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[54] **MAGNETO IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES**

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[51] **Int. Cl.**... **F02d 1/00**

[58] **Field of Search** .... 123/148 E; 315/209 CD

[56] **References Cited**

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[57] **ABSTRACT**

To provide for better uniformity of ignition pulses in capacitor discharge ignition systems, the magneto armature is formed with two windings of different numbers of turns which are both coupled to the charge circuit for the ignition capacitor, but uncoupled from each other by diodes, and a further control winding is wound on one of the cores associated with each one of the windings, connected in opposite phase with respect to the winding on the associated core, and electrically connected to trigger discharge of the capacitor through an ignition coil.

12 Claims, 3 Drawing Figures

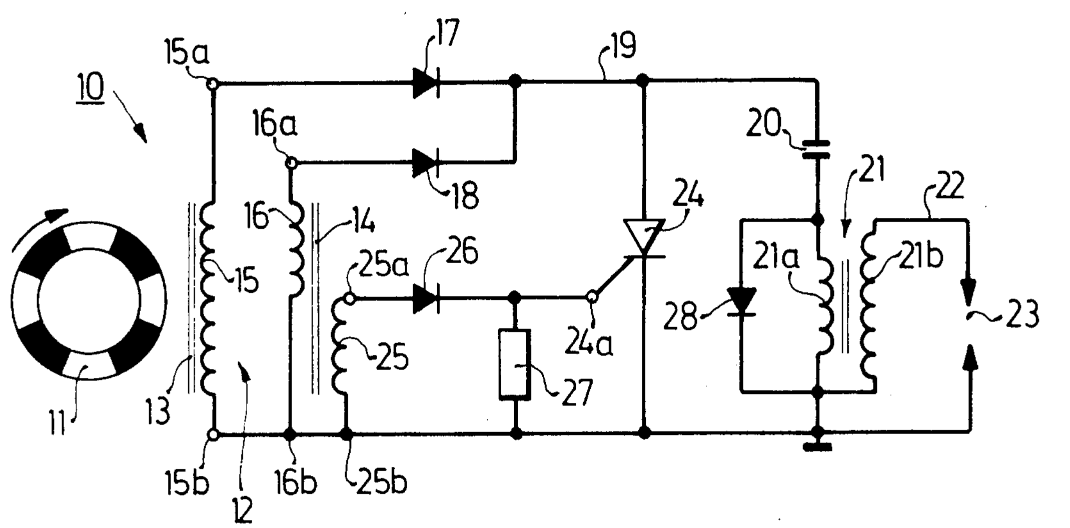


Fig. 1

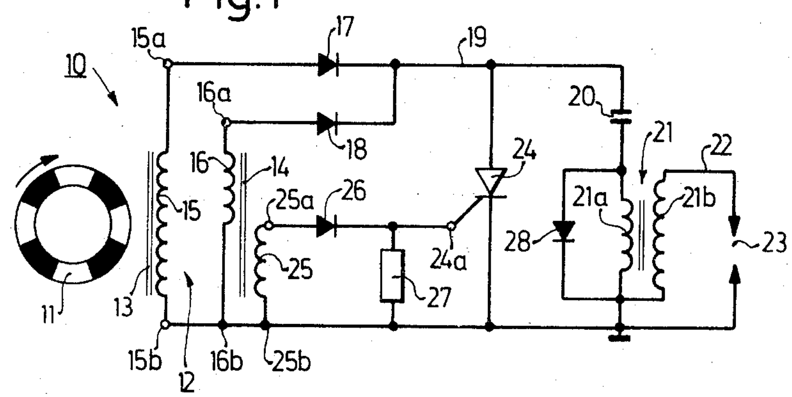


Fig. 2

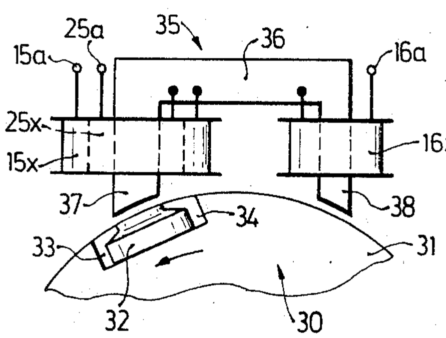
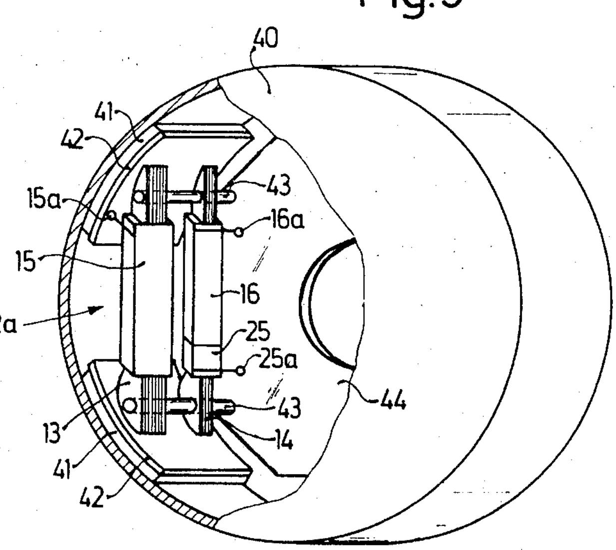


Fig. 3



MAGNETO IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES

The present invention relates to an ignition system for internal combustion engines, and more particularly to a magneto ignition system in which an armature circuit is connected to a diode to charge an ignition capacitor which is triggered to be discharged by means of an electronic triggering element, the discharge being connected through an ignition coil to provide an output spark at a spark plug connected to the secondary of the coil.

Capacitor discharge ignition systems have been proposed in which an ignition capacitor is first charged by a half wave derived from the magneto armature, for example during the occurrence of the positive half wave. During the subsequent negative half wave, the capacitor is discharged through an ignition coil or transformer. Discharge of the capacitor is controlled by a trigger circuit including a semiconductor switch, such as a transistor, a thyristor, or the like, the conduction of which is, in turn, controlled from a control winding connected in phase opposition to the charge winding of the armature of the magneto. When a pulse is obtained from the control winding, the thyristor, or similar switching element is rendered conductive to discharge the capacitor.

