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IGNITION SYSTEM FOR INTERNAL-COMBUSTION ENGINES

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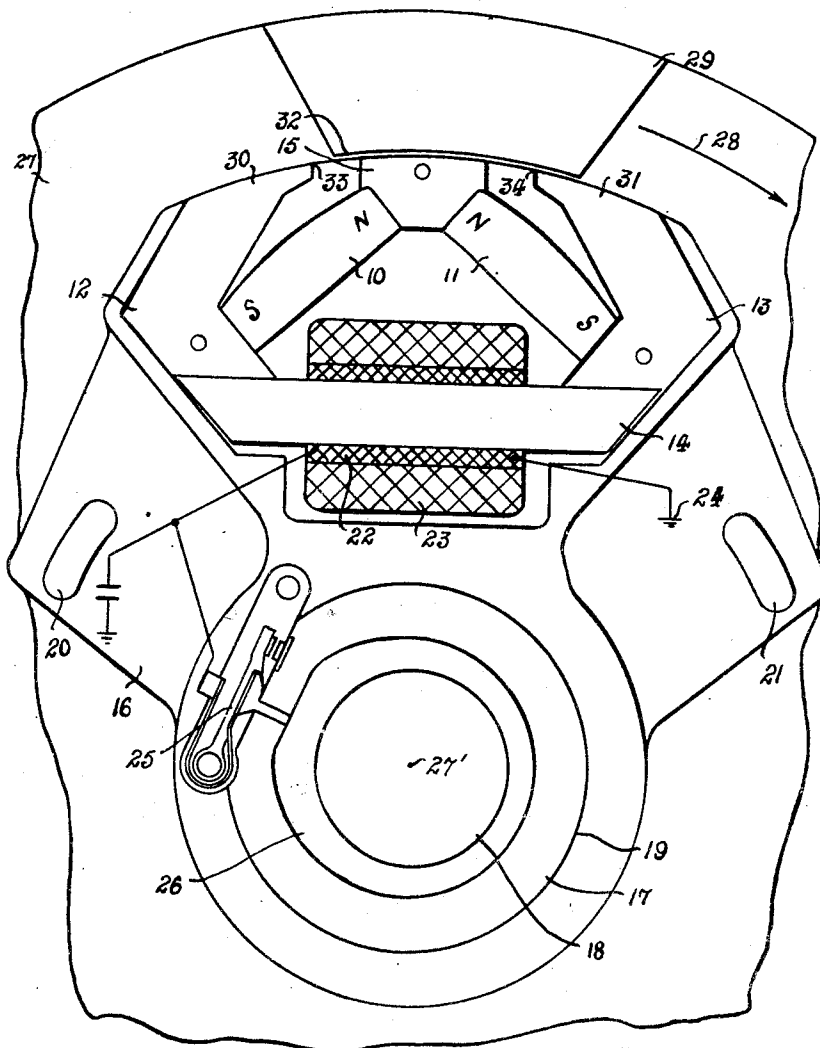


Fig. 1.

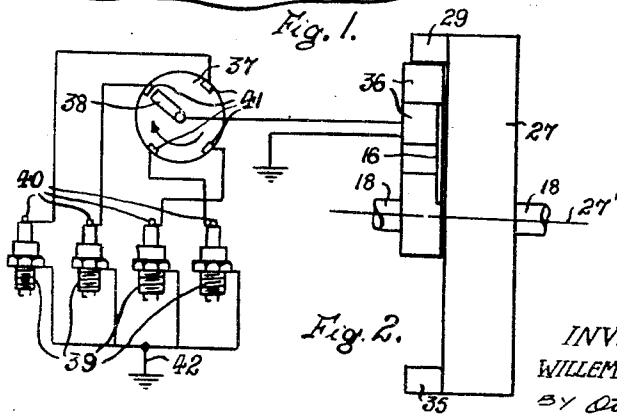


Fig. 2.

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IGNITION SYSTEM FOR INTERNAL-COMBUSTION ENGINES

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3 Claims. (Cl. 171—209)

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The present invention relates to ignition systems for internal combustion engines and has for its principal object to provide an improved ignition system capable of generating an adequate sparking voltage at very low engine speeds.

