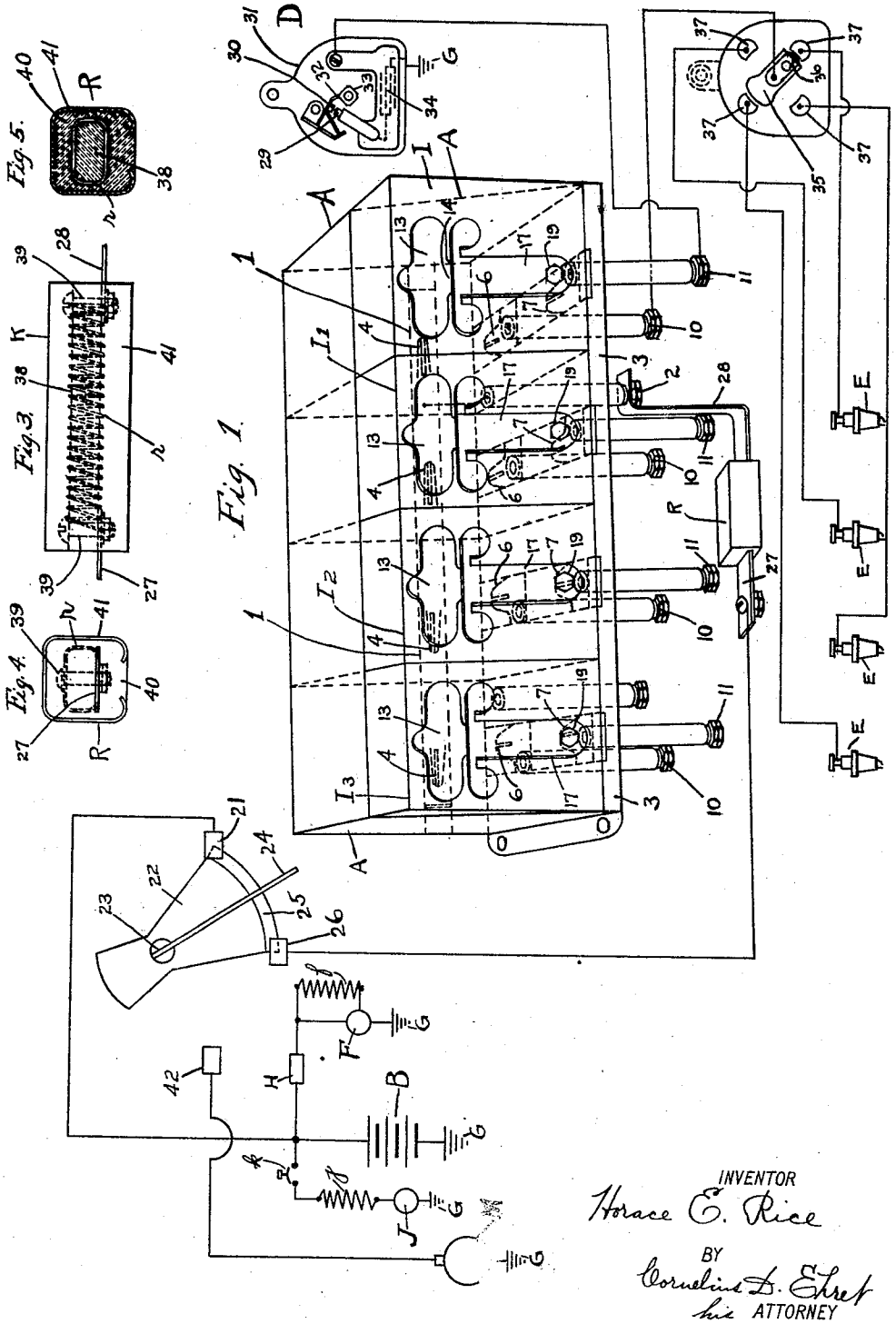
Jan. 13, 1925. 1,522,909

H. E. RICE

CONVERTED IGNITION SYSTEM

Filed Aug. 10, 1921 2 Sheets-Sheet 1



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Fig. 6.