Circuits of this kind, which have been proposed, have the disadvantage that upon increasing speed of the internal combustion engine, the armature winding of the armature is highly loaded. The capacitor must be charged during shorter time intervals as the speed increases. This loading results in an armature reaction which prevents complete charging of the ignition capacitor when the engine operates at its upper speed ranges; further, the armature reaction influences the voltage available from the control winding. The positive voltage half wave derived from the control winding is attenuated at increasing speed due to the counteracting flux due to armature reaction and, further, retarded in phase. In higher ranges of speeds of the internal combustion engine, the control winding will therefore provide a control pulse only at a later instant in time, resulting in, effectively, retardation of the spark, which decreases the efficiency of the internal combustion engine. If the ignition capacitor cannot be charged completely, the voltage at the spark plug will decrease, which limits the upper speed which can be obtained by the internal combustion engine.

It is an object of the present invention to provide an ignition system which is simple, and effective over the entire speed range of the internal combustion engine and provides an essentially uniform ignition voltage throughout the speed range of the engine and which, preferably, increases the ignition pulse timing towards spark advance as the speed of the engine increases.

Subject Matter of the Present Invention

Briefly, the armature is formed to have two windings of different numbers of turns, located on individual cores, which are connected to the capacitor charging circuit through individual coupling diodes, so that the windings are uncoupled from each other. The control winding is wound on one of the cores, for example on the core having the smaller number of turns of the armature winding thereon, and connected in phase opposition with respect to the winding on the respective core.

The two charge windings of the armature are so matched to the charge capacitor that the winding having the greater number of turns charges the capacitor in the lower range of speed; the winding having the lower number of turns charges the capacitor in the upper range of speed of the engine. This optimum charge of the capacitor permits full control voltage to appear across the control winding, since the positive half wave of the control voltage is not attenuated by armature reaction. As the speed of the engine rises, the rate of change of the voltage, with respect to time, appearing in the control winding will likewise rise, so that the triggering voltage for the discharge circuit is reached sooner and the ignition timing is changed to advance the spark.

