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M. MALLORY

IGNITION SYSTEM

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Fig 1

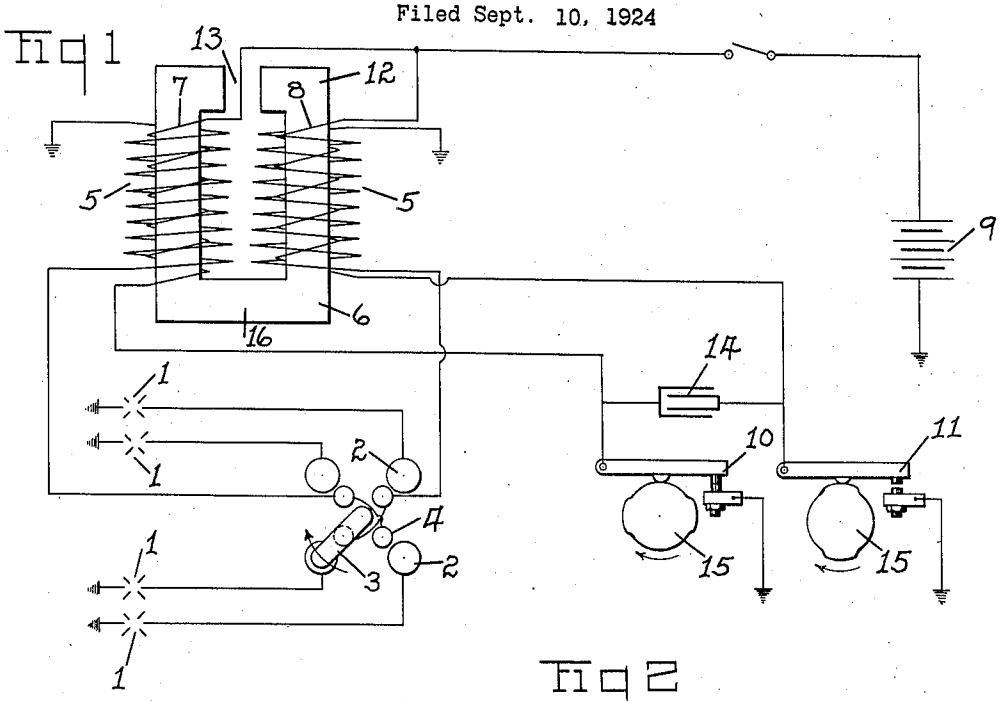
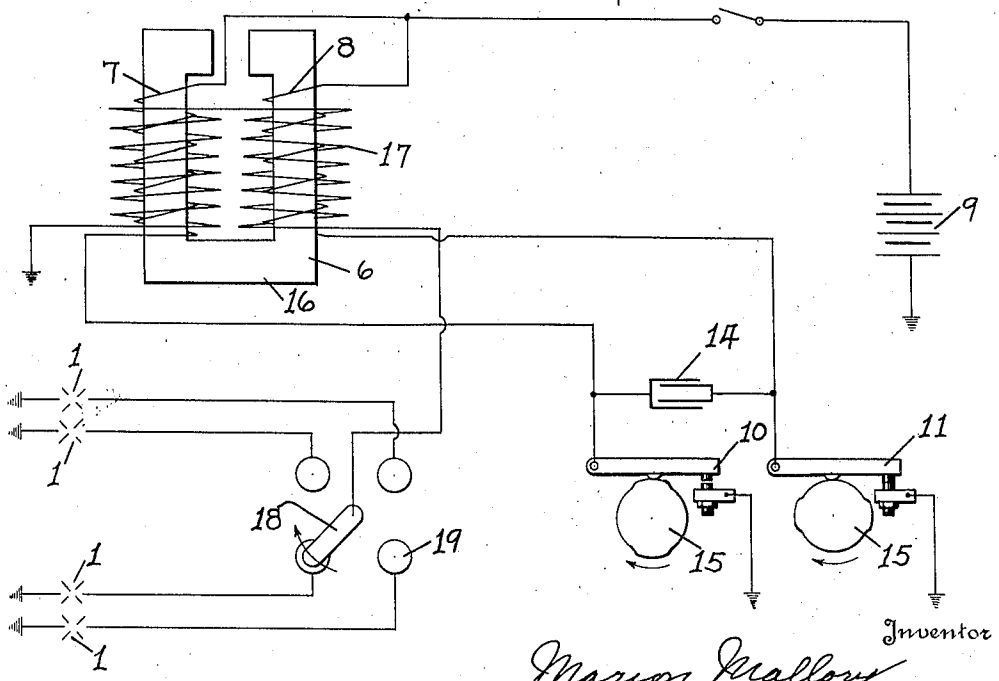


Fig 2



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UNITED STATES PATENT OFFICE.

