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 TRIGGERED IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES
 WITH MEANS TO RESTRICT OPERATION TO UNIT
 DIRECTIONAL ROTATION
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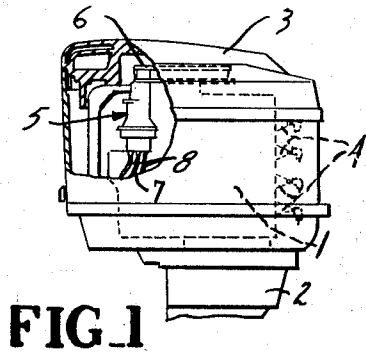


FIG. 1

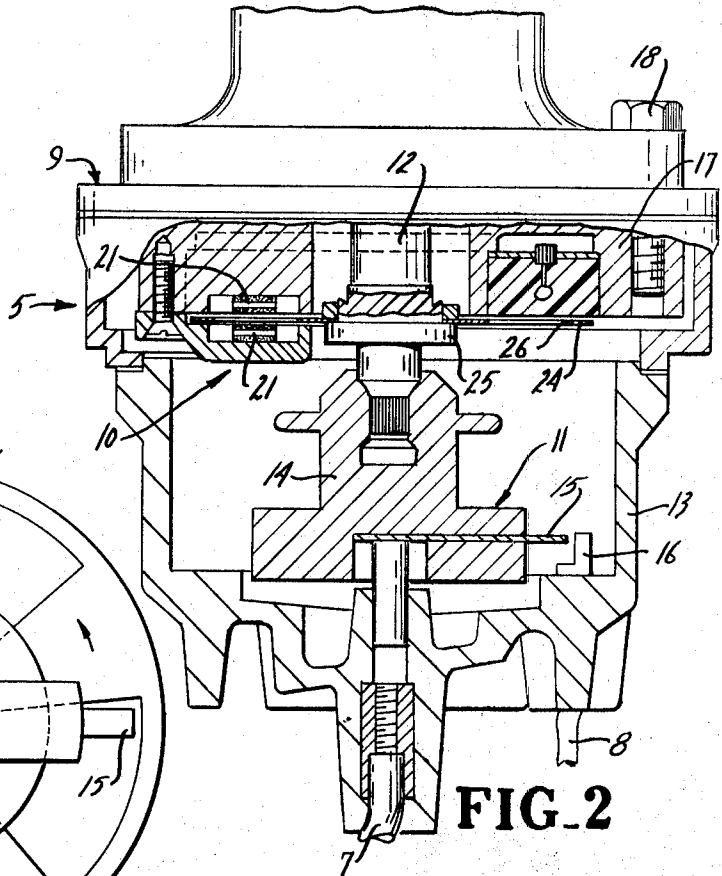


FIG. 2

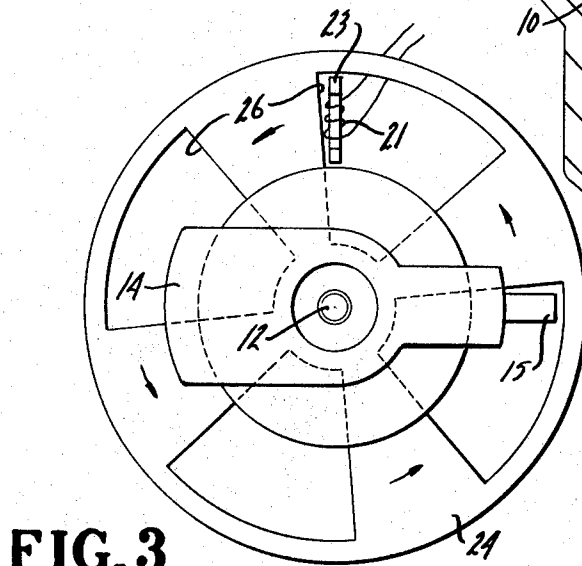


FIG. 3

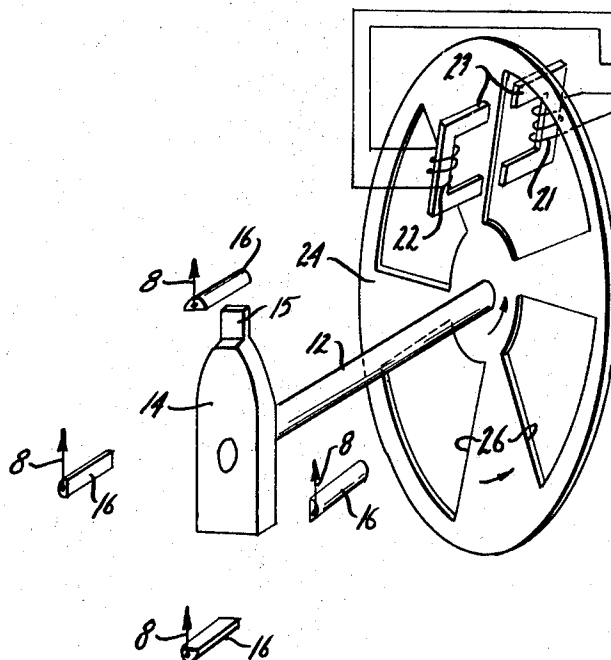
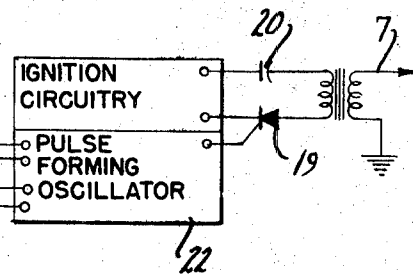


FIG. 4

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TRIGGERED IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES WITH MEANS TO RESTRICT OPERATION TO UNIT DIRECTIONAL ROTATION

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3 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to an ignition system for operation of an internal-combustion engine with a single rotational direction.

A capacitor is connected to the battery for charging and in series with a silicon controlled rectifier to the distributor for discharging. A vane controlled oscillator includes a rotating vane connected to the distributor shaft and rotated in synchronism therewith between a pair of U-shaped cores to couple and decouple a pair of oscillator windings wound on the cores which in turn results in the generation of a signal pulse which is applied to the rectifier gate.

The vane is a rotating disc of thin conductive metal having an aperture for each spark plug of the engine. Each aperture span is slightly more than fifty percent of the disc between corresponding locations of the adjacent two firing apertures and are then separated by a conductive turn-off portion of a lesser span.

The leading part of the turn-on portion of the vane actuates the oscillator to form a firing signal pulse. If reverse rotation starts, the leading part of the aperture of the reversely rotating vane is offset with respect to the proper firing angle and causes misfiring and killing of the engine.

This invention relates to a triggered ignition system for internal-combustion engines and particularly to a triggering means for restricting operative rotation of the engine to a single direction.

Capacitor discharge ignition systems for internal combustion engines and the like have been found to provide a highly satisfactory means for firing of the spark plugs or other firing means. Generally, in capacitor discharge ignition systems, a capacitor is interconnected through a special charging circuit to the battery and/or generator system and is interconnected to the spark plugs through a pulse transformer and a high speed switching means such as a silicon controlled rectifier or the like. The copending application of F. M. Minks entitled "Housing and Mounting for Ignition Trigger Control" filed on Jan. 3, 1967 with Ser. No. 606,609 and assigned to the assignees of this application, provides a highly satisfactory breakerless triggering unit for a capacitor