

[54] **FLYWHEEL MAGNETO IGNITION DEVICE
WITH CAPACITOR-THYRISTOR IGNITION
COMBINED WITH GENERATOR**

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310/70

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[58] Field of Search 123/148 E, 149 R, 149 D,
123/149 C; 310/153, 70

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[57]

ABSTRACT

A flywheel magneto ignition device with capacitor-thyristor ignition combined with generator comprises a first component group for producing an ignition effect and a second component group for generating current for lighting and/or battery charging purposes, the first component group comprising a rotor having mounted therein permanent magnets the pole of which are arranged to coact with coils containing at least one coil core and intended for the capacitor-thyristor-ignition circuit, and the second component group comprising a system of coils provided with iron cores and fixedly mounted in a rotating magnetic field from a body corotating with the rotor in the first component group, the rotor and the corotating body being mechanically connected together but with the respective magnetic fields shielded from each other.

5 Claims, 6 Drawing Figures

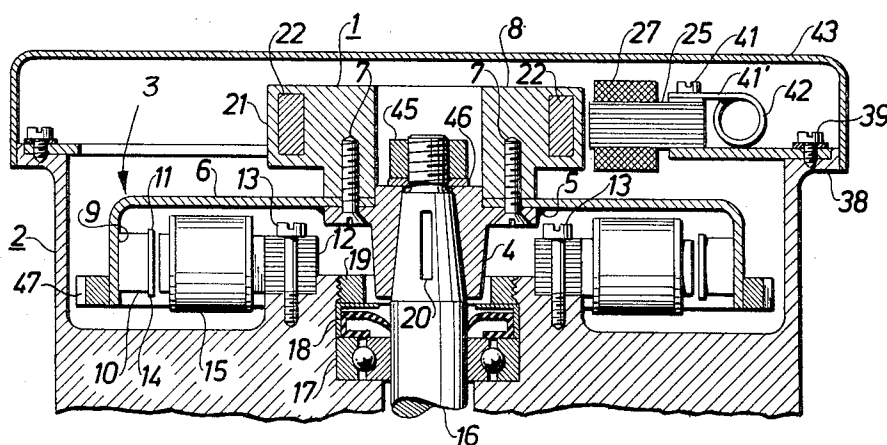


Fig. 1

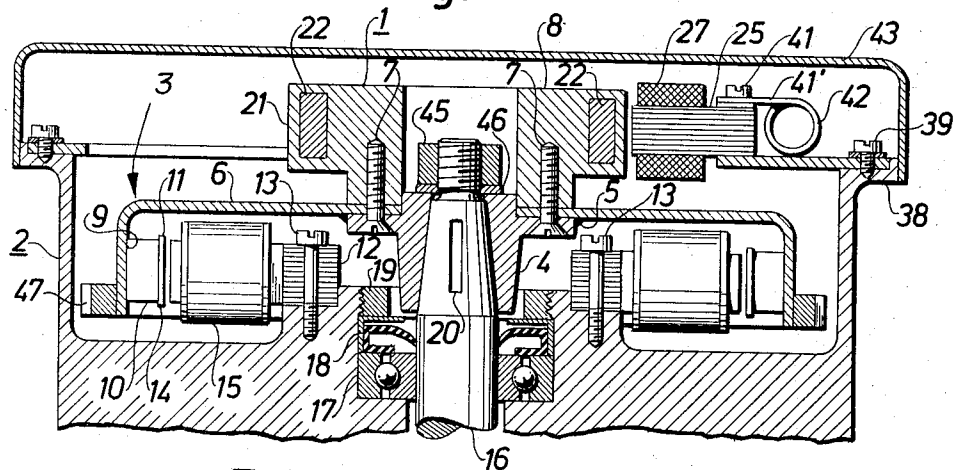


Fig. 2

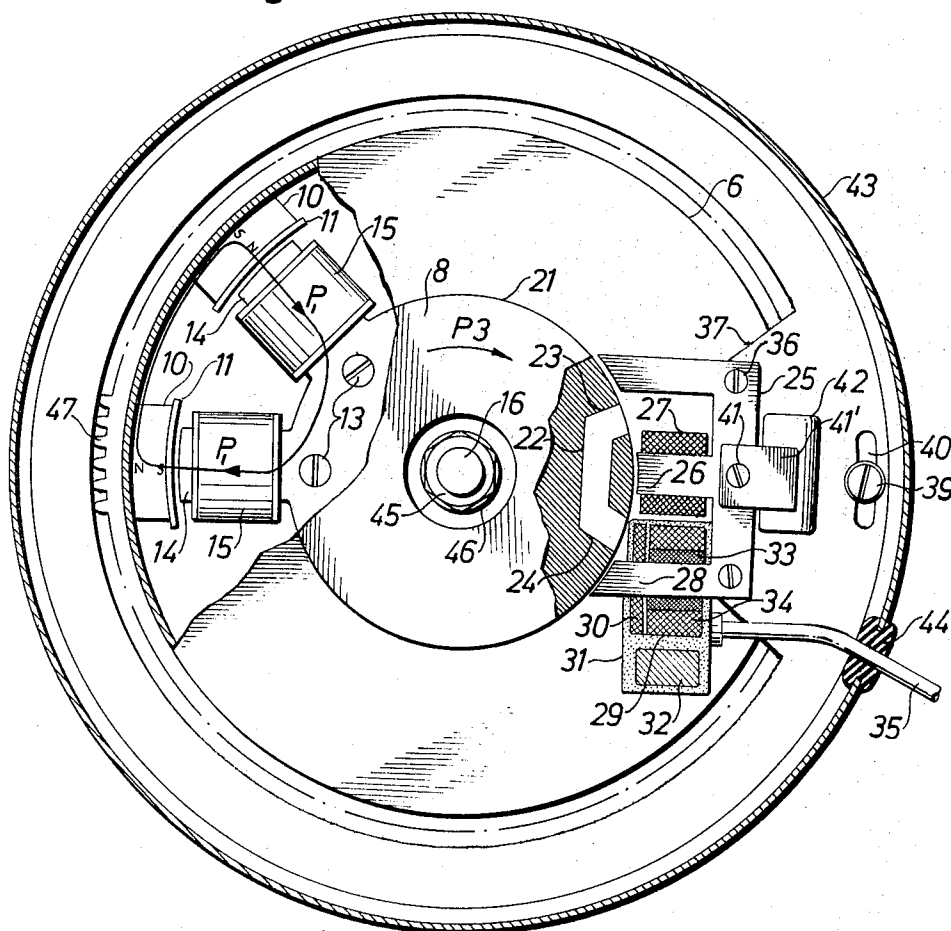


Fig. 3

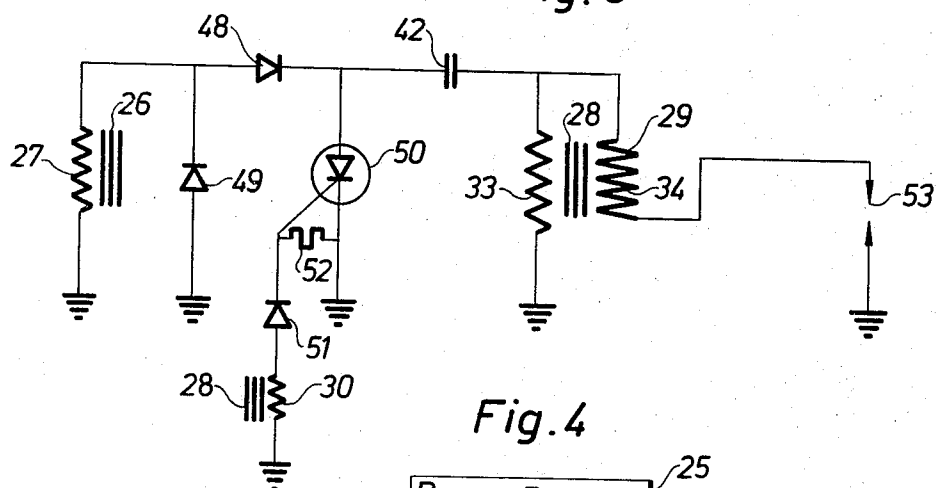


Fig. 4

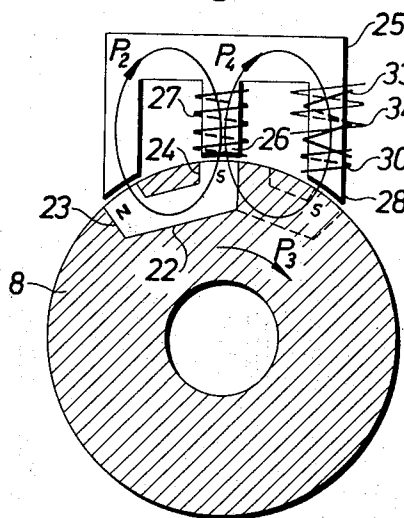


Fig. 5

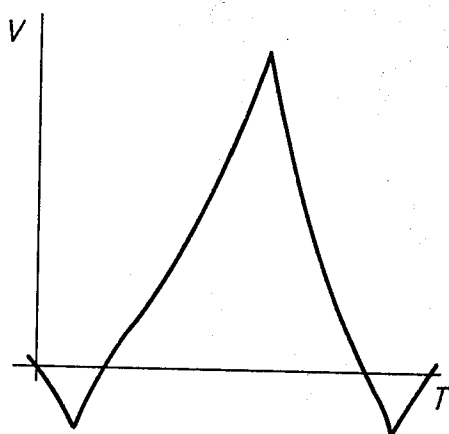
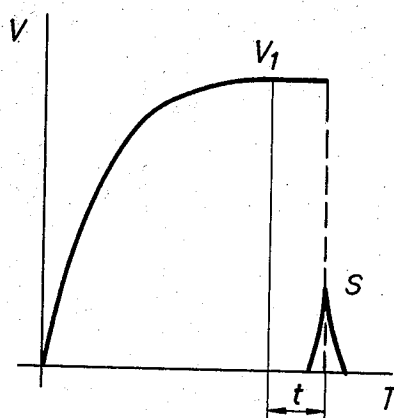


Fig. 6



FLYWHEEL MAGNETO IGNITION DEVICE WITH CAPACITOR-THYRISTOR IGNITION COMBINED WITH GENERATOR

The combination flywheel magneto ignition device-generator has long been known to the art. By means of this combination it is possible to supply to the spark plugs of an engine the high voltage required to operate the engine and also to produce the low voltage often required to operate the lighting systems of such vehicles as autocycles, motorcycles, motor boats and the like. In recent years the requirements placed on ignition power and generator power have greatly increased. Ignition power is a decisive factor of engine operation, both with respect to engine working speeds and idling speeds, and is of decisive importance to engine starting speeds. Thus, every improvement on ignition power is immediately reflected in engine performance. The demand for increased generator power is the result of increased standards on lighting conditions at sea for example, and thus on the ability of marine systems to generate sufficient power. The current supply must be sufficient to charge a battery, which in turn in certain cases must be dimensioned to supply current to the starting motor of an internal combustion engine.

With conventional flywheel magnetos using the inductive ignition principle, the generator current can normally be produced in direct combination with the ignition system by arranging one or more generator coils in the magnetic circuit of the flywheel. By inductive ignition is meant here the age old solution of arranging in the magnetic circuit of the flywheel an ignition coil having a primary and a secondary winding. A mechanical breaker, over the breaker points of which a capacitor is connected in parallel, is actuated by a cam on the engine shaft to break the primary circuit of the ignition coil at maximum voltage levels in the primary circuit. In this way there is induced in the secondary circuit a high voltage with an operational voltage of 8-10 kV, wherewith spark is produced on the spark plug.

