Nov. 20, 1962 E. M. MARTENSSON 3,065,285

DEVICE FOR PREVENTING REVERSE ROTATION OF TWO-CYCLE ENGINE

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Fig. 1.

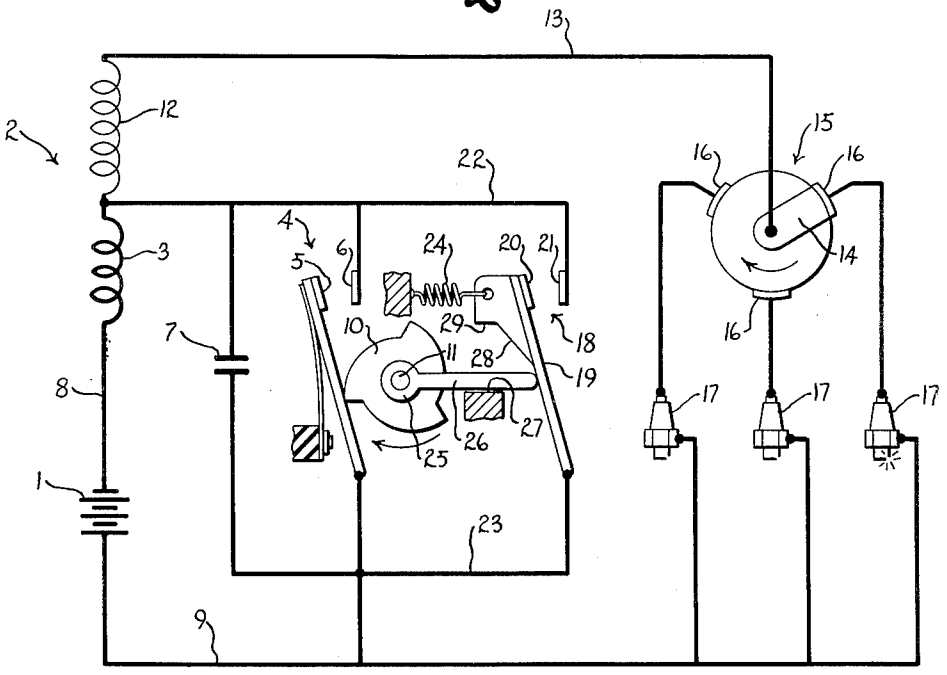

Fig. 4.

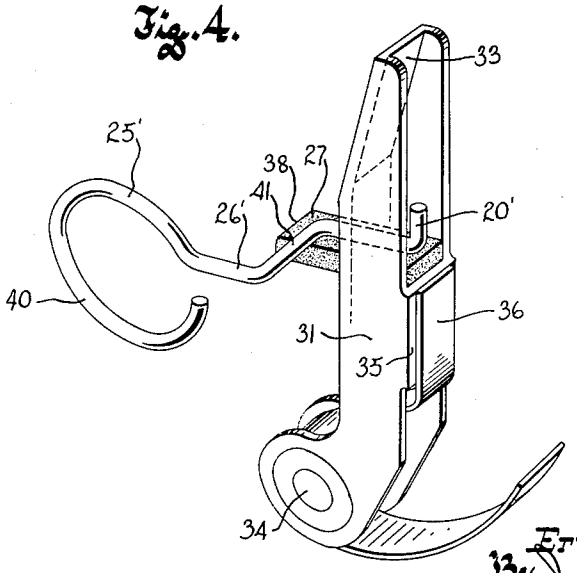

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Fig. 2.