discharge ignition systems variety. As more fully disclosed in such application, the capacitor is interconnected in a discharge circuit employing a silicon controlled rectifier. The gate circuit for the control of the rectifier includes a rotating vane controlled oscillator forming a part of a pulse forming circuit for periodically applying a turn-on pulse to the gate of the silicon controlled rectifier. The vane controlled oscillator includes a rotating vane connected to the distributor shaft and rotated in synchronism therewith to couple and decouple the windings of the oscillator which in turn results in the generation of a proper pulse. The vane is a conductive member and includes a plurality of circumferentially distributed slots to establish alternate conductive and nonconductive portions. The vane

rotation results in coupling and decoupling of the oscillator windings with the resulting controlled pulse generation. Generally, as disclosed therein the apertures are relatively narrow apertures with the coupling being limited to a relatively short time period.

Applicant has found that the engine with the vane controlled triggering system would at times operate or rotate in the opposite or reverse direction. If for any reason the engine should start a reverse rotation the firing would be such that the engine would continue to operate in that direction even though not at the same efficiency or smoothness as the forward rotation. This could create an extremely dangerous operating condition. For example, if an outboard motor were to be started and operated in the reverse direction from that intended, and the engine thrown into gear the operator would be operating the controls in a directly opposite manner from that which would be required and consequently present a highly dangerous operating condition.

The present invention is particularly directed to a very simple and reliable and inexpensive means to eliminate possible reverse rotation and to limit the operation of the engine to the desired forward rotation. Generally, in accordance with the present invention, the vane device or other cyclically coupled control means is formed with relatively wide turn-on portions and relatively narrow turn-off portions, such that rotation in one direction establishes a proper timed sequence to the firing means and reverse rotation an improper timed sequence. Applicant realizes that this relatively simple revision would result in an unidirectional engine rotation because only the leading part of the turn-on portion of the vane is really employed in the triggering of the ignition system and that the continuance of a vane turn-on portion of the vane would not adversely affect the forward operation of the engine. However, when reverse rotation is established, the leading part of the reversely rotating vane is offset with respect to the proper firing angle and causes misfiring and killing of the engine.