In such a case, the generator coils can be arranged to advantage in the same geometric plane and in the same rotary magnetic field as the ignition coil (or coils), and when the generator coils are correctly designed and correctly arranged in the magnetic field in relation to the ignition coil, no disturbing effect from the generator coils on the ignition is obtained. The generator power output is essentially a question of the dimensioning of the generator portion.

In recent years intensive development work has been carried out on the capacitive ignition system. With such a system, a pre-charged capacitor is discharged over the primary winding of an ignition coil as a result of a control element closing the circuit. The control element may be a mechanical device in the form of a breaker similar to the type used with inductive ignition systems, or may also comprise an electronic circuit including a thyristor, a diode and a trigger coil provided with an iron core. The trigger coil is arranged in the rotating magnetic field of the flywheel and opens and closes the diode by voltage signals induced in the coil under the influence of the magnetic field.

The capacitive ignition system enables the ignition power to be increased over the whole operating range of the engine. The spark-over voltage in special spark plugs intended for this system is from 18-20 kV. The

engine runs more smoothly and more positively at top engine speeds and at idling speeds, while the starting r.p.m. can be considerably reduced. In addition, a thyristor controlled capacitive system obviates the use of mechanical interruption means, thereby eliminating problems such as wear and tear unavoidably incurred with such devices.

On the other hand, the use of capacitive ignition systems provided with trigger coil/thyristor as a control means instead of a purely mechanical switching element, has been found to present unexpected problems in combination with generator coils for producing lighting and charging currents. This is connected with the fact that the thyristor in capacitive systems has two functions to perform. Firstly it must open a circuit with a charging coil having a parallel-connected and series connected diode for charging the capacitor, and secondly to close a circuit with the capacitor and primary winding of the ignition coil to cause the capacitor to discharge and therewith the high voltage current in the secondary winding of the ignition coil to spark over at the spark plug. Thus, the timing and magnitude of the control pulse from the trigger coil to the thyristor must be particularly accurately adjusted. Since, with respect to these factors, the control pulse is totally determined by the rotating magnetic field, the field must have a particularly high degree of stability.

Using the technique known from the inductive system as a standpoint, the capacitive ignition system has been developed with generator coils disposed in the same plane i.e., the same rotating magnetic field as the aforementioned charging coil and trigger coil for the thyristor. In this connection, it has been found extremely difficult to screen off to a sufficient extent (i.e., practically totally) the magnetic field variations caused by the generator coils from the magnetic field actuating the trigger coil. Owing to varying degrees of load on the generator coils, a magnetic field common to all coils and located in a single plane is subjected to unavoidable variations in magnitude and direction (sense). The differences in the magnetic field with loaded and unloaded generator coils can be significant, and even varying degrees of load can give the same phenomenon. This results in such changes in the trigger coil control pulse that its thyristor control function, and therewith the ignition process, is seriously impaired. This can in turn result in lower ignition power, displacement of the timing etc., i.e., changes which cannot be tolerated.

The object of the present invention is to eliminate these disadvantages and to construct and design the elements forming part of the flywheel magneto ignition device - generator combination in a manner which affords significant advantages from the aspect of manufacture and servicing.

This object is obtained by means of the device according to the invention, which relates to a flywheel magneto ignition device, using a capacitor-thyristor ignition system, and generator combined, comprising a first component group for producing an ignition effect and a second component group for generating current for lighting and/or battery charging purposes. The device is mainly characterized in that the first component group comprises a rotor having mounted therein permanent magnets the poles of which are arranged to coact with coils containing at least one coil core and intended for the capacitor-thyristor-ignition circuit, and

wherein the second component group comprises a system of coils provided with iron cores and fixedly mounted in a rotating magnetic field from a body co-rotating with the rotor in said first component group, the rotor and the co-rotating body being mechanically connected together but with respect to respective magnetic fields shielded from each other.