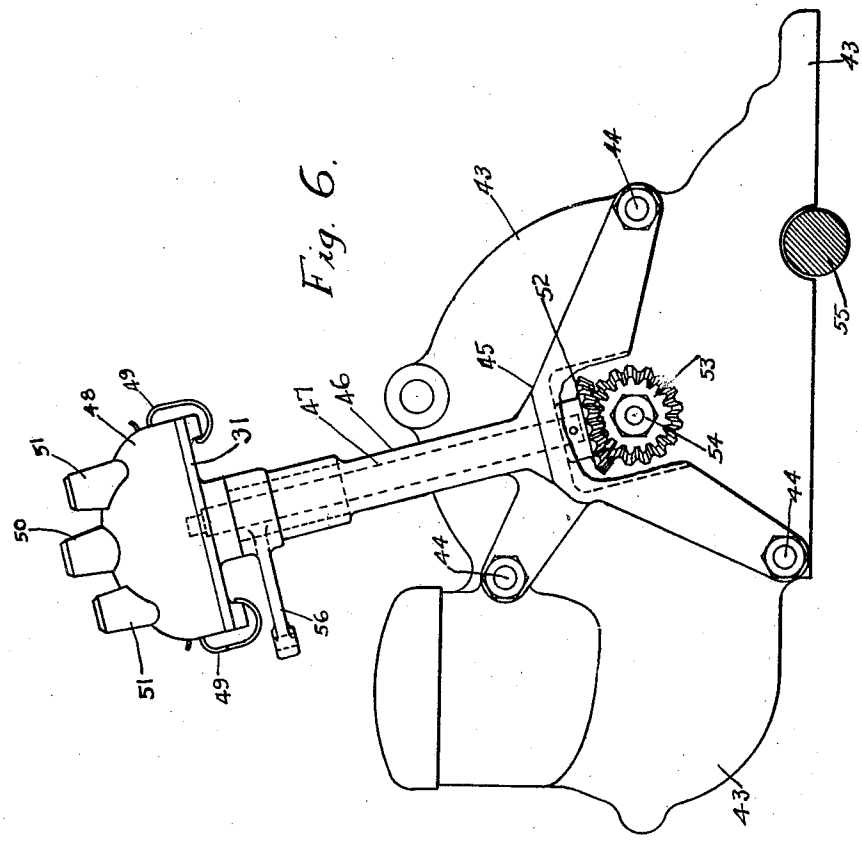
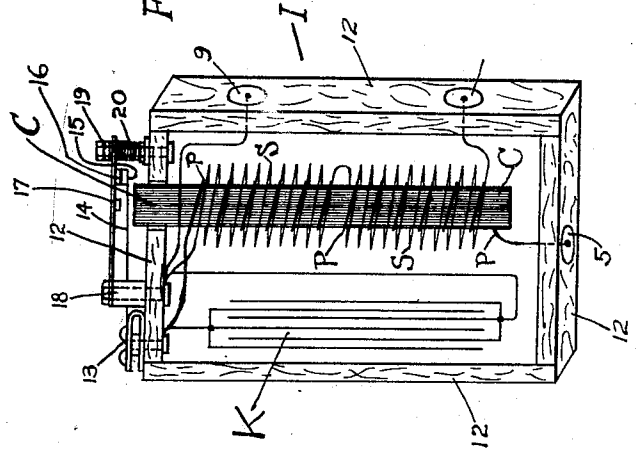


Fig. 2.



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UNITED STATES PATENT OFFICE.

HORACE E. RICE, OF PHILADELPHIA, PENNSYLVANIA; KATHLEEN F. RICE ADMINISTRATRIX OF SAID HORACE E. RICE, DECEASED.

CONVERTED IGNITION SYSTEM.

Application filed August 10, 1921. Serial No. 491,115.

To all whom it may concern:

Be it known that I, HORACE E. RICE, a citizen of the United States, residing in the city and county of Philadelphia, State of Pennsylvania, have invented new and useful Improvements in Converted Ignition Systems, of which the following is a specification.

My invention relates to electric ignition systems for internal combustion engines, and particularly those employed upon automobiles or other motor vehicles.

In accordance with my invention, an ignition system, such, for example, as now and heretofore employed upon Ford automobiles, comprising a vibrator induction coil for each engine cylinder, with an engine driven timer or commutator for delivering current to the primaries of the induction coils in predetermined sequence, and having direct connections from the secondary terminals of the coils to the spark plugs of the engine cylinders, is readily and cheaply converted into a system wherein one of the vibrator induction coils is employed, but rendered non-vibrating, for supplying high tension ignition current to all of the engine cylinders, the primary of the induction coil being once closed and opened for each of the explosions in the cylinders of the engine, by the cam-controlled interrupter mechanism, and the high tension secondary current delivered by the single coil is distributed in proper sequence to the spark plugs of the respective engine cylinders.