In a preferred construction, the vane is a rotating disc located between a pair of coil units and having an aperture for each firing means of the engine generally as disclosed in the previously identified copending application. However, the apertures are made to span a very substantial portion of the distance between the two firing apertures and are separated by relatively narrow conductive turn-off portions. The present invention has been found to provide a very simple and reliable means to establish unidirectional engine rotation for a breakerless ignition system.

The drawing furnished herewith illustrates a preferred construction of the present invention in which the above advantages and features are disclosed as well as other which will be clear from the following description.

In the drawing:

FIG. 1 is a side elevational view of an outboard motor with parts broken away to diagrammatically illustrate an engine and distributor.

FIG. 2 is an enlarged side elevational view of the distributor with parts broken away and sectioned.

FIG. 3 is an enlarged view of the control vanes; and

FIG. 4 is an exploded pictorial view more clearly showing the distributor contacts, vane and a control winding of the trigger unit.

Referring to the drawings, and particularly to FIGS. 1 and 2, a portion of an outboard motor is shown including an internal-combustion engine 1 mounted to the upper end of the lower drive shaft unit 2. The lower end, not shown, if the drive shaft housing 2 carries the propeller, not shown, which is coupled to the engine 1 through a suitable drive shaft mechanism in accordance with any

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known or desired construction. A protective and decorative cowling 3 is provided encircling the upper portion of the engine 1.

The engine 1 is the usual internal-combustion engine having a plurality of spark plugs 4 defining means for sequentially firing of the various cylinders and a distributor 5 mounted to the engine and coupled through a fly-wheel assembly 6 to be driven in synchronism with the engine. The distributor 5 is connected by a lead 7 to the output transformer, not shown, and by a plurality of lead 8 to the several spark plugs 4 for sequential firing thereof.

Referring particularly to FIG. 2, an enlarged sectional view of the lower portion of the distributor 5 is shown constructed in accordance with the present invention. Generally, the distributor includes a drive shaft housing assembly 9 which is supported on the engine block and to which is secured a trigger pulse forming assembly 10 and a high voltage distributing assembly 11.

The distributor further includes a shaft 12 which terminates within a distributor cap 13. A plastic rotor cap 14 is secured to the lower end of the shaft 12 and carries a contact plate 15 which sequentially moves by a plurality of circumferentially distributed terminals or electrodes 16 which are interconnected by the proper leads 8 to the several spark plugs 4. A generally U-shaped housing 17 is secured encircling the shaft 12, by a plurality of screws 18 in accordance with the teaching of the previously referred to copending application. The housing 17 contains a trigger control circuitry for a capacitor discharge ignition system, partially shown in FIG. 4, wherein a silicon controlled rectifier 19 or the like is triggered to discharge a capacitor 20 and transfer the energy to a proper spark plug 4 through the distributor 5. A pair of control coil units 21 form a part of a pulse forming oscillator 22 which constitutes a part of a switching means to sequentially supply power to the spark plugs 4. Each unit 21 includes a U-shaped core 23 with the cores arranged with the ends of the legs in spaced aligned relation. As the detail of the circuitry is not of any particular significance and a preferred circuitry is provided in detail in the previously referred to copending application of F. M. Minks no further illustration or description is set forth other than as necessary to a clear and complete understanding of the present invention. A metallic or other conductive disc 24 is secured to the shaft 12 with the disc passing between and controlling the coupling of the two control coil units 21. The disc 24 is firmly fixed to rotate with the shaft 12 by clamping of the disc 24 against an enlarged portion of the shaft by an oppositely disposed and press-fitted clamping ring 25, as shown in FIG. 2. Referring particularly to FIGS. 3 and 4 a preferred construction of the present invention particularly with respect to the metal disc 24 is clearly illustrated. The rotating metal disc 24 includes four circumferentially distributed apertures 26. Each aperture 26 controls the firing of given cylinders of the four cylinder engine and is specially constructed in accordance with the teaching of the present invention to limit rotation of the engine to a single direction. Each of the apertures 26 includes essentially radial edges and spans a substantial portion of the distance between successive apertures, and very substantially greater than required to form the necessary trigger pulse for proper firing of the related cylinder. In the illustrated embodiment of the invention, each aperture 26 spans slightly more than 45 degrees with a corresponding lesser span of conductive body metal therebetween. For the purpose of explanation, a counterclockwise rotation of the disc 24 and the associated rotor cap and electrode 15 is selected as producing proper firing of the engine 1 in a forward direction. The disc 24 and the rotor electrode 15, as most clearly shown in FIG. 3, are secured to the shaft 12 in such relationship that the electrode 15 is aligned with the cap contact or electrode 16 when the leading portion of the aperture 26 is aligned with coil units 21. The cylinder firing order may be cylinders 1-3-2-4 and the apertures