The invention will now be described with reference to an embodiment thereof illustrated in the accompanying drawings, in which

FIG. 1 illustrates in vertical cross section a flywheel magneto ignition device in combination with a generator in accordance with the invention and employing a capacitor-thyristor ignition system, the device being illustrated as housed in one half of the crankcase of an internal combustion engine (not shown).

FIG. 2 is a horizontal cross-sectional view, partly in elevation, of the flywheel magneto ignition device shown in FIG. 1, showing an E-shaped, laminated iron core provided with a charging coil, an ignition coil having a primary and a secondary winding, and a trigger coil.

FIG. 3 is a wiring diagram for the capacitor-thyristor ignition system according to the invention.

FIG. 4 diagrammatically illustrates in principle a rotor provided with a permanent magnet and intended for the ignition device illustrated in FIGS. 1 and 2, and also shows the laminated iron core and coil windings illustrated in FIG. 2,

FIG. 5 is a diagram showing the voltage pattern of the charging current generated in the charging coil of FIGS. 2 and 4 to a capacitor arranged in the circuit diagram of FIG. 3, and

FIG. 6 is a charging curve in respect of the voltage created in the capacitor through the voltage pattern shown in FIG. 5 and a trigger pulse for opening and closing a thyristor in the circuit illustrated in FIG. 3.

In FIG. 1 a flywheel magneto ignition device is generally indicated with the reference numeral 1, and a portion of one half of an engine crankcase is generally indicated with the reference numeral 2. The ignition device has a flywheel 3, comprising a flywheel casing 6 securely attached to a hub 4 as by a weld joint 5 for example, and a rotor 8 securely mounted over the casing 6 with a plurality of bolts 7 for example. The flywheel casing 6 is made from a ferromagnetic material, such as iron sheet, and has securely mounted along the periphery of an inner, generally cylindrical surface 9, a number of permanent magnets 10, the number of which can be varied to suit the generator power for which the device is dimensioned. The permanent magnets 10 are symmetrically arranged on the surface 9 and retained in the casing 6 by screws (not shown), which pass through the casing 6 from the outside thereof and are respectively screwed into pole shoes 11, so that the permanent magnets 10 are firmly clamped between the pole shoes 11 and the surface 9. This screw joint is often strengthened with an adhesive, of the thermosetting epoxy resin type for example. Attached firmly to the crankcase half 2 in substantially the same plane as the permanent magnets 10 is a laminated stator 12 of dynamo sheet, held in position by a number of screws 13. The stator 12 has radially outwardly extending legs 14, which form cores for a pair of generator coils 15. The permanent magnets 10 are magnetized in the direction shown in FIG. 2 with the references N.S. and S.N. Thus, each time the perma-

nent magnets 10 pass the stator legs 14, a magnetic field is created through the stator 12 and the flywheel casing 6, said field having the direction shown by the arrow P1 in FIG. 2. As the flywheel casing rotates there is thus created in the coils 15 an alternating current which can be used directly for lighting purposes or/and be rectified for battery charging purposes.

The hub 4 has a frusto conical internal configuration and is mounted on an engine shaft 16 mounted on the crankcase half 2 by a bearing assembly 17, having an axially externally located sealing ring 18, the bearing assembly 17 and the sealing ring 18 being held in position by a ring nut 19. A key 20 fixes the hub 4, and therewith the flywheel 3, to the shaft 16 and ensures co-rotation of the said elements together with their correct angular orientation relative to the shaft 16.

The rotor 8 is made of a non-magnetic material, such as aluminium, zinc, reinforced thermosetting resin or the like, and has arranged along an outer cylindrical surface 21 one or more permanent magnets 22 each having a pair of generally radially outwardly directed poles 23, 24, the outer surfaces of which lie in plane with the cylindrical surface 21.