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IGNITION SYSTEM.

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My invention has for its object to provide an ignition system for internal combustion engines wherein a substantially uniform and an exceedingly effective spark or arcing flame will be produced at the proper times in the cylinders of the engine, notwithstanding the speed of the engine. In systems embodying the invention induction coils are used which are so constructed and connected to other parts of the systems that opportunity is given for the building up of opposing magneto-motive forces and the production of their resultant lines of force in the cores of the induction coil between ignition operations whether the engine is operating at slow speed or high speed, and then periodically discontinuing one of the magneto-motive forces which enables the other to readily de-energize one of the cores and inductively affect the secondary coil to produce arcing flames at the electrodes of the spark plugs which are successively connected to the secondary coil. Thus the invention provides a means whereby double the time is given for building up fields of force preparatory to breaking the circuits that is given for the ordinary coil to build up its field of force, which is ample for whatever speed the engine may be driven.

The invention may be contained in systems which in the details of their arrangements and in the construction of their parts may vary. To illustrate a practical application of the invention I have selected a system as an example of systems embodying the invention and shall describe it hereinafter. The system selected for the purpose of illustration is shown in the accompanying drawings.

Figure 1 of the drawings depicts a preferred form of a system containing my invention. Figure 2 shows a modification of the system shown in Fig. 1.

As usual in such systems the spark plugs 1 are connected to the contacts 2 of the distributor. In the form of the invention shown in Fig. 1, the rotating member 3 of the distributor completely closes the circuit between pairs of contacts successively, such as the contacts 2 that are connected to the spark plugs and the contacts 4 that are connected to the secondary coils 5. The contacts 4 are divided into two sets and the contacts of each set are connected together and to a secondary coil 5 of the induction coil 6.

The two secondary coils 5 of the induction coil are entirely independent of each other except that they are located on a common core. They are connected in independent closed circuits through the two sets of contacts 4 and are alternately connected with the spark plugs and thus have ample opportunity to function in the production of sparks. They are each in direct inductive relation to a primary coil. The primary coils 7 and 8 are connected to the source of current 9 and to a pair of circuit breakers 10 and 11. The circuit breakers are operated in proper time to close and open the circuits of the coils 7 and 8. The coils 7 and 8 are located on the legs of a U-shaped core 12 that has a comparatively narrow gap 13 in the magnetic circuit located at one end of the induction coil 6. Since both of the circuit breakers at no time are open, a condenser 14 connected across the circuits of the circuit breakers 10 and 11 will shunt the point of the break of either circuit breaker when the circuit breaker is open, thus reducing the arcing effects on the terminals of the circuit breakers. The coils assist each other in being de-energized, resulting in a rapid flux change which produces a very hot spark. As each coil produces only one half the sparks required for the engine, they will be given twice the time to be energized as a coil would be given in systems using a single coil.

The circuit breakers are opened by the cams 15 during short periods in the rotation of the cam and the distributor shaft. Each cam is located on the shaft so as to permit the circuit breaker with which it is associated to remain closed during periods preferably about three times as long as the periods that the circuit breakers are maintained open. The number of cam points on the cams 15 will depend upon the number of cylinders of the engine, that is, according to the number of the spark plugs 1. In the system shown, four spark plugs are depicted and consequently each of the cams is provided with two cam points and the cam points of one circuit breaker are placed 90° in advance of the cam points of the other circuit breaker and the relation between the cam points and the distributor arm 3 is such that when one or the other of the circuit breakers is opened, connection between the spark plugs is established by

the distributor arm 3. The coils 7 and 8 are wound in the same direction with respect to the leg on which it is located and consequently will produce poles of like signs at opposite ends of the induction coil when both circuit breakers are closed. The external fields thus formed will then extend largely from the gap 13 and the closed side 16 of the core of the induction coil and between the coils. Upon rotation of the cams 15 the rotating member 3 will successfully make a closed connection between one secondary coil 5 and a spark plug at the time the circuit of the primary winding 8 is broken by the circuit breaker 11, and upon further rotation of the cams 15 the rotating member will break the circuit between the said secondary coil 5 and the spark plug and make a closed connection between the other secondary coil and another spark plug at the time the circuit is broken in the primary winding 7 by the circuit breaker 10. Consequently one coil produces a spark for only one half of the explosions required in the engine. The points on the cams 15 are so spaced that both of the primary circuits will always be closed before a primary circuit is broken.