In accordance with my invention, an induction coil having the windings and core suited for or having the characteristics of a vibrator induction coil, has connected in series in its primary circuit a resistance which changes the characteristics of the primary circuit to adapt it for single spark ignition, as distinguished from vibrator spark ignition, an interrupter of the so-called closed circuit type being included in the primary circuit.

Further in accordance with my invention, the system of the character referred to is utilized in connection with a storage battery as the source of energy for the primary circuit, the storage battery being charged by a generator driven by the engine, and supplying current also to a motor for cranking or starting the engine; in this relation the voltage of the storage battery, or the voltage impressed upon the primary circuit of the ignition system, varies within wide limits, and such variations are accentuated by variations in temperature, as between winter and summer; and notwithstanding such wide variations in voltage, the induction coil of vibrator induction coil characteristics, with the appurtenant apparatus, serves to produce the effective ignition under all conditions as to temperature, starting, and under different engine speeds.

My invention resides in the features hereinafter described and claimed.

For an illustration of one form of my invention, reference is to be had to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view of the circuit arrangements and apparatus of my system.

Fig. 2 is a view illustrative of the construction of a vibrator induction coil.

Fig. 3 is an elevational view of a resistance unit.

Fig. 4 is an end elevation of the structure shown in Fig. 3.

Fig. 5 is a cross sectional view of the structure shown in Fig. 3.

Fig. 6 is an end elevational view of the interrupter and distributer structure and its mounting.

Referring to Fig. 1, A is a box of sheet metal or other suitable material within which are disposed the four induction coil units I, I_1, I_2 and I_3, one for each cylinder of the engine. The box and the induction coil units therein will be recognized as those commonly employed upon a Ford automobile, the box and coils, however, being laid upon a side, for facility in illustration.

Inside of the box and extending longitudinally of the bottom thereof and suitably insulated is the conducting strip or bus bar 1, with which connects the terminal 2 projecting from the wooden side 3 of the box A. Struck up from and integral with the bar 1 are the yielding contacts 4 with which engage the contact buttons 5, Fig. 2, on the bottoms of the several coil units.

On the inner side of the board 3 there is a pair of yielding contacts 6 and 7 for each coil unit, and with these engage, respectively, the contact buttons 8 and 9, Fig. 2, of each coil unit.

With the contacts 6 communicate the terminals 10 supported by and projecting from the outside of the board 3. Communicating with the contact 7 are the terminals 11 carried by and projecting from the outside of the board 3.

As is well known, the terminal 2 has been connected to the source of current, either magneto or battery, upon a Ford car, and the terminals 11 in the primary circuits of the coils have been connected to the several contacts of the timer or primary commutator driven by the cam shaft of the engine, while the secondary or high tension terminal 10 were separately connected, respectively, to the several spark plugs of the engine, whereby the primary circuits of the different coil units were energized in succession, and upon the energization of each there was produced at the spark plug of the corresponding cylinder a succession of sparks due to the vibrator action.

Referring to Fig. 2, there is illustrated an induction coil unit of the vibrator type. Within the wooden box structure 12, whose side is removed for the sake of clearness, there is disposed the core C comprising a cylinderical bundle of iron wires projecting through the top of the box. Ordinarily the core C is one-half inch in diameter and about five inches in length. Around it is wound the primary coil or winding P, generally consisting of about 220 turns of No. 19 insulated copper wire disposed in two layers, and having a resistance, at ordinary temperature, of about two-tenth of an ohm. One terminal of the primary P connects to the button 5 and the other terminal connects to the metallic support 13, to which is secured one end of the vibrator spring 14 carrying the vibrator contact 15 normally held by the spring 14, when the primary P is deenergized, against the stationary vibrator contact 16 carried by the conducting member 17 secured at its one end to the post 18, connected to the button 9. The member 17 is ordinarily adjustable toward and away from the contact 15 by the nuts 19 threaded upon a bolt, a spring 20 holding the member 17 against the nuts 19. Surrounding the primary winding P, and generally divided into two sections, is the high tension secondary winding S, one of whose terminals connects to the post 18 and whose other terminal connects to the button 8. Ordinarily the secondary S consists of about seventeen or eighteen thousand turns of fine insulated copper wire, for example, No. 38. Within the box 12 is disposed a condenser K, whose terminals are connected, respectively, to the posts 13 and 18, the condenser, therefore, as usual shunting the vibrator contacts 15 and 16.