The invention will be described by way of example with reference to the accompanying drawings, wherein:

FIG. **1** is a schematic circuit diagram of a capacitor discharge system with a magneto generator, to generate both a charge voltage as well as a control voltage;

FIG. **2** is a schematic side view of an armature winding with a U-shaped core; and

FIG. **3** is a perspective view, partly broken away, of a fly-wheel utilized, simultaneously, as the rotating magnet of a magneto in which the armature is arranged on cores which are located in chords of the internal circumference of the fly-wheel.

An internal combustion engine, not shown, is connected to a magneto generally shown at **10** (FIG. **1**). The internal combustion engine drives a magnetic ring **11**, which is in magnetic circuit relationship with an armature **12**. Armature **12** is wound on two separate cores **13, 14,** each of which has an armature winding **15, 16,** respectively, wound thereon. The number of turns of the windings **15** and **16** is different. One terminal **15***a* of the armature winding **15,** being the winding with the higher number of turns, is connected to the anode of a diode **17.** A corresponding terminal **16***a* of the armature winding **16,** that is, the winding with the smaller number of turns, is connected to the anode of a diode **18.** The cathodes of the two diodes **17, 18** are connected together and to a supply line **19** which is connected to one terminal of the charging ignition capacitor **20.** The other terminal of ignition capacitor **20** is connected to the primary **21***a* of an ignition coil **21.** The secondary **21***b* of the ignition coil **21** is connected by means of an ignition cable **22** to a spark plug **23.** The other terminals of the primary and secondary windings of the ignition coil **21,** as well as the terminals **15***b*, **16***b* of the armature windings **15, 16** are connected to chassis or ground. A diode **28** bridges the primary winding **21***a*. The series circuit formed of capacitor **20** and the primary **21***a* of the ignition coil **21** is bridged by the main current path of a thyristor **24,** having a gate or trigger contact **24***a*.

The core **14,** carrying the winding with the smaller number of turns has a control winding **25** applied thereto, phased oppositely to the winding **16.** One terminal **25***b* is connected to the common ground or chassis line. The other terminal **25***a* is connected through a diode **26** with the gate electrode **24***a* of the thyristor **24.** A resistor **27** bridges the gate electrode **24***a* to chassis.

Operation: Upon starting of the internal combustion engine, the magnet wheel **11** is rotated in the direction of the arrow. Upon such rotation, an alternating voltage is induced in the windings **15, 16.** The negative half waves which are induced are blocked by the diodes **17, 18.** The positive half waves are transmitted over diodes **17, 18** to the ignition capacitor **20.** The charge circuit is closed over the primary winding **21***a* of the ignition coil **21** and over the ground or chassis return line to the armature windings **15, 16.** In lower ranges of speed, the voltage induced in winding **15** (with the larger number of turns) rises rapidly, so that it can charge the ignition capacitor **20** almost to its upper limit. As the speed of the engine increases, however, the voltage in winding **15** decreases due to armature reaction. Charge in the capacitor **20** is applied from the winding **16** having a lesser number of turns, since the armature reaction due to current flow in winding **16** is much smaller. The charge windings **15, 16** are so matched to the capacity of the capacitor **20** that, even in upper speed ranges, the entire positive voltage half wave is not required to completely charge the ignition capacitor **20.** After the ignition capacitor **20** is charged, armature reaction in the windings **15, 16** drops to zero, so that the subsequent negative voltage half wave occurs without time delay and phase retardation.

The control winding **25** is wound in phase opposition to the charge winding **16.** During the negative half wave in the charge winding **16,** a positive half wave will be induced in the control winding **25,** which is applied over diode **26** to the control electrode **24***a* of the thyristor **24.** Thyristor **24** has a certain response threshold level. When the voltage has reached this threshold or triggering level, the thyristor is rendered conductive and the capacitor **20** can rapidly discharge over a discharge circuit formed by the ignition capacitor **20,** thyristor **24,** chassis connection and the primary **21***a* of ignition coil **21.** This rapid suddenly occurring pulse, having a high rate of change of current, results in a high voltage pulse in the secondary **21***b* of ignition coil **21** to provide the spark at spark plug **23.** The charge and discharge cycle repeats on the ignition capacitor **20** upon each half rotation of the magnetized or magnet wheel **11.** The control winding **25** operates practically without loading. The rate of voltage rise thus increases as the speed of the engine increases, so that the triggering level of the thyristor is reached earlier and earlier as the speed increases, and so that the discharge of the capacitor **20** is likewise advanced, thus changing the timing of the ignition of the internal combustion engine in the direction to advance the spark as the speed of the engine itself increases.