Arranged on a level with the rotor 8 and externally of the cylindrical surface 21 is one or more laminated, preferably E-shaped coil cores 25, the centre arm 26 of which is provided with a charging coil 27 and one side arm 28 of which co-operates with an ignition coil 29 and a trigger coil 30. The ignition coil 29 and the trigger coil 30 are cast in a block 31 of thermosetting resin, e.g. epoxy resin, which also encloses the electronic components 32 forming part of the ignition system and described in more detail hereinafter with reference to FIG. 3. Thus, the ignition coil 29, which comprises a primary winding 33 and a secondary winding 34, the trigger coil 30 and the electronic components 32 are present as a compact unit in the form of the block 31, which is particularly well protected, both mechanically and with respect to moisture attack. Necessary cables, of an ignition cable 35 as shown in FIG. 2, are connected to terminals sealed in the block.

The laminated coil core 25, which is made from dynamo sheet, is attached by a pair of screws 36 to a preferably annular holder plate 37 which at one outer circular edge runs along a rim 38 arranged on the crankcase half 2 concentrically in relation to the shaft 16. The holder plate 37 is mounted to the rim 38 with screws 39, the plate 37 being provided with a number of attachment slots 40 to enable the angular position of the coil core 25 to be adjusted relative to the crankcase half 2 and thus also relative to the position of a piston (not shown) in the internal combustion engine.

A capacitor 42, hereinafter described with reference to FIG. 3, is mounted on the core 25 by means at least one screw 41 and a lug 41'. The core 25, the charging coil 27, the block 31 and the capacitor 42 form a complete unit comprising all the mechanical and technical elements which, together with the rotor 8, provide the necessary ignition voltage. Since the unit is secured to the holder plate 37 solely by the screws 36, it can readily be removed for servicing purposes.

The combined generator-flywheel magneto ignition device shown in FIGS. 1, 2 is totally contained within the crankcase half 2 and a cap 43 which is mounted to the rim 38 and which has a plastic or rubber grommet 44 for the ignition cable 35. Removal of the cap 43 pro-

vides direct access to all the principal elements of the ignition system for adjusting or servicing purposes.

In order to inspect the generator element requiring less servicing, it is necessary first to remove a locking nut 45 and a locking washer 46 on the engine shaft 16, whereafter — using appropriate tools — the flywheel 3 can be drawn from the shaft 16 to expose the stator 12.

As illustrated in FIGS. 1, 2, the casing 6 can be arranged to co-act with a welded gear ring or annulus 47 against which a bendix drive mounted on a start motor spindle (not shown) can work when starting the engine electrically.

The elements and sequence of operations producing the ignition voltage are totally separated in respect of the magnetic field from the elements and operations producing the generator voltage. The ferromagnetic flywheel casing 6 effectively shields the magnetic field outwardly from the permanent magnets 10 arranged within the casing and the non-magnetic rotor 8 is free from all tendency to attract the field from the permanent magnets 10. This means that no interference or disturbances from the generator portion caused, for example, by variations in load can affect the ignition elements, especially the trigger coil 30. The mode of operation of the trigger coil and the other elements active in the ignition process is described with reference to FIGS. 3-6, in which — where applicable — with reference to FIGS. 1 and 2 like reference numerals are used to identify like elements.

FIG. 3 is a circuit diagram of the electrical elements active in the ignition process, i.e., the charging coil 27 with the iron core 26, the ignition coil 29 with the primary winding 33 and the secondary winding 34, and the iron core 28. FIG. 3 also illustrates the capacitor 42 and a first diode 48, which rectifies the a.c. voltage advanced from the charging coil 26 to the capacitor 42, and a second diode 49, which releases the first diode 48 from excessively high voltages from the negative half-wave of the charging coil. Connected between the first diode 48 and the capacitor 42 is a thyristor 50 which is switched on and off in response to control signals from the trigger coil 30 also associated with the iron core 28. A third diode 51 is connected between the trigger coil 30 and the thyristor 50. A second line from each of the charging coil 27, the second diode 49, the thyristor 50, the trigger coil 30 and the primary winding 33 of the ignition coil 29 is connected to ground.