An induction coil of the character above described has characteristics, particularly as effected by the core C and primary P, suited for control by a trembler or vibrator 14 which upon each energization of the core C upon engagement of the contact 15 with the contact 16, is attracted, opening the circuit of the primary, producing a spark, and demagnetizing the core C, causing the member 14 to again move away from the core C, carrying the contact 15 again into engagement with the contact 16. This cycle is very rapidly reproduced, thereby producing a vibrating or trembling action and producing a series of ignition sparks for each closure of the primary circuit at the commonly used commutator or timer.

A coil of the character above described is one having vibrator coil characteristics and is not suited for employment in ignition systems wherein a single spark is produced for each explosion of combustible mixture in the engine by an interrupter or timer structure comprising fixed and movable contacts in series in the primary circuit and whose engagement and separation are controlled by a cam or equivalent driven by the engine.

This unsuitability of an induction coil having vibrator coil characteristics for use in a closed circuit type of ignition system is in part due to the fact that the resistance and inductance of its primary winding are such that the closure of the primary circuit through the closed circuit type of interrupter, even at high engine speeds, is of such duration that a relatively stronger current flows through the primary winding than when the induction coil is used for its intended purposes, namely a vibrator coil. This is due to the fact that the inductance of the primary winding is not sufficiently great, and permits the current to reach high value within and during the period of closure of the closed circuit interrupter. Such greater current is detrimental to the interrupter contacts, and is a useless waste of electrical energy supplied by the battery or other source.

By the introduction of the resistance r, as herein described, the electrical characteristics of the primary circuit of the induction coil are modified so that the energizing current is materially reduced in magnitude, effecting substantial saving in electrical energy and yet producing sufficiently powerful and effective sparks in the engine cylinder. An induction coil having vibrator coil characteristics, and when operating as a vibrator coil, permits, due to the resistance and inductance of its primary winding, a relatively large current to pass through that winding, whereas when not utilized as a vibrator coil and having my resistance applied thereto the current is materially reduced and yet producing effective and sufficiently powerful ingition sparks with consumption

of materially less electrical energy. For example a vibrator coil operating as such may allow passage of a current of such magnitude that its arithmetic mean, and as measured by a direct current D'Arsonval ammeter, is of the order of 2 amperes when supplied by a so called 6 volt storage battery; but when the same induction coil has applied thereto my resistance and when operating non-vibrating, in a closed circuit system as herein described, the current is reduced to about ¾ of an ampere or, roughly, to about ⅓, nevertheless ensuing for both high and low engine speeds sufficiently powerful ignition sparks.

It is accordingly a characteristic of my invention that the resistance applied in accordance therewith effects a running current in the primary circuit of the induction coil which averages less than the current flowing through the primary when the induction coil is utilized as a vibrator coil.

A single induction coil having vibrating coil characteristics and provided with my resistance serves to produce ignition sparks for all the cylinders of a multi-cylinder engine, while it has been the practice, on Ford cars at least, to utilize a separate vibrating coil for each engine cylinder and to bring these coils successively into operation. In such arrangement each coil is for a very large fraction of the time out of circuit and therefore does not rise in temperature to the extent that it would if used for supplying ignition energy to all of the engine cylinders. Yet by employing a single induction coil having vibrator coil characteristics, in accordance with my invention, the rise in temperature is not excessive, due in part at least to the fact that change in the electrical characteristics of the primary circuit a relatively smaller current is utilized, as above explained, and therefore developing less heat.

In accordance with a feature of my invention, however, I employ an induction coil of vibrator coil characteristics, for example a coil of the character above described and, not withstanding the self-reduction and resistance of the primary P suited for a vibrating induction coil, will effect a single spark system by eliminating the primary timer or commutator and introducing into the primary circuit a resistance which changes the electrical characteristics of the primary circuit to suit them for single spark production; and in series with the primary circuit there is introduced a so-called closed circuit type of interrupter or timer comprising fixed and movable contacts controlled by a cam or equivalent driven by the engine.