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26 are so related by the corresponding numbers on the outer portion of the disc 24 in FIG. 3. With proper forward rotation of the engine 1, the leading part or portion of aperture 26 is aligned with the coil units 21 with the electrode plate 15 aligned with a preselected distributor cap electrode 16 for the proper sequence firing of one of the plugs 4. At this time, the coil units 21 are coupled to actuate oscillator 22 and produce a trigger pulse which in turn will result in firing of the controlled rectifier 19 of the ignition system with the proper transfer of energy to the desired spark plug 4. The continued rotation establishes the sequential firing of plugs 4 for the selected sequence of cylinders 1-3-2-4.

If the engine should initiate rotation in the opposite direction, the coil units 21 are first aligned with the normal trailing portion of the aperture 26 and results in formation of a trigger pulse signal. However, the distributor rotor 14 and attached electrode 15 are now located intermediate the two distributor cap electrodes 16. Further, as the aperture 26 is slightly greater than 45 degrees the electrode 15 is more closely aligned with the trailing contact 16 and will fire the improper plug 4. Thus, if the engine should be fired 1-3-2-4 for forward rotation and, therefore 4-2-3-1 for reverse rotation, the present invention would fire 2-3-1-4 resulting in miss or cross firing of the engine. This would rapidly cause the engine 1 to stop and positively prevent operation in the reverse direction.

Thus the present invention provides a very simple, reliable and inexpensive means for controlling the rotation of the engine and thereby avoiding the dangers and disadvantages which may result from accidental reverse rotation.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims, particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. In a trigger assembly for firing an ignition system for an internal-combustion engine having a pulse power source connected to a distribution means for sequentially supplying of power pulses to a series of firing means, said distribution means having a switching means the output of which is controlled by cyclical movement relative to a control means having spaced control portions sequentially coupled to said switching means as a result of said movement and actuating the switching means in response to the leading part of each of said control portions to connect said power source to said distributive means and apply a power pulse to the firing means, the improvement in said control means comprising a pair of spaced coil units defining said switching means and connected to establish an output signal when in magnetic coupling, a rotating member defining said control means having alternate conductive decoupling portions and non-conductive coupling portions mounted to rotate between said spaced coil units to control the coupling thereof and establishing an output in response to alignment of the coupling portions with the coil units, said coupling portions having a length substantially greater than the corresponding portion of the coil units and actuating said switching means by the leading part of each control portion in proper timed sequence to apply the power pulse to said firing means during said leading portion in response to forward cyclical movement of said rotating member in one direction and is activated by the opposite leading part of each coupling portion in improperly timed sequence to apply the power pulse to said firing means during said opposite leading part in response to reverse cyclical movement of said rotating member in the opposite direction.

2. The trigger assembly of claim 1 wherein said rotating member includes a thin rotating metal disc and said pair of coil units are disposed one each adjacent the opposite faces of the metal disc, and said metal disc being rotatably mounted and having alternate conductive decoupling portions and non-conductive coupling portions

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to control the coupling of said windings and establishing an output in response to alignment of the coupling portions with the coil units, each of said coupling portions having a radial edge and a circumferential length substantially greater than the corresponding portion of the coil units and in excess of fifty percent of the length inclusive of a coupling portion and a decoupling portion whereby firing pulses are established in a preselected proper order in response to forward rotation of said metal disc and are established in a preselected improper order in response to reverse rotation of said metal disc.

3. The trigger assembly of claim 1 wherein said rotating member includes a thin rotating metal disc and said pair of coil units are disposed one each adjacent the opposite faces of the metal member, each coil unit including a similar magnetic core having legs terminating in alignment with the corresponding legs of the other core, said metal disc rotating between said aligned legs and having alternate conductive decoupling portions and coupling apertures to control the coupling of said windings, an

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aperture being provided for each firing means and establishing an output in response to alignment of the coupling aperture with the coil units, said coupling apertures having a circumferential length greater than the adjacent decoupling portion and substantially greater than said core legs whereby firing pulses are established in a preselected proper order in response to forward rotation of said metal disc and are established in a preselected improper order in response to reverse rotation of said metal disc.

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LAURENCE M. GOODRIDGE, Primary Examiner

U.S. Cl. X.R.

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