Assuming that the cam shaft is in position such that both of the circuit breakers are closed and the circuit breaker 11 is about to open, then when the circuit through the coil 8 is broken, the number of lines of force are lowered in the leg of the core on which it is located and through the secondary coil 5 surrounding the primary coil 8. Demagnetization of this leg of the core is hastened by the coil 7 since the magneto-motive force established by the coil 7 tends to produce lines of force in a direction opposite to that produced by the coil 8. The current in the coil 7 however is not materially increased on account of the self-induction due to doubling the quantity of iron through which the lines of force pass. During the demagnetization, the distributor connects the secondary surrounding the coil 8 with a spark plug and will immediately pass from the connecting pairs of contacts. Compared to the period that the connection with the spark plug exists, the change of field requires an appreciable time, though such change of field is substantially the same as the change of field produced in the well known magneto commonly used for producing sparks in engines.

When the circuit breaker 11 is again closed, the leg of the core on which the coil 8 is located is again magnetized. The circuits of both coils are now both closed and the original external field is re-established. The circuit breaker 10 is then opened and the lines of force in the leg of the core on which the coil 7 is located are reduced by reason of the cessation of the current in the coil 7. During this time the distributor closes the secondary coil that surrounds the coil 7 through a succeeding contact of the distributor, and the same change in the magnetic conditions occurs in the leg surrounded by the coil 7 and the effects on and reactions of the secondary coil surrounding the coil 7 are reproduced in the same manner as was done in connection with the secondary coil that surrounds the primary coil 8 in the previous operation as described. Thus when the circuit of either coil 7 and 8 is broken, the first effect, operating through an appreciable interval of time relative to the speed of the distributor, is to discontinue the external field as the demagnetization of the legs of the core alternately takes place, and since the lines of force created by each coil when both circuit breakers are closed extend only through half of the core, the change in the number of lines of force due to the opening of each circuit will be rapid since they pass through only one half of the mass of the iron of the core. This is further aided by the gap 13 and by the creation of the external field.

This demagnetization of the alternate legs of the core occurs at the time that connection is established with one or the other of the secondary coils. The cams of the circuit breakers may be adjusted relative to the arm of the distributor to obtain the full benefit of this rapid change in the magnetic condition of the core.

By this arrangement there is a swinging first from one side of the induction coil to the other in that there is a periodic raising of the core and the induction coil to the maximum lines of force produceable where the lines are forced to form an external field, and reduction of the lines of force to near or slightly below zero while the spark plug is connected with the induction coil. This produces a high tension hot flames at the spark gaps although the speed of the engine may be raised to a large number of revolutions, ample time being given for building up of the opposing lines of force in the legs of the core and the creation of the external field at the ends of the induction coil. In this connection it appears that when the lines of force of one primary coil have established themselves in the other leg of the core, the coil of said other leg will not establish as large a number of lines of force when its circuit is subsequently closed, probably because of the counter effect of residual magnetism or magnetic inertia of the iron. The first mentioned coil will maintain a larger number of lines of force until its circuit is broken. Demagnetization of the core within the said other coil is however aided substantially to the same extent by the coil, since its field is well established but is ready

to demagnetize the remaining part of the core.