For the above mentioned purpose the vibrator coil unit, such as indicated in Fig. 2, may be employed. This may be accomplished by screwing down the nuts 19 so far as to maintain the contacts 15 and 16 permanently in engagement with each other and preventing vibration of the trembler 14.

Referring again to Fig. 1, it will be understood that one of the four coil units only is employed. In the example illustrated, the coil unit I is employed, while the units I_1, I_2 and I_3 are out of circuit, and are retained in the box A as spare coils, or may be entirely removed. With the vibrator contacts 15 and 16 permanently in non-vibrating engagement with each other, the circuit arrangement is as follows:

The battery B, as a three cell lead storage battery or a so-called six volt battery, or any other suitable source of current, has its one terminal grounded at G, as by connecting it to the frame of the automobile, engine or other conducting body. Its other terminal connects with the switch contact 21, with which co-acts the switch member 22 rotatable about the pivot 23 by handle 24 and carrying the conducting member or contact 25. With the switch in the position shown the contact 21 is in electrical communication through the contact 25 with the switch contact 26, which is connected to the terminal strip 27 of the resistance unit R, whose other terminal strip 28 is connected to the aforesaid terminal 2 upon the box A, and through it to the bus bar 1, which in turn is in electrical communication with the button 5 of the coil unit I. Accordingly, one terminal of the primary P of the induction coil I is in communication with one terminal of the battery B, and the other terminal of the primary P is in electrical communication with the button 9, which is in engagement with a contact 7 on the board 3, and through it and the terminal 11 is connected with the fixed contact 29 of the interrupter or timer mechanism D, of the closed circuit type, whose movable contact 30 is in electrical communication with the plate 31, which is grounded to the framework of the engine through the structure hereinafter described. The movable contact 30 is carried by an arm 32, which is spring pressed toward or against the cam 33, which is driven by the engine and has a face for each cylinder of the engine. Shunted across the interrupter contacts is the condenser 34. This closed circuit interrupter or timer mechanism may be of any suitable form or character and in the example illustrated is of the character disclosed in Reissue Letters Patent of the United States No. 15,128.

Rotating with the cam 33 is the distributor block 35 having at one end a terminal 36 in electrical communication with the terminal 10 upon the side of the box A and communicating with the button 8 of the coil unit I. The spark plugs E, one for each cylinder of the engine, are connected, re-

spectively, with the stationary distributor terminals 37, past which the aforesaid distributor terminal 36 is rotated, the terminal 36 being in cooperative relation with a terminal 37 each time the movable contact 30 separates from the stationary contact 21 of the closed circuit interrupter D.

The resistance unit R may have any suitable construction, the resistance conductor itself, however, being suitably proportioned with respect to the primary P of the induction coil to effect such characteristic of the primary circuit as to provide a closed circuit single spark ignition system notwithstanding an induction coil of vibrator coil characteristics is employed.

The resistance conductor itself may be of any suitable material, such as nickel or other wire.

In the example illustrated, the resistance conductor *r*, Figs. 3, 4 and 5, is coiled around a member 38, of asbestos or the like, and its ends are soldered or otherwise electrically connected to the terminal strips 27 and 28, which are held to the member 38 by the bolts 39. This structure is embedded in a mass 40 of insulating material of any suitable character, including such material as Wirt's Dielite, which is to some or suitable extent a conductor of heat, and to some or suitable degree limits the rise in temperature of the resistance conductor *r*. The mass 40 is preferably surrounded by a sheet metal housing or shell 41.

With an induction coil having the core C and primary P. of the proportions, number of turns and resistance above given by way of example, the resistance conductor *r* may be of nickel wire, No. 24, about forty-five inches in length and having a resistance cold or at ordinary temperature of approximately six-tenths of an ohm, that is, two or more times the resistance of the primary coil P. When hot the primary P may have a resistance of approximately thirty-five one-hundredths or four-tenths of an ohm, and the conductor *r* hot may have a resistance of approximately seven-tenths or eight-tenths of an ohm, and therefore both hot and cold, in this example, preponderates over the resistance of the primary P.