According to the present invention an ignition device for an internal combustion engine comprises a core of magnetic material surrounded by a winding and two permanent magnets arranged to apply magneto-motive forces respectively in opposite senses to the core, the arrangement being such that by the use of a suitable inductor, paths of relatively low reluctance separate from the core can be provided to reduce the said magneto-motive forces applied to the core alternately to a relatively low value and hence produce flux reversals in the core.

Such a device may be used as the stator in an ignition system, the rotor comprising the inductor fixed or coupled to the engine shaft.

One embodiment of the invention will be described, by way of example, with reference to the accompanying drawing, in which

Figure 1 is a diagrammatic part front sectional elevation of the embodiment, and

Figure 2 is a diagrammatic side elevation on a reduced scale, showing two diametrically opposite inductors.

Throughout Figures 1 and 2 like parts are given like references.

Referring to Figure 1, two permanent magnets 10 and 11 have a common closed magnetic circuit constituted by two laminated pole pieces 12 and 13, a laminated core 14 and a third pole piece 15, all of which are of high permeability magnetic material. The south poles of the magnets 10 and 11 are arranged to bear against the pole pieces 12 and 13 respectively and the north poles both bear against the pole piece 15. Thus the magnets are arranged in series relatively to the core 14 and oppose one another, that is to say they apply magneto-motive forces in opposite senses to the core 14. The magnets 10 and 11 are arranged to be of substantially equal pole strengths whereby the resultant flux in the core 14 is approximately zero.

All these parts are mounted on a frame 16 which has an aperture 17 through which is passed the crankshaft 18 of an engine (not shown). The frame 16 is spigotted on to the crankcase of the engine at a circumference 19 concentric with the crankshaft 18, and is held in place by two bolts passed through two concentric slots 20 and 21 into the crankcase. The reason for providing the slots 20 and 21 will be given later.

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Mounted around the laminated core 14 is a primary winding 22 and a secondary winding 23. One terminal of the primary winding 22 is directly earthed at 24, the other terminal being connected to earth through the contacts of a contact breaker 25 which co-operates with a cam 26 mounted on the crankshaft 18.

Fixed to the crankshaft 18 is a cast iron flywheel 27 which rotates about a common axis 27 with the crankshaft in the direction of the arrow 28, and cast integral with the flywheel is a cast iron inductor 29.

The laminated pole pieces 12 and 13 have upper arms 30 and 31 respectively and the inductor 29 when rotated with the flywheel 27 is arranged to pass close to the upper surfaces of the arms 30 and 31 and the pole piece 15. The length of the co-operating surface 32 of the inductor 29, in the direction of rotation, is arranged to be approximately equal to the gap between the edges 33 and 34 of the arms 30 and 31 respectively.

There will now be described the effect upon the flux in the core 14 when the inductor 29 is rotated with the flywheel 27. When the inductor 29 is approaching the left arm 30 the flux in the core 14 is substantially zero as previously described. On reaching a position where it bridges the gap between the arm 30 and the pole piece 15, that is to say where it greatly reduces the reluctance of that gap, a path of low reluctance is set up from the north pole of the magnet 10 through the pole piece 15, the inductor 29 and the arm 30 to the south pole of the magnet 10. When this occurs the majority of the flux from the magnet 10 is shunted through this path, resulting in a flux being set up in the core 14, in a left to right direction in the drawing. This flux is due to the magnet 10. Thus an electromotive force is induced in the primary winding 22.

On the inductor 29 moving to a central position where it bridges both gaps between the arm 30 and the pole piece 15, and the pole piece 15 and the arm 31 respectively, the flux through the core 14 once more falls to approximately zero. On moving further, however, the inductor uncovers the gap between the arm 30 and the pole piece 15 at the same time continuing to bridge the gap between the pole piece 15 and the arm 31.

When this occurs a flux due to the magnet 10 is set up in the core 14 and in a direction from right to left in the drawing.

Thus as the inductor 29 passes through the central position, the reluctance of the gap between the pole piece 15 and the arm 30 commences to increase at substantially the instant when the re-

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luctance of the gap between the pole piece 15 and the arm 31 becomes a minimum, a reversal of flux takes place through the core 14 and a second E. M. F. is induced in the primary winding 22.

When the inductor 29 moves to a position where the reluctance of the gap between the arm 31, and the pole piece 15 is once again at its relatively high value, the flux in the core 14 falls to approximately zero and for a third time an E. M. F. is induced in the primary winding 22.