FIG. 2 shows a magneto generator **30** in which a permanent magnet **32,** having pole shoes **33, 34** at the sides thereof, is located on the circumference of a fly-wheel **31** of the internal combustion engine. The fly-wheel **31** is driven by the internal combustion engine from a shaft, not shown. The permanent magnet **32** co-operates with an armature **35** on the engine, which is stationary. It includes a U-shaped iron core **36** with two projecting legs **37, 38,** on which the windings **15***x*, **16***x* and the control winding **25***x* are wound. The windings **15***x*, **16***x*, **25***x* correspond to the windings **15, 16, 25** of FIG. **1.** The cross-sectional areas of the legs **37, 38** are different. The control winding **25***x* and the armature winding **15** are located on the core leg **37** which has the larger cross-sectional area. The winding 16, having the smaller number of windings, is located on core leg **38** having a smaller cross-sectional area. The three windings have one terminal, each, connected to the core **36,**

and hence to chassis of the machine; the other terminals are brought out at terminals **15***a*, **16***a*, **25***a*, respectively, and connect to the corresponding terminals **15***a*, **16***a*, **25***a* of FIG. **1.**

Operation: Basically, the operation of the magneto generator **30** of FIG. **2** is essentially the same as that described in connection with FIG. **1.** The different cross-sectional area of the two core legs **37, 38** provides for relatively great leakage of the flux derived from the permanent magnet **32,** as it passes with its pole shoes between the ends of the core legs **37, 38.** This, then, effectively de-couples the windings **15***x* and **16***x* from each other, so that a counter-flux in one of the windings does not adversely effect the induced voltage in the other winding.

The control winding **25***x* is connected in phase opposition with respect to the winding **15***x*. In operation of the engine, the ignition capacitor is first charged by the windings **15***x* or **16***x*, respectively, and then discharged, at the ignition instant, by the positive voltage half wave arising in the control winding **25***x*, thereby rendering thyristor **24** conductive and discharging capacitor **20.** The charge and discharge cycle with respect to ignition capacitor **20** and the resulting ignition of spark plug **23** of the internal combustion engine only occurs once upon each rotation of the fly-wheel **31.** If more frequent ignition is desired, more than one magnetic structure **32, 33, 34** can be located around the circumference of fly-wheel **31.**

The magneto generator generally shown at **10** in FIG. **1** may be associated also with hollow fly-wheels. Referring to FIG. **3,** a pot-shaped, cylindrical, hollow fly-wheel **40** has located therein four segment-shaped permanent magnets **41,** of alternating polarity. The cut-away portion of the fly-wheel makes visible the magneto structure **12***a* which includes cores **13, 14** formed as chords with respect to the circumference of the cylindrical fly-wheel **40.** The permanent magnets **41** are supplied with pole shoes **42.** The chord-located cores **13, 14** are magnetically in parallel, and located axially staggered in the cylindrical fly-wheel - armature combination. Non-magnetic spacer pins **43** space the cores **13, 14** from each other and additionally secure the cores on an armature plate **44,** which is stationary. The lower, or inner core **14** has a smaller cross sectional area than the outer, or upper core **13.** Space utilization is particularly efficient when the control winding **25** is wound together with the winding **16,** having the lesser number of turns on one common core **14** (which is the core of smaller cross-sectional area). The other main winding **15,** with the larger number of turns, is then located on core **13** having the larger cross-sectional area.