While it is preferred to employ my ignition system with the battery B, it will be understood that by rotating the switch 22 in clockwise direction, the contact 26 is connected through the switch contact 25 with the switch contact 42, whereby there is brought into the primary circuit the magneto or dynamo-electric generator M, such as employed upon a Ford car, one terminal of which connects with the contact 22 and the other terminal of which is grounded.

At F is indicated the armature of a direct current generator driven by the engine and having the shunt field winding *f*, the generator serving to charge the battery B, through the usual automatic cut-out H, for all engine speeds in excess of a predetermined minimum speed.

J represents the armature of a direct current electric motor having the series field winding *j*, for cranking the engine for starting it, upon closing the switch *k*.

At starting the engine, with the switch *k* closed, the motor draws so much current from the battery B that the voltage impressed upon the primary circuit of the ignition system is materially reduced. Furthermore, when the battery B is being charged by the generator F, the voltage impressed upon the primary circuit is materially higher. And both of these voltages are further changed by changes of temperature, as those of winter and summer. However, throughout the wide changes of voltage under all the conditions above described, the primary circuit including the resistance conductor *r* has such characteristics, notwithstanding the fact that the induction coil I has vibrator coil characteristics, that sufficiently hot or powerful ignition sparks are produced at the plugs E both in winter and summer, and when starting and when the engine is running at all speeds.

Referring to Fig. 6, 43 represents a casting at the front of the Ford or other engine. To it is secured by the bolts 44 the member 45 having the upwardly extending housing or bracket 46 in which rotates the shaft 47 upon which the aforesaid cam 33 is secured and by which is rotated the aforesaid distributor block 35, the latter disposed within the cap 48, of insulating material, secured by spring hooks 49 upon the base plate 31 of the interrupter D. The high tension conductor from the terminal 10 upon the box A connects to a terminal within the boss 50 on the cap 48, which terminal, as well understood in the art, effects communication with the distributor terminal 36. The distributor terminals 37 are exposed within the cap 48 and are extensions of terminals in the bosses 51 on the cap 48, suitable conductors extending from these bosses 51 to the spark plugs of the respective cylinders of the engine.

On the lower end of the shaft 47 is secured the bevel gear 52 meshing with and driven by the bevel gear 53 secured by nut 54 upon the cam shaft of the engine, whose main or crank shaft is indicated at 55. The ignition is advanced or retarded by rotating the plate 31 and cap 48 as a unit by lever 56, which may be connected through any suitable means with the spark controlling lever upon the steering wheel of the vehicle.

With a vibrating or trembler induction coil there occurs an appreciable lag or lapse of time between the actual closure of the primary circuit and the actual proper func-

tioning of the vibrator in interrupting the circuit and producing sparks. This lag is constant and is the same for all engine speeds, and consequently, with increasing engine speed there occurs a relative retardation of spark production, which is undesirable, since with increasing engine speed the spark should be produced earlier, instead of later, in the engine cycle. By my arrangement, however, employing an interrupter of the character of D, no such lag occurs, and the spark is produced instantly upon separation of the contact 30 from contact 29, an induction coil of vibrator coil characteristics being nevertheless employed.

While I have herein referred to the vibrator contacts 15 and 16 as permanently in engagement with each other by screwing down the nuts 19, it will be understood that the same effect may be procured by permanently connecting the members 13 and 18 in any suitable way; or by connecting that terminal of the primary P normally connected to the member 13 to the post 18 or to the contact 9. Or any other suitable means may employed for cutting out or rendering the vibrator or trembler inoperative.

As to one of its aspects, my invention is a vibrator coil ignition system converted into a single spark ignition system, without recourse to a new or different induction coil, but employing the original vibrator or trembler coil. My invention is therefore distinguished from other converted vibrator coil systems, as Ford systems, in which a specially designed induction coil is employed in substitution for the old trembler coils; or in which a closed circuit type interrupter controls the original vibrator induction coil in which, however, the vibrator continues to function as such; or from a system in which a master vibrator or trembler controls primary circuits of all the original induction coils which, as before, have their high tension terminals separately connected to the respective spark plugs.

In accordance with my invention, an ignition system involving a plurality of trembler or vibrator induction coils is cheaply and effectively converted into a superior single spark system by retaining one of the original induction coils, connecting in its primary circuit a resistance and also a closed circuit type interrupter, with a high tension distributor.