The contact breaker 25 is arranged to open when the second E. M. F. due to the reversal of flux through the core 14, is substantially at its peak. The frame 16 is mounted for limited rotation about the axis 27', by means of the slots 20 and 21 and can be moved to adjust this timing.

When the contact breaker 25 opens, a relatively high E. M. F. is induced in the secondary winding 23, this E. M. F. being used for engine ignition purposes.

The contact breaker 25 may be arranged to close just after the cessation of the first E. M. F., to open at substantially the peak of the second E. M. F., and to remain open until the inductor 29, or another inductor on the flywheel 27, reaches a position where once again the first E. M. F. of the next cycle has just fallen to zero.

With this embodiment it is found possible to obtain a substantially constant amplitude of secondary E. M. F.'s over a wide range of engine speeds.

With a four cylinder engine two diametrically opposite inductors are provided as shown in Figure 2, at 29 and 35, whereby two ignition E. M. F.'s are provided during each cycle of the crankshaft and the balance of the flywheel 27 is not disturbed. In this case a suitable distributor 37 is provided, one end of the secondary winding 23 (Figure 1) being connected to the arm 38 of the distributor, the other end of the secondary winding 23 being earthed. Four sparking plugs 39, one for each cylinder of the four cylinder engine, have their terminals 40 connected to the four output terminals 41 respectively of the distributor 37, and have their metal casings earthed at 42. Where the number of cylinders in the engine, and hence the number of inductors on the flywheel 27, is such that the flywheel is not balanced by diametrically opposite inductors, one or more non-magnetic protrusions may be provided for balancing purposes.

The magnets 10 and 11, the pole pieces 12, 13 and 15, the core 14 and the windings 22 and 23 may be arranged in a hermetically sealed container shown at 36 in Figure 2, or the container 36 may be in the form of a block or moulding of non-magnetic material in which these elements are embedded. In the latter case the container may be, for example, an aluminium casting or a plastic moulding. Furthermore, part of the container 36 may be in the form of a hermetically sealed container, for example that part containing the windings, the other part being a casting or moulding having the remaining parts embedded therein. The above-mentioned timing of the contact breaker 25 has been found to result in the production of satisfactory secondary E. M. F.'s at low speed without producing excessive primary current at high speeds.

In some engines it is possible for the main

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bearing to wear considerably before it prevents satisfactory operation of the engine. Such wear usually takes place at the bottom of the bearing. The said magnetic circuit is therefore preferably mounted with the two permanent magnets 10 and 11 disposed symmetrically with respect to the horizontal plane containing the axis 27' of the flywheel 27. The air gap between the inductor 29 and the pole piece 15 and the arms 30 and 31 then remains nearly constant in spite of wear of the main bearing.

I claim:

1. An ignition device for an internal combustion engine, comprising a core of magnetic material, a winding surrounding said core, two permanent magnets arranged to apply magneto-motive forces respectively in opposite senses to said core, a magnetic circuit extending between the poles of each magnet and consisting of a structure of magnetic material having two polar surfaces defining a gap of relatively high reluctance, an inductor mounted for rotation about an axis, a surface on said inductor to co-operate with said structure in the vicinity of said gaps, said surface having a length in the direction of said rotation substantially equal to the distance between those of said polar surfaces which are farthest apart in said direction, for reducing greatly the reluctance of each gap alternately.

2. An internal combustion engine having a flywheel of cast ferro-magnetic material and an ignition system comprising a core of magnetic material, two permanent magnets arranged to apply magneto-motive forces respectively in opposite senses to said core, an inductor cast integrally with said flywheel for providing paths of relatively low reluctance, separate from said core, between the poles of said magnets, to reduce the said magneto-motive forces applied to said core alternately to a relatively low value, and hence produce flux reversals in said core.

3. An internal combustion engine having a flywheel rotatable about an axis and an ignition system comprising a core of magnetic material, two permanent magnets arranged to apply magneto-motive forces respectively in opposite senses to said core, an inductor upon and rotatable with said flywheel for providing paths of relatively low reluctance, separate from said core, between the poles of said magnets, to reduce the said magneto-motive forces applied to said core alternately to a relatively low value, and hence produce flux reversals in said core, said core and magnets being disposed in approximately the same horizontal plane as said axis.

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