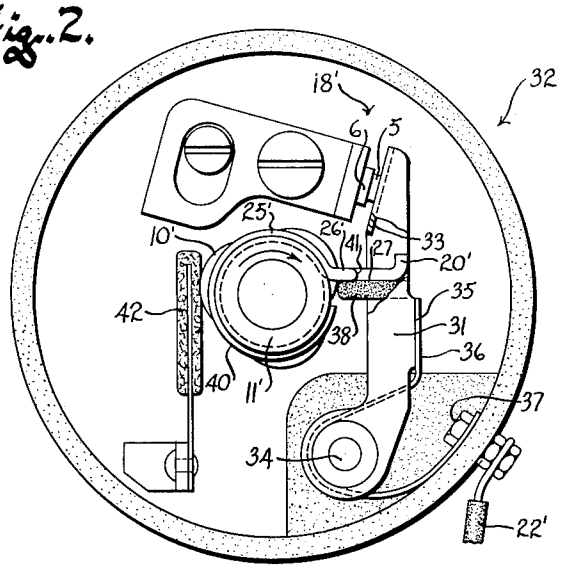
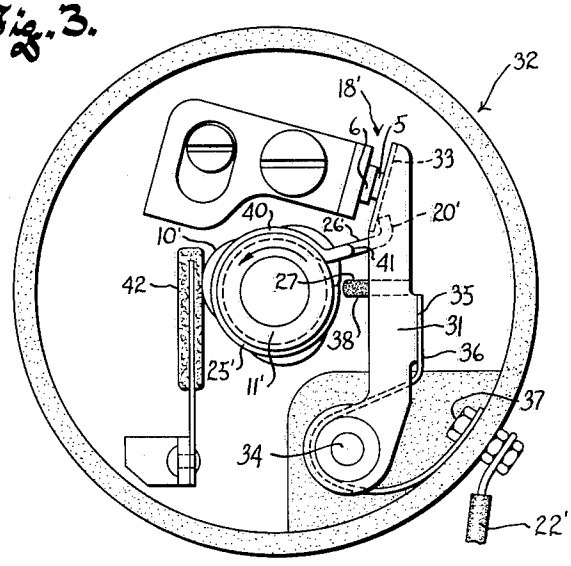


Fig. 3.



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DEVICE FOR PREVENTING REVERSE ROTATION OF TWO-CYCLE ENGINE

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This invention relates to ignition systems for two-stroke cycle internal combustion engines, and refers more particularly to means in the ignition system of such an engine for preventing the engine from operating with its crankshaft rotating in the direction opposite to that desired.

In two-stroke cycle internal combustion engines the direction of crankshaft rotation has no effect upon the timing of intake and exhaust, which occur at the same times in either direction of operation. Hence the engine tends to run in whichever direction the crankshaft is rotated during starting, particularly if spark plug firing is timed to occur near top dead center. Thus the normal direction of crankshaft rotation is determined by ignition timing, but if a two-cycle engine kicks back during starting, or for some other reason gets started in the direction of rotation opposite to that desired, it may continue to run in that direction indefinitely.

Where such an engine is used for powering a vehicle such as an automobile, motorcycle or scooter, it is especially important that it not be permitted to operate in the reverse of its normal intended direction of crankshaft rotation. In most cases the operator would have no way of knowing that the engine crankshaft was rotating in the reverse direction until he engaged the clutch or otherwise coupled the engine to the drive wheel or drive wheels of the vehicle, and reverse operation of the engine could therefore have very serious consequences under these conditions.

The problem of preventing reverse operation of a two-cycle engine is important enough to have received considerable attention, and several arrangements have heretofore been proposed for accomplishing that objective. None of these expedients has been completely satisfactory, however.

One such prior device incorporated ignition breaker points which were made in two parts that were movable relative to one another in response to the direction of crankshaft rotation, and which were arranged so that they changed the spark timing when the crankshaft rotated in the reverse direction and thus caused the engine to stop. In practice this expedient was found to have an adverse effect upon normal operation of the engine.

Another device heretofore proposed for the prevention of reverse operation of a two-cycle engine comprised a rotating distributor electrode having a peripheral extension which was substantially elongated circumferentially in the direction opposite to that of normal distributor rotation. When a particular cylinder of the engine failed to fire, and the engine kicked back, another cylinder which was not under full compression was caused to fire by the juxtaposition of the rotary electrode extension to the fixed distributor electrode for that cylinder. Due to the slight compression of the charge in the cylinder which was caused to fire, only a small force was exerted against the piston therein, which caused the engine to stop. Because of the circumferential extension of the rotating distributor electrode, each spark produced by such a device during normal operation was necessarily of relatively long duration, and the extended sparking intervals tended to break down the insulation in the distributor cap. After a more or less brief period of operation current transfer occurred on the suface of the distibutor cap, due to the failure of its insulation, and ignition timing became extremely erratic.