In the appended claims, the term "induction coil having vibrator coil characteristics" shall be understood as one whose primary circuit has such inductance and resistance that even for the extremely brief periods of circuit closure effected by the trembler or vibrator the primary current builds up from zero to a magnitude such as to effect both sufficient energy in the resultant spark and to actuate the vibrator or trembler at its high vibratory speed. The time constant, depending upon the ratio of inductance to resistance, of the primary circuit is in general short, and shorter than the time constant of an induction coil suited for the so-called closed circuit systems. In accordance with my invention, the introduction of a resistance in the primary circuit of an induction coil having vibrator coil characteristics for use as a closed circuit system further shortens the time constant of the primary circuit of the coil having vibrator coil characteristics and to greater degree shortens it as compared to the time constant of an induction coil suited for closed circuit ignition systems; and notwithstanding this shortening of the time constant the average of the magnitude of the current consumed for ignition purposes is materially reduced below that consumed with the same coil of vibrator coil characteristics when used as a trembler or vibrator coil. Though mine is a closed circuit system, it is neither the closed circuit system commonly employed, nor is it the vibrator coil system commonly employed, for the time constant of my primary circuit differs from both the vibrator coil systems and closed circuit systems.

What I claim is:

1. An ignition system comprising a non-vibrating induction coil having vibrator coil characteristics, a resistance permanently in the primary circuit of said induction coil for all engine speeds, a source of current in said primary circuit, an engine driven interrupter of the closed circuit type controlling said primary circuit, and a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of said engine.

2. An ignition system comprising an induction coil provided with a vibrator and having vibrator coil characteristics, means rendering said vibrator inoperative, a source of current in the primary circuit of said induction coil, a resistance permanently in the primary circuit of said induction coil for all engine speeds, an engine driven interrupter of the closed circuit type controlling said primary circuit, and a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of said engine.

3. An ignition system comprising a non-vibrating induction coil having vibrator coil characteristics, a resistance permanently in a series for all engine speeds in the primary circuit of said induction coil having a magnitude greater than the resistance of the primary winding of said induction coil, a source of current in said primary circuit, an engine driven interrupter of the closed circuit type controlling said primary

circuit, and a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of said engine.

4. An ignition system comprising a non-vibrating induction coil having vibrator coil characteristics, a resistance permanently in series for all engine speeds in the primary circuit of said induction coil having a magnitude more than twice the resistance of the primary winding of said induction coil, a source of current in said primary circuit, an engine driven interrupter of the closed circuit type controlling said primary circuit, and a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of said engine.

5. An ignition system comprising an induction coil provided with a vibrator and having vibrator coil characteristics, means rendering said vibrator inoperative, a source of current in the primary circuit of said induction coil, a resistance permanently in series for all engine speeds in the primary circuits of said induction coil having a magnitude greater than the resistance of the primary winding of said induction coil, an engine driven interrupter of the closed circuit type controlling said primary circuit, and a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of said engine.

6. An ignition system comprising an induction coil provided with a vibrator and having vibrator coil characteristics, means rendering said vibrator inoperative, a source of current in the primary circuit of said induction coil, a resistance permanently in series for all engine speeds in the primary circuit of said induction coil having a magnitude more than twice the resistance of the primary winding of said induction coil, an engine driven interrupter of the closed circuit type controlling said primary circuit, and a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of said engine.

7. A single spark ignition system of the closed circuit type comprising a non-vibrating induction coil having vibrator coil characteristics, a source of current in the primary circuit of said induction coil, a resistance permanently in series with the primary winding of said induction coil for all engine speeds, and an engine driven interrupter of the closed circuit type controlling said primary circuit to effect ignition sparks at starting and at all speeds of the engine, said resistance having a magnitude such that the mean value of the interrupted current traversing the primary winding of said induction coil is less than the mean interrupted current traversing said winding of the coil when utilized as a vibrating coil.

8. A single spark ignition system of the closed circuit type for a multi-cylinder engine comprising a single non-vibrating induction coil having vibrator coil characteristics, a source of current in the primary circuit of said induction coil, a resistance permanently in series with the primary winding of said induction coil for all engine speeds, an engine driven interrupter of the closed circuit type controlling said primary circuit to produce ignition sparks at starting and at all speeds of the engine, and a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of the engine, said resistance having a magnitude such that the mean value of the interrupted current traversing the primary of said induction coil is less than the mean interrupted current traversing said winding of the coil when utilized as a vibrating coil.

