Jan. 6, 1959 R. A. CRUMBLISS 2,867,785

IGNITION COIL

Filed March 6, 1953

Fig. 2.

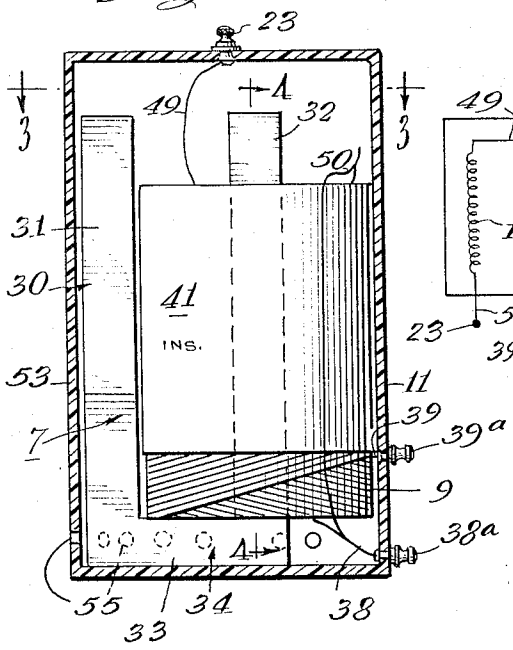


Fig. 1.

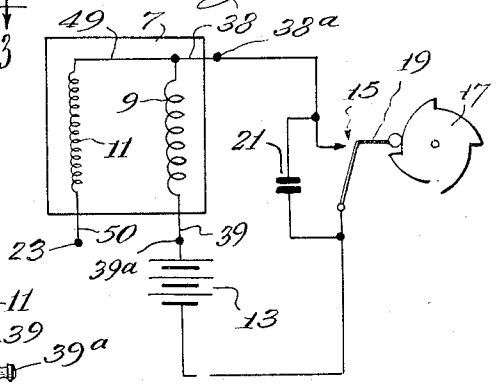


Fig. 4.

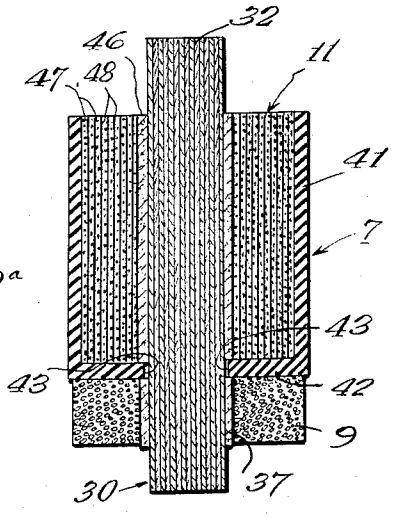
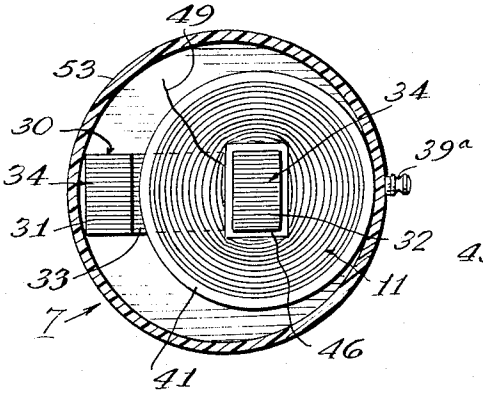


Fig. 3.



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IGNITION COIL

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8 Claims. (Cl. 336—178)

The present invention relates to an improved ignition coil assembly for internal combustion type engines. The invention also has general applicability to other types of transformer structures which present the same problems as ignition coils.

As is well known, internal combustion engines require a high voltage source of electrical energy for the purpose of providing a spark to ignite fuel in the combustion chamber. Such a high voltage is provided by means of a transformer or ignition coil the primary of which is energized by a pulsating current. Such pulsating current is developed in a series circuit which includes a battery, the primary of the ignition coil, and a pair of contacts which are mechanically opened and closed by a cam. A condenser is in parallel with the points to reduce sparking and absorb the charge from the primary when the points are opened in the course of operation.

