator lead to the battery lead and is operated by an electromagnetic arrangement involving a high inductance, high resistance coil 36, and a low inductance, low resistance coil 37, so that it is controlled by the speed of the engine 12, said coils 36 and 37 having a common connection 38, the coil 36 having its other terminal connected to ground. The potential terminal of the battery 18 is connected by a conductor 40 through a dash-board switch 42, commonly known as the ignition switch, to a terminal of the primary winding 44 of the open core spark coil or transformer unit 20. The other terminal of said primary 44 is connected to a contact (not shown) of the interrupter 43 in the distributor 22, the other contact (not shown) of the interrupter 43 being connected to ground. The interrupter 43 is provided with a rotating control driven by the cam shaft or other movable part of the engine to make and break the circuit of the primary coil 44 at predetermined intervals. A conductor 90, one end of which is connected to the potential terminal of the battery 18, may lead to the radio set 26 for the purpose of delivering to said set the electrical energy required for its operation.

The secondary coil 46 of the transformer unit 20 has one of its terminals connected by the conductor 48 with the center post or contact 50 of the distributor 22, while its other terminal is connected to ground. The center post 50, by means of some device, such as a rotating contact arm 51, the position of which is controlled by the engine 12, is brought successively into engagement with the contacts 52, which are connected by the separate conductors 48*a* to the insulated terminals of the spark plugs 24, six of which are shown. The latter are of the customary type, each comprising an outer shell grounded on the engine cylinder head 54 and an inner portion which is insulated therefrom and is connected with its respective contact 52. The spark plugs provide spark gaps, located within the cylinders, and due to their construction, they also act as condensers in the high frequency circuit paths hereinafter described.

The distributor 22, illustrated and described in conjunction with this invention, is of the type in use wherein a single spark coil does duty for an engine having a plurality of cylinders, in which the explosions are timed to occur at different intervals. It is to be understood, however, that the invention, as described, is applicable to any sys-

tem of ignition operating under the same general principles, wherein a spark gap discharge, or the like electrical discharge, is used.

It is readily apparent that the radio set 26, unless especially protected, must necessarily be disturbed in its operation by the normally existing extremely high frequency oscillations, of the order of 10,000 kilocycles, arising from such incidents as sparking at the commutator brushes of the generator 16, arcing at the cut-out switch 34, arcing at the interruptor 43, arcing at the distributor contacts 52, and spark discharges at the spark plugs 24, and, if the distributor 22 contains an auxiliary gap (not shown) as is often the case, spark discharges at said auxiliary gap. It is noted that the interfering oscillations can be divided into two groups, one occurring on the secondary side of the transformer unit 20 within high tension paths, this group normally creating the greatest disturbance, and the other occurring on the primary side of said unit within high current paths.

The interfering oscillations in the second group just mentioned may be materially reduced by the use of condensers of suitably high capacity value connected in shunt to the spark producing elements which cause those oscillations. The interfering oscillations in the first group, however, cannot be eliminated in this way, and the means and arrangement by which these oscillations are eliminated is the subject of the present invention.

The extent of objectionable oscillations produced in a wire by the break of a spark in series with said wire is largely governed by the distributed inductance and distributed capacity of said wire and other factors. Thus, objectionable oscillations will normally be caused in the conductors 48 and 48*a* by sparking at the spark plugs 24 and at the distributor 22, their extent in magnitude and frequency being largely governed by the distributed inductance, distributed capacity, and length of said conductors, and their arrangement with relation to one another and to ground. These objectionable oscillations are not transmitted beyond the point of connection of the wire 48 to the secondary 46 of the transformer unit 20, owing to the high impedance afforded by said unit to said oscillations.

Applicant has discovered that lumped resistance units of suitably high ohmic value and suitably low capacity and inductance, when inserted at certain locations in the secondary or high tension circuits of an ignition system, will make those paths normally directing the flow of high frequency oscillations caused by sparking in said high tension circuits, aperiodic to those oscillations, with the result that the latter are substantially completely suppressed. One such resistance unit 64*a* is arranged in each of the conductors 48*a* leading to the spark plugs 24; and one such resistance unit is arranged in the conductor 48 leading from the secondary of the induction coil 20 to the center post 50 of the distributor 22. The lumped resistance 64 suppresses objectionable oscillations normally existing in that portion of the path 48 connecting said resistance with the induction coil 20, since it offers a high resistance to the oscillations set up in the other portion of the path existing between said resistance unit and the distributor 22 where the sparking occurs at the contacts 52. For the same reason, the lumped resistances 64*a* effectively suppress objectionable oscillations, caused by the sparks at the spark plugs 24, in those portions of the paths 48*a* connecting said resistances with the contacts 52 of the distributor. To obtain maximum efficacy in the suppression of objectionable oscillations, the resistances 64 and 64*a* must be connected as closely as possible to the distributor 22 and the spark plugs 24 respectively. The resistance 64, and the group of resistances 64*a*, are both required owing to the time difference in the sparking at the spark plugs 24 and at the distributor 22. If desired, other resistance units may be inserted in the conducting paths 48*a* adjacent the distributor 22.