A shunt system 52 which includes a fixed resistance and optionally also a capacitor adapted for capacitive ignition systems for all sizes is connected from the ground connection to the thyristor 50 and the line passing therefrom to the third diode 51. Further, an output line from the secondary winding 34 on the ignition coil 29 is connected to an insulated central electrode on a spark plug 53, on which a second electrode is grounded.

FIG. 4 illustrates diagrammatically the changes in magnetic flux occurring in the coil core 25 when the permanent magnet 22, with its poles 23 and 24, arranged in the rotor 8 has passed by, the poles being marked with N and S respectively, to show the direction of magnetization. In a charging coil 27. Thus the trigger coil 30 will send a control signal S (FIG. 6) a very short time after the capacitor has reached its full charging voltage V1 (FIG. 6). Charging of the capacitor 42, triggering of the thyristor 50 and therewith dis-

charging of the capacitor 42 with resulting sparking on the spark plug 53 takes place in a very rapid sequence determined by mechanically bound element positions and tuning between the trigger coil 30 and the thyristor 70, which sequence can in no way be influenced by magnetic field disturbances from the generator portion. As previously mentioned, this is a prerequisite of positive ignition.

Thus, the described combined flywheel magneto ignition apparatus — generator provides all the desired technical effects. As previously mentioned, it also affords important advantages with respect to manufacture and servicing. The block 31 is a complete unit in which the electronic elements are well protected. The block 31 may also embody the charging coil 27, so that said coil is more hermetically sealed and better protected. All elements of the described device can be mass produced. It is also possible to use one and the same flywheel magneto ignition device for single, double or multicylinder engines by arranging on the holder plate 37, FIGS. 1, 2, iron cores 25 with associated co-operating elements in positions and numbers corresponding to the number of cylinders and cylinder positions.

I claim as my invention:

1. A combined magneto and generator device, comprising:

a. means for producing an ignition effect for connection to a thyristor-capacitor ignition circuit, said means including

- (1) at least one charging coil and one trigger coil each having a coil core,
- (2) a rotor, and
- (3) a number of permanent magnets mounted in said rotor, the magnetic field of which is arranged to coact with said coils;

b. means for generating direct current for a connection to a lighting and/or battery charging type of circuit, said generating means including

- (1) a ferromagnetic casing corotatably secured to said rotor in coaxial alignment, and with said rotor and its coacting coils disposed at one side thereof,
- (2) permanent magnets disposed on the side of said casing opposite to said rotor, and providing a rotatable magnetic field, and
- (3) a system of coils having iron cores and fixedly mounted in said rotatable field; and

c. said ferromagnetic casing constituting a magnetic shield between said ignition effect means and said generating means.

2. A combined device according to claim 1 in which said first-named coil core has arms defining an E-shape, one of said first-named coils being a charging coil disposed on a first of said arms, a second of said first-named coils being an ignition coil disposed on a second of said arms which, in the direction of rotor rotation, is behind said first arm, said ignition coil having a primary winding and a secondary winding, and a third of said first-named coils being a trigger coil disposed on said second arm.

3. A combined device according to claim 2 in which said trigger coil is disposed nearer said rotor than said ignition coil.

4. A capacitor-thyristor ignition system having a combined device according to claim 2 including a capacitor, a diode, a thyristor and a spark plug connected

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to said secondary winding, said charging coil being connected first to charge said capacitor through said diode, said trigger coil being connected to provide a control signal at said thyristor for discharging said capacitor through said primary winding of the ignition coil for thereby creating a spark on said spark plug.

5. A system according to claim 4 in which said igni-

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tion coil, said trigger coil and a number of the electronic components in circuit therewith are cast in a block having the physical properties of thermosetting resin to comprise a compact, shock-proof and moistureproof unit.

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