The design of ignition coils for various types of operation has, in the past, been more or less of a compromise, in order to operate with satisfactory efficiency at low engine speeds as well as at high engine speeds. As a result, coils have been primarily designed for most efficient operation at intermediate speeds, it being recognized that less satisfactory results were obtained at starting speeds and at high speeds. However, special coils were designed with core structures and windings of particular design for use with engines which normally operate under low speed or high speed conditions. There has not been available, up to the present time, an ignition coil which would provide high performance at starting, high and intermediate engine speeds.

In addition to the foregoing limitations on presently available ignition, these coils have to be replaced not infrequently due to their construction. More particularly, the ignition coils now available are generally constructed by winding a primary coil about a core and then placing a tube over the primary coil, around which is wound the secondary coil. The coils are placed in a plastic cup and coated with a material such as a bitumen. In operation the coil becomes heated, frequently causing the resistance between the coils to become reduced and inefficient or unsatisfactory operation to result.

The present invention, however, provides an ignition coil which has a substantially constant voltage characteristic at all engine speeds and which has longer operating life than presently available ignition coils.

The improved ignition coil assembly of the present invention includes a generally U-shaped core of magnetic material, a primary winding which is disposed along one leg of the core, and a secondary winding which is disposed on the same leg of the core in serial relation to the primary coil as distinguished from superposed relation. In a preferred embodiment of the invention, a heat insulating, non-magnetic container is mounted on the core to receive the secondary coil to permit immersion of the coil in an insulating material, such as a bitumen, and to minimize the amount of heat transfer from the primary coil to the secondary coil. This type of structure

has been found to give a substantially constant operating characteristic from starting speeds to high speeds and to provide effective thermal insulation between the primary and secondary windings. In addition, the arrangement of the coils makes possible independent cooling of the primary coil so as to assure long and satisfactory coil life.

An object of the present invention is to provide an improved ignition coil and to provide such a coil having a substantially constant voltage characteristic over a wide range of engine speeds.

Another object of the present invention is to provide an improved ignition coil in which the secondary windings are effectively insulated from the primary windings both electrically and thermally.

A still further object of the invention is the provision of an improved arrangement of elements in an ignition coil so as to make possible ventilation of the primary winding.

Other objects and advantages of the present invention will become apparent from the following description and the attached sheet of drawings which illustrates a preferred form of an ignition coil embodying the principles of the present invention.

Figure 1 is a schematic diagram showing a conventional single spark system for motor vehicles, the system being adapted to include an ignition coil of the invention;

Figure 2 is a view in elevation of the improved ignition coil;

Figure 3 is a plan view of the ignition coil, the view being taken along line 3—3 in Figure 1; and

Figure 4 is a cross-sectional view taken substantially along the line 4—4 of Figure 2.

In order to more fully understand the invention, reference is made to Figure 1 which illustrates a conventional one spark system which includes an ignition coil 7 comprising a primary winding 9 and a secondary winding 11. The primary winding 9 is connected in series with a battery 13 and a pair of contacts 15 which are opened and closed by a cam 17 by means of a cam follower 19. The cam is normally rotated by the engine. In parallel with the contacts 15 is a condenser 21 which has substantial capacity, normally about .25 microfarad.

The secondary winding 11 is connected at one end to the primary winding 9 and the other end is normally connected to a distributor (not shown) so as to apply the voltage to the spark plugs (also not shown) at selected times.

An ignition coil 7 of the invention is shown in detail in Figures 2, 3 and 4 and includes a generally U-shaped core 30 made of magnetic material, the core having legs 31 and 32 and a base leg 33. The core 30 is preferably built up from a plurality of generally U-shaped laminations 34, as best illustrated in Figures 3 and 4. The core 30 may be fabricated from various ferromagnetic materials, such as silicon steel.