In the form of construction illustrated in Fig. 2, the coils 5 instead of being independently connected to the spark plugs through pairs of contacts are connected in series and form the secondary coil 17. The coil 17 is connected in series with the arm 18 of the distributor that connects the secondary coil with the spark plugs 1 in succession. The other connections of the system are the same as those illustrated in Fig. 1. In the operation of the system illustrated in Fig. 2, the coils 7 and 8, when their circuits are closed through the circuit breakers 10 and 11, produce the fields at the opposite ends of the induction coil 6 as in the system of Fig. 1. Then when either one of the circuit breakers is open, the coil connected to the other circuit breaker demagnetizes the core of the coil connected to the circuit breaker that is open at the same time that the distributor connects the secondary coil 17 with the particular spark plug. The lines of force in one leg of the core are built up so that when the current is induced in that part of the secondary coil surrounding the primary that is broken, it will readily pass through the other part of the secondary since the lines of force are already established within that part of the secondary coil in a direction that would be established by its flow, and consequently there is absolutely no choking of the secondary current. If there is any magnetic effect in the leg of the core by its flow it will be to assist the primary of that leg in increasing the magneto-motive force of that leg to de-energize the other leg. Apparently if the primary coils produce a magnetic flux approximating saturation, the secondary current will meet no opposition to the flow through its parts. Thus the systems embodying my invention may be used in connection with very high speed motors and speed engines, since the sluggishness due to the iron is reduced one-half of what would be produced if the lines of force passed circuitously through both legs of the core instead of forming the external fields at the end of the induction coil during the periods intermitting the demagnetization of the cores within the secondary coil. This enables the coils to take the current and enables the current to rise quickly in the coils to maximum, that is, to near double its quantity, during demagnetization of the cores.

I claim:—

1. In an ignition system for internal combustion engines, a source of current, a transformer core, a pair of primary coils located in parallel circuits and connected to the source of current and wound to produce opposing poles in the core, the core having a gap between two of the opposing poles produced by the primary coils, a pair of circuit breakers located in the circuits of the primary coils for alternately opening the circuits of the primary coils and a secondary coil supported on the core.

2. In an ignition system for internal combustion engines, a source of current, an induction coil U-core having a gap in its magnetic circuit, a pair of primary coils located on the legs of the core and in parallel circuits connected to the source and wound to produce like poles in the ends of the core, a pair of circuit breakers located in the parallel circuits of the primary coils, means for operating the circuit breakers to alternately open the circuits of the primary coils and secondary coils supported on the legs of the core.

3. In an ignition system for internal combustion engines, a source of current, an induction coil U-core having a gap in its magnetic circuit, a pair of primary coils located on the legs of the core and in parallel circuits connected to the source and wound to produce like poles in the ends of the core, a pair of circuit breakers located in the parallel circuits of the primary coils, means for operating the circuit breakers to alternately open the circuits of the primary coils, secondary coils supported on the legs of the core, a distributor for connecting the secondary coils of the induction coil to the spark plugs of the engine in succession when the circuit breaker opens one of the circuits of the primary coils.

4. In an ignition system for internal combustion engines, a source of current, an induction coil U-core having a gap in its magnetic circuit, a pair of primary coils located on the legs of the core and in parallel circuits connected to the source and wound to produce like poles in the ends of the core, a pair of circuit breakers located in the parallel circuits of the primary coils, means for operating the circuit breakers to alternately open the circuits of the primary coils, secondary coils supported on the legs of the core, a distributor for connecting the secondary coils alternately to the spark plugs of the engine, each secondary coil being connected to a spark plug when a circuit breaker opens the circuit of the primary coil of the leg of the induction coil core on which the secondary coil is located.

5. In an ignition system for internal combustion engines, a pair of secondary coils, a source of current, a pair of primary coils and a pair of circuit breakers connected in the circuit of the primary coils and the source of current, the primary coils connected to the source of current during periods that alternate with the periods during which but one of the primary coils is connected to the source, means for alternately connecting the

secondary coils with the spark plugs, the connection being such that the secondary coil associated with the primary coil whose circuit is broken will at the same time be connected to the spark plug, whereby the leg of the core on which the last named secondary and its associated primary is located is rapidly de-energized.

6. In an ignition sytem for internal combustion engines in combination with an induction coil having two secondary coils, a distributor having two sets of contacts, the contacts of each set being connected to one of the secondary coils, a distributor arm for connecting successively a contact of each set and the secondary coils alternately with the spark plug.

7. In an ignition system for internal combustion engines, a U-shaped core having a pair of secondary coils located in independent circuits and on the legs of the core, a source of current, a pair of primary coils located on the core for creating an external field and a pair of circuit breakers connected in the circuit of the source of current and the primary coils for alternately opening the circuits of the coils to alternately de-energize the legs of the core after periods during which the circuits of both primary coils are closed when the secondary associated with the primary coil whose circuit is open is connected with an ignition plug.

In testimony whereof, I have hereunto signed my name to this specification.

MARION MALLORY.