9. An ignition system comprising a non-vibrating induction coil having vibrating coil characteristics, the primary winding of said induction coil having a resistance approximately one-quarter of an ohm and comprising approximately 200 turns, a three cell lead storage battery in series with said primary winding, a resistance of magnitude greater than the resistance of said primary winding permanently in series with said primary winding for all engine speeds, an engine driven interrupter of the closed circuit type controlling the primary circuit of said induction coil, and a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of said engine.

10. An ignition system comprising a non-vibrating induction coil having vibrating coil characteristics, the primary winding of said induction coil having a resistance approximately one-quarter of an ohm and comprising approximately 200 turns, a three cell lead storage battery in series with said primary winding, a resistance of magnitude of more than twice the resistance of said primary winding permanently in series with said primary winding for all engine speeds, an engine driven interrupter of the closed circuit type controlling the primary circuit of said induction coil, and a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of said engine.

11. Ignition apparatus comprising a coil box, an induction coil having a vibrator disposed in said box, means rendering said vibrator inoperative, primary and secondary contacts in said box, primary and secondary contacts on said induction coil engaging said contacts in said box, primary and sec-

ondary terminals carried by said box on the exterior thereof and communicating with said first named contacts in said box, a storage battery connected to one of said primary terminals on the exterior of said box, a resistance unit permanently in series at all engine speeds with said battery and the primary of said induction coil, an engine driven interrupter of the closed circuit type controlling the primary circuit of said induction coil and having one terminal connected to another of said primary terminals on the exterior of said box, and a distributor connecting the secondary terminal on the exterior of said box with the different spark plugs of said engine.

12. Ignition apparatus comprising a coil box, an induction coil having a vibrator disposed in said box, means rendering said vibrator inoperative, primary and secondary contacts in said box, primary and secondary contacts on said induction coil engaging said contacts in said box, primary and secondary terminals carried by said box on the exterior thereof and communicating with said first named contacts in said box, a storage battery, a resistance unit in circuit at all engine speeds and having terminal strips one of which is secured to one of said primary terminals on the exterior of said box and the other of which is connected to said storage battery, an engine driven interrupter of the closed circuit type controlling the primary circuit of said induction coil and having one terminal connected to another of said primary terminals on the exterior of said box, and a distributor connecting the secondary terminal on the exterior of said box with the different spark plugs of said engine.

13. The combination with a storage battery, of a variable speed generator for charging the same, an engine cranking motor adapted to be energized by said battery, a non-vibrating induction coil having vibrator coil characteristics, a resistance permanently in series with said battery and the primary winding of said induction coil for all engine speeds, an engine driven interrupter of the closed circuit type controlling the primary circuit of said induction coil, and a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of said engine, said resistance being of such magnitude that for all variations of voltage impressed upon said primary circuit during operation of said motor and during operation of said generator the secondary of said induction coil delivers current of such magnitude and voltage as to produce sparks capable of igniting the combustible mixture of said engine.

14. An ignition system comprising a non-vibrating induction coil of vibrator coil characteristics, a storage battery, a magneto, a resistance permanently in series with the primary winding of said induction coil for all engine speeds, an engine driven interrupter of the closed circuit type controlling the primary circuit of said induction coil, a distributor connecting the high tension terminal of said induction coil successively to the different spark plugs of said engine, and a switch for bringing either said magneto or said battery into circuit with said resistance and the primary of said induction coil.

15. Ignition apparatus comprising a coil box, an induction coil having a vibrator disposed in said box, means rendering said vibrator inoperative, primary and secondary contacts in said box, primary and secondary contacts on said induction coil engaging said contacts in said box, primary and secondary terminals carried by said box on the exterior thereof and communicating with said first named contacts in said box, a storage battery, a resistance unit in circuit at all engine speeds and having one terminal connected with one of said primary terminals on the exterior of said box, a switch intervening between the other terminal of said resistance and said storage battery, an engine driven interrupter of the closed circuit type controlling said primary circuit having one terminal connected to another of the primary terminals on the exterior of said box, and a distributor connecting the secondary terminal on the exterior of said box with the different spark plugs of said engine.

In testimony whereof I have hereunto affixed my signature this 9th day of August, 1921.

HORACE E. RICE.