The leg 32 of the core structure 30 carries both the primary winding 9 and secondary winding 11 of the ignition coil. The primary winding 9, consisting of a self-supporting coil of relatively heavy insulated wire, is wound around a non-magnetic core, such as a heavy paper core 37 (Figure 4), and is disposed on the leg 32 adjacent the base leg 33 of the core 30. The primary winding 9 is tightly wound around the core 37 and the individual turns of the winding may be held together with a suitable non-conductive material such as shellac, resin, or the like. A pair of leads 38 and 39 extending from the primary winding 9 are adapted for connection to the battery 13 and to the contacts 15 (Figure 1), the leads connecting to terminal posts 38*a* and 39*a*, respectively.

Immediately above, relative to the base leg 33, the primary winding 9 is a hollow container 41 having a bot-

tom 42 provided with a centrally disposed aperture 43 by means of which the container 41 may be slidably fitted onto the leg 32 of the core 30. The container 41 is composed of a non-magnetic material having good thermal insulating qualities such as hard rubber or other suitable material having such thermal and magnetic properties. The base 42 of the container 41 is preferably bottomed on top of the primary winding 9 as shown in Figures 1 and 3.

The secondary winding 11 is contained within the container 41, the upper end of which is opened, and may consist of a more or less conventional winding arrangement, which is also self-supporting. In the form of the invention illustrated, the secondary winding 11 is wound around a non-magnetic core 46, which may also be made of paper, the latter being of such cross-sectional dimension as to slidably fit onto the leg 12. The secondary winding 11 may comprise spaced series of windings 47, each of the series of windings 47 consisting of a plurality of turns. The relative size of the windings 47 has been increased in the drawings for purposes of clarity. Between each of the series of windings 47 there is a relatively thin sheet of flexible insulating material 48, such as paper. To increase the insulating or dielectric properties of the paper 48, the paper is impregnated with or treated with suitable compositions, such as resinous compositions and the like. With the structure shown in the drawings, further insulation of the secondary winding is readily possible through filling the container 41 with insulating material, as for example a bitumen in a molten state. When molten material is used, it will solidify, upon cooling, uniformly about the secondary winding 11.

As shown in Figure 2, the secondary winding 11 also has a pair of output leads 49 and 50 extending therefrom, which leads are adapted for connection to the primary winding 9 and terminal 23, respectively (Figure 1).

While the turns on the secondary winding 11 and the primary winding 9 will vary depending upon the voltage desired for the spark plugs, for most applications, the primary winding 9 will include about 175 windings, while the secondary winding 11 will comprise from about 12,000 to about 20,000 windings, the average being about 18,000 windings.

The core 30 and associated windings are disposed in a protective casing 53 made of plastic or other material having non-magnetic and insulating properties. It will be seen that through this arrangement the lower portion of the protective casing may be ventilated, as by ventilating holes 55 (Figure 2). Thus, the heat generated by the primary winding may be easily dissipated without causing any melting of the material in the container 41 with resulting impairment of the insulation between the windings of the secondary winding 11. The arrangement, accordingly, provides outstanding advantages over presently available coils.

In a commercial embodiment of the invention, the core 30 is built up from selections of silicon steel, the core comprising 38 laminae. Each of the legs 31 and 32 are 3½ inches long and the cross-sectional dimensions are about ⅝ inch by ⅜ inch. The base leg is 1½ inches (outside dimension) and has cross-sectional dimensions of ⅝ inch and 5/16 inch. As a result, the gap between the legs 31 and 32 at the upper end is about ¾ inch.

In the commercial embodiment, the primary winding 9 comprises 175 turns and is about 1¾ inches in diameter, the coil being ½ inch in thickness. The secondary winding, comprising 18,000 turns, is contained in a plastic container 41 which is about 1⅞ inches (outside diameter) in diameter, the container being 2½ inches in height and having a wall thickness of about ⅛ inch. The secondary winding substantially conforms to the interior of the container, the winding being similarly dimensioned. The container 41 fits flush against the primary winding 9 for more satisfactory operation.

The voltage output of the above described coil is substantially constant at engine speeds from 0 to 4500 R. P. M. as distinguished from the presently generally available coils which are not operable above 3000 R. P. M. and lose their efficiency at less than 50 R. P. M. The coil operates in balance over the entire range of present day high speed engines. It not only delivers high and low speed output with uniformity, as mentioned above, but, in addition, prevents excessive burning of the contact points 15 and of the spark plug electrodes. It has been found that these contact points and spark plug electrodes are substantially unpitted after weeks of operation with the coil, while presently used coils fouled both of these elements over comparable periods.