The values of the lumped resistance units 64 and 64*a*, required for proper suppression of objectionable oscillations are subject to wide variations, say from 200 ohms up, said values depending upon the particular conditions encountered. A particular value of 25,000 ohms for a resistance unit 64 or 64*a*, however, has been found to produce satisfactory results for general use under varying conditions. Thus, a lumped resistance 64 or 64*a* not only is convenient in handling and insertion in the circuits, but may be made a standard so as to adapt it for general use. It is noted that regardless of the value of the resistance used, it will not impair the operation of the ignition system as it is small as compared to that of the air gaps when open circuited, the added resistance merely damping the oscillations of fundamental frequency.

In the particular embodiment of the invention illustrated herein, the resistance unit 64 or 64*a* is seen to take the form of a body of high resistance material such as a molded graphite rod (not shown), housed within the insulating casing 66, the ends of the high resistance body being connected between the metallic terminal portions 68. By using a body of high resistance material, a resistance unit 64 or 64*a* is made to possess substantially no inductance and very little distributed capacity. The latter may be adapted for soldering at 70 to conductor leads, as shown in Fig. 2. It is of course understood that

the particular form taken by the resistance unit as a whole is of no material importance so far as the inventive concept is concerned.

Since best results in suppression of objectionable oscillations are obtained when the resistance units are located as closely as possible to the spark gap contacts, I have conceived that a convenient and effective means of connecting the resistance units 64*a* in circuit is to mount said units directly on the spark plugs 24. For this connection, a projecting end of a unit is received within an opening 76 formed in an attaching strap 78, and soldered therein. Another opening 79 in the strap 78 may be used to attach said strap to the terminal of a spark plug. The other end of the unit may be soldered, or otherwise electrically connected to a conducting lead 48*a*. The mounting of the resistance units 64*a* directly on the spark plugs 24, and the arrangement of the resistance unit 64 in proximity to the distributor head, are particularly effective in suppressing objectionable oscillations and are important features of my invention.

In the particular arrangement of parts shown in the drawing, the objectionable oscillations normally occurring on the low tension side of the induction coil 20 may be materially reduced by the shunt condensers 58, 60, 61 and 62, of suitably high capacity values. These shunt condensers have a relatively high impedance to the low frequency pulsations of the ignition primary circuits, with little or no effect upon the operation of the ignition system. They merely act to alter the wave of the useful oscillations of fundamental frequency. However, they offer extremely low impedances to the high frequency objectionable oscillations generated by sparking, or by capacitive or inductive coupling, and provide short path circuits for such oscillations, one portion of which may be grounded, with the result that the coupling between the circuits provided by the condensers and the remaining circuits is materially reduced, thus materially reducing objectionable oscillations in said remaining circuits and materially reducing the interference from this cause.

The condenser 58 is connected directly across the terminals of the armature 32 of the generator 16, thus providing a low impedance path for the objectionable oscillations set up by sparking at the commutator brushes. The condenser 61 is connected between the common connection 38 of the coils 36 and 37 of the electromagnetic cut out device 35 and ground, for the purpose of eliminating, as far as possible, the effect of the make and break, at the cut-out switch 34, upon the operation of the radio set 26. The condenser 60 is connected across the interruptor 43, in parallel with the usual condenser (not shown) across said interruptor, thus materially reducing the effect of any sparking at said interruptor. The condenser 62 is connected across the terminals of the induction coil primary 44, thus providing in conjunction with the condenser 60 a low impedance path to any objectionable oscillations set up in the conductor 40 by possible inductive or capacitive coupling with remaining conductors or circuits of the ignition system or by sparking at the ignition switch 42, and materially reduces their effect. The condensers 61 and 62 effectively prevent transmission of objectionable oscillations along the conductor 90 to the radio set 26. A value of 2 microfarads for all of the condensers 58, 60, 61, 62 has been found to produce satisfactory results.

The means for eliminating the effect of sparking in the secondary circuits of the ignition system, described herein, is effective, simple, may be made in standard units, and may be installed with ease and at little additional cost.

As various embodiments might be made of the invention described, and as various modifications might be made in the embodiment described, it is understood that all matter herein set forth is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. In an electric ignition system for an internal combustion engine having spark producing elements normally creating oscillations disturbing to radio apparatus, means for substantially eliminating said disturbing oscillations comprising a substantially non-inductive and substantially non-capacitive lumped resistance unit connected in series with said elements and in close proximity thereto.