Various changes and modifications may be made within the inventive concept. It is possible, for example, to locate the cores **13, 14** not axially staggered, as shown in FIG, **3,** but rather axially aligned and offset with each other by 90°, or 180° electrical. The main windings **15, 16** must, however, have different numbers of turns, and the control winding **25** must be located on one of the cores associated with one of the main windings, and connected in phase opposition with respect thereto.

Typical dimensions for a magneto generator, of the type of FIG. **1** may be:

coil 15:	7000	turns

-Continued

coil 16:	1500	turns
coil 25:	100	turns
cross section of armature core 13:	4.0	cm^2
cross section of core 14:	2.5	cm^2
charge capacitor 20:	2.0	μF.

The foregoing is merely an example and various changes and modifications may be made within the inventive concept.

We claim:

1. Magneto ignition system for internal combustion engines comprising

an armature (**12**), a rotating magnet (**11**) magnetically coupled to the armature, an ignition storage capacitor (**20**), a charging circuit (**17, 18**) connecting the capacitor and the armature to charge the capacitor, and a discharge circuit (**26, 24, 27**) including a discharge control winding (**25**) polarized oppositely to the armature and connected to the capacitor to discharge the capacitor through an ignition coil (**21**) to generate an ignition spark pulse for a spark plug (**23**),

and wherein the armature comprises two individual cores (**13, 14**) and two windings (**15, 16**) each located on an individual core (**13, 14**); the charging circuit comprises diodes (**17, 18**) connected and poled to electrically uncouple said two windings (**15, 16**) from each other,

characterized in that

the numbers of turns of the windings (**15, 16**) are different to provide charge energy to the capacitor (**20**) over a wide range of engine speed;

and in that the control winding (**25**) is a separate winding wound on one of said individual cores, and connected in phase opposition with respect to the winding on said one core to provide energy to control the discharge of the capacitor when no charge energy is required from the armature windings, and to generate said control energy independently of induction in any one of the armature windings.

2. System according to claim **1**, wherein the cores (**13, 14; 37, 38**) have different cross-sectional area, the control winding (**25***x*) and one of the armature windings (**15***x*) being located on the core of greater cross-sectional area.

3. System according to claim **2**, wherein the cores form the leg parts (**37, 38**) of a U-shaped core structure (**36**) in which the leg parts are of different cross-sectional area.

4. System according to claim **1**, wherein the magnet (**41, 42**) is located at the inner surface of a hollow rotating structure (**40**);

the armature cores (**13, 14**) are located within the hollow structure on chords with respect to the center of the rotation thereof.

5. System according to claim **4,** wherein the armature cores are separate core elements;

a carrier (**44**) and means securing the armature core elements to the carrier while providing for magnetic isolation of said cores with respect to each other.

6. System according to claim **4,** wherein the armature cores are separate core elements (**13, 14**) located magnetically in parallel with respect to the magnet (**41, 42**).

7. System according to claim **1,** wherein the control winding (**25**) is located on the core (**14**) carrying the winding (**16**) with the smaller number of turns.

8. System according to claim **1,** wherein the cross-sectional area of the cores is different and the control winding (**25**) is located on the core with the smaller cross-sectional area.

9. System according to claim **1,** wherein one, terminal, each, of both windings (**15, 16**) of the armature windings, and of the control winding (**25**) are commonly connected to ground, or chassis of the engine.

10. System according to claim **1,** wherein the engine has a fly-wheel (**40**) having a cylindrical, hollow portion;

the magnet (**41**) is located at the inner surface of the fly-wheel, and the armature cores are located inside said hollow portion, magnetically coupled to the magnet;

a support carrier (**44**) facing said hollow portion;

and non-magnetic attachment means (**43**) attaching the cores to the support portion.

11. System according to claim **10,** wherein the cores are located adjacent and parallel to each other, spanning a chord of the cylindrical portion, and the attachment means comprises axially extending pins (**43**) passing through said cores, separating said cores from each other, while attaching both said cores to the carrier;

the control winding (**25**) is located on the core (**14**) carrying the winding (**16**) with the smaller number of turns.

12. System according to claim **1,** wherein the cores (**13, 14**) are of different cross-sectional area, and the winding (**16**) having the smaller number of turns, as well as the control winding (**25**) are located on the core (**14**) having the smaller cross-sectional area.

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