The coil of the invention provides ease in starting and high efficiency at high, low and intermediate speeds. Such performance is not possible with ignition coils now being used.

It will be evident from the foregoing that various modifications can be made in the coil without departing from the principles of the invention and it is intended that such modification be included in the scope of this invention.

The various features of the invention, believed to be new, are set forth in the following claims.

I claim:

1. An ignition coil comprising a pair of legs and a base member defining a generally U-shaped core, made of magnetic material, said legs being connected together solely by said base member, a primary winding disposed on one leg of said core adjacent said base member and a secondary winding disposed on the same leg of said core, said secondary winding being located above said primary winding and away from said base member.

2. An ignition coil comprising a pair of legs and a base member defining a generally U-shaped core, made of magnetic material, said legs being connected together solely by said base member, a primary winding disposed on one leg of said core adjacent said base member and a secondary winding disposed on the same leg of said core immediately above said primary coil relative to the base member of said core, said secondary winding being centrally disposed on said one leg.

3. An ignition coil comprising a pair of legs and a base member defining a generally U-shaped ferromagnetic core, said legs being connected together solely by said base member, a primary winding disposed on one leg of said core, closely adjacent the base member of said core, an open-ended nonmagnetic container on said leg above said primary winding, and a secondary winding disposed about said one leg in said container.

4. An ignition coil comprising a pair of legs and a base member defining a generally U-shaped ferromagnetic core, said legs being connected together solely by said base member, a self-supporting primary winding disposed on one leg of said core, closely adjacent the base member of said core, a nonmagnetic, heat insulating container slidably fitted on said one leg and bottomed on said primary winding, and a secondary winding contained within and closely adjacent the bottom of said container and disposed about and centrally located relative to said one leg.

5. An ignition coil comprising a pair of legs and a base member defining a generally U-shaped, laminated ferromagnetic core, said legs being connected together solely by said base member, a self-supporting primary winding disposed about one leg of said core and closely adjacent the base member of said core, a nonmagnetic, heat insulating container having an apertured base slidably fitted on said leg and in adjacent relation to said primary winding, a secondary winding disposed centrally of and along said leg within said container, and a protective casing surrounding said core and said windings, said casing being ventilated in the region of said primary winding.

6. An ignition coil comprising a pair of legs and a

base member defining a generally U-shaped ferromagnetic core, said legs being connected together solely by said base member, a self-supporting primary winding disposed about one leg of said core and closely adjacent the base member of said core, a nonmagnetic, heat insulating container having an apertured base slidably fitted on said leg, said base being bottomed on said primary winding, a secondary winding disposed centrally of and on said leg within said container, said container being filled with insulating material, and a protective casing surrounding said core and said windings, said casing being ventilated in the region of said primary winding.

7. An ignition coil comprising a generally U-shaped, laminated ferromagnetic core having a pair of generally parallel legs and a base member, said parallel legs being spaced about ¾ inch at their upper end and said parallel legs being connected together solely by said base member, and being about 3½ inches in length, a self-supporting primary winding disposed about one leg of said core and closely adjacent the base of said core, said winding being about ½ inch in thickness, a secondary winding fitted on said one leg immediately above said primary winding, said secondary winding being about 2 inches in thickness and being contained in insulating material.

8. An ignition coil comprising a generally U-shaped, laminated ferromagnetic core having a pair of generally parallel legs and a base leg, said parallel legs being spaced about ¾ inch at their upper end, and being about 3½ inches in length, a self-supporting primary winding disposed about one leg of said core and closely adjacent the base of said core, said winding being about ½ inch in thickness, a secondary winding fitted on said one leg immediately above said primary winding, said secondary winding being about 2 inches in thickness and being contained in insulating material, and a protective casing surrounding said core and said windings, said casing being ventilated in the region of said primary winding.

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