2. In an electric ignition system for an internal combustion engine having spark producing elements normally causing oscillations disturbing to radio apparatus, means for substantially eliminating said disturbing oscillations comprising a substantially non-inductive and substantially non-capacitive lumped resistance unit in the form of a body of high resistance material connected in series with said elements in close proximity thereto.

3. In an electric ignition system for an internal combustion engine having spark plugs normally causing oscillations disturbing to radio apparatus, means for substantially eliminating such disturbing oscillations comprising substantially non-inductive and substantially non-capacitive lumped resistance units each in the form of a body of high resistance material connected in series with the circuits of said spark plugs and secured to and supported thereby.

4. In an electrical ignition system for an

internal combustion engine including a spark producing element disturbing to radio apparatus and having a conductor normally radiating energy due to sparking, a non-arcing substantially non-inductive and substantially non-capacitive lumped resistance member electrically connected directly to said spark producing element and directly to one terminal of said conductor for eliminating the transmission of disturbing oscillations from said spark producing element and the conductor.

5. An electric ignition system for an internal combustion engine having a voltage-producing means, a plurality of spark plugs, a distributor, a conductor for establishing electrical connection from said voltage-producing means to said distributor, and conducting means for establishing electrical connections from said distributor to said spark plugs; a substantially non-inductive and substantially non-capacitive lumped resistance unit connected in said conductor in proximity to said distributor, said resistance substantially eliminating oscillations disturbing to radio apparatus normally created by sparking in said ignition system.

6. An electric ignition system for an interal combustion engine having a voltage-producing means, a plurality of spark plugs, a distributor, a conductor for establishing electrical connection from said voltage-producing means to said distributor, and conducting means for establishing electrical connections from said distributor to said spark plugs; a substantially non-inductive and substantially non-capacitive lumped resistance unit in the form of a body of high resistance material connected to said conductor in close proximity to said distributor, said resistance substantially eliminating oscillations disturbing to radio apparatus normally created by sparking in said ignition system.

7. An electric ignition system for an internal combustion engine having a voltage-producing means, a plurality of spark plugs, a distributor, a conductor for establishing electrical connection from said voltage-producing means to said distributor, and a plurality of other conductors for establishing electrical connections from said distributor to said spark plugs; means for substantially eliminating the oscillations disturbing to radio apparatus normally created by sparking at said distributor and spark plugs, said means comprising a substantially non-inductive and substantially non-capacitive lumped resistance unit connected in the first named conductor in close proximity to said distributor and a plurality of substantially non-inductive and substantially non-capacitive lumped resistance units connected respectively in the second named conductors and in proximity to said spark plugs.

8. An electric ignition system for an internal combustion engine having a voltage-producing means, a plurality of spark plugs, a distributor, a conductor for establishing electrical connection from said voltage-producing means to said distributor and a plurality of other conductors for establishing electrical connections from said distributor to said spark plugs; means for substantially eliminating the oscillations disturbing to radio apparatus normally created by sparking at said distributor and spark plugs, said means comprising substantially non-inductive and substantially non-capacitive resistance units each in the form of a body of high resistance material, one of said units being connected in the first named conductor in close proximity to said distributor and the others being connected respectively in the second named conductors and in close proximity to said spark plugs.

9. An electric ignition system for an internal combustion engine having a high-tension transformer secondary circuit having a pair of spark producing elements between which sparking normally creates oscillations disturbing to radio apparatus, means for substantially eliminating said disturbing oscillations comprising a substantially non-inductive and substantially non-capacitive lumped resistance unit connected in said circuit in close proximity to said elements.

10. An electric ignition system for an internal combustion engine having a high-tension transformer secondary circuit having a pair of spark producing elements between which sparking normally creates oscillations disturbing to radio apparatus, and means for substantially eliminating said disturbing oscillations comprising a substantially non-inductive and substantially non-capacitive lumped resistance unit in the form of a body of high resistance material connected in said circuit in close proximity to said elements.

11. In an electric ignition system for an internal combustion engine having a high tension transformer secondary circuit having a spark plug at which sparking normally creates oscillations disturbing to radio apparatus, means for substantially eliminating said disturbing oscillations comprising a substantially non-inductive and substantially non-capacitive lumped resistance unit connected in said circuit in close proximity to said spark plug.

12. A device of the character described for use in an electrical system having an air-gap across which sparking is produced, consisting of a lumped resistance unit for substantially eliminating oscillations disturbing to radio apparatus normally created by said sparking, said unit being substantially non-inductive and substantially non-capacitive and being adapted for connection

in circuit with and in proximity to said air gap.

13. A device of the character described for use in a spark plug circuit having an air-gap across which sparking is produced comprising a lumped resistance unit for substantially eliminating oscillations disturbing to radio apparatus normally created by said sparking, said unit being substantially non-inductive and substantially non-capacitive and in the form of a body of high resistance material adapted to be connected in said circuit in proximity to said air gap.

In testimony whereof, I affix my signature.

ANTHON A. LEONARD.