Still another expedient heretofore proposed for the prevention of reverse rotation of a two-cycle engine has been the provision of two sets of breaker points connected in series with one another, one of which, the master breaker point set, determined the ignition timing and was connected in parallel with a condenser in the usual manner. No condenser was connected across the other set of points. The two sets of breaker points were opened in rapid succession for brief spark plug firing, and when the crankshaft was rotating in the correct direction the master breaker set opened first so that a spark was produced. However, during reverse rotation the other breaker set opened first, and because no condenser was connected across it, no ignition took place. This arrangement substantially complicated the ignition system and its operation.

It will be observed that each of the prior expedients just described was applicable only to a multiple cylinder two-cycle engine and thus afforded no solution to the problem of reverse rotation operation of single cylinder two-cycle engines, which comprise the greater number of such power units. By contrast, it is an object of this invention to provide a device for preventing operation of a two-cycle engine in the direction of rotation opposite to that desired, which device is equally effective on both multiple cylinder and single cylinder engines of the two-cycle type.

Since simplicity and low selling price are among the principal attractions of the two-cycle engine, it is another and very important object of this invention to provide a device of the character described which is very simple and inexpensive and which, moreover, is compact and dependable and does not in any wise affect the normal operation of an engine on which it is installed.

More specifically, the present invention has for its object the provision of simple and highly effective means in an ignition system for a two-stroke cycle engine for completely and effectively preventing spark plug firing upon reverse rotation of the engine crankshaft, without interference with normal operation of the engine.

It is another specific object of the present invention to provide means for preventing spark plug firing at times when the crankshaft of a two-cycle engine is turning in the wrong direction, which means includes simple switch means actuated by a part rotatable with the engine crankshaft and which is rendered operative in consequence of reverse rotation of the crankshaft to close the primary circuit of the engine ignition system.

Still another specific object of this inventiton resides in the provision of a device for preventing reverse rotation of the crankshaft of a two-stroke cycle internal combustion engine, which device includes means cooperable with a part that is rotatable with the engine crankshaft and with the carrier for the movable breaker point of the engine ignition system, and which means effects short circuiting of the breaker points upon reverse rotation of the crank-

shaft and thereby prevents spark plug firing so long as the crankshaft is rotating in the reverse direction.

With the above and other objects in view which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particualrly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate two complete examples of the physical embodiments of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

FIGURE 1 is a diagrammatic view of a two-cycle engine ignition system incorporating the apparatus of this invention for preventing the engine from running with its crankshaft rotating in the direction opposite to that desired;

FIGURE 2 is an elevational view of an embodiment of a device adapted to be incorporated into a distributor for a two-stroke cycle engine and illustrating the apparatus with the engine crankshaft rotating in the desired direction;

FIGURE 3 is a view similar to FIGURE 2 but showing the conditions existing when the crankshaft rotates in its reverse direction; and

FIGURE 4 is a fragmentary perspective view of a portion of the apparatus illustrated in FIGURES 2 and 3.

Referring now to the accompanying drawings in which like numerals designate like parts throughout the several views, FIGURE 1 illustrates more or less diagrammatically an ignition system for a three cylinder two-stroke cycle engine in which a battery 1 provides a source of ignition current. It will become apparent as the description proceeds that the arrangements herein shown and described are merely illustrative, since the invention is as well adapted to a magneto ignition system as to battery ignition, and is entirely suitable for a single cylinder engine as well as a multi-cylinder unit.

As is conventional, an ignition coil 2 is connected in series with the battery, and the circuit through the battery and the primary 3 of the ignition coil is made and broken in timed relation to rotation of the engine crankshaft by means of a breaker assembly 4 comprising a movable breaker point 5 which cooperates with a fixed breaker point 6. The usual capacitor 7 is connected across the breaker points.

When the breaker points 4 are closed, the primary circuit is completed through a conductor 8 which connects one battery terminal with a terminal of the primary winding 3 and a conductor 9 which connects the other battery terminal with the movable breaker point 5. In practice the conductor 9 would comprise the engine itself, to which the battery and movable breaker point would be grounded.

A cam 10 mounted on a part 11 rotatable with the engine crankshaft actuates the movable breaker point 5 toward and from engagement with the fixed breaker point 6 in timed relation to crankshaft rotation. The part 11 may comprise a distributor rotor shaft, a separate shaft geared to the crankshaft, or even an end portion of the crankshaft itself.

When the cam 10 effects closing of the breaker points, current from the battery flows through the primary 3 of the coil 2; but when the breaker points are opened, the abrupt cessation of current flow through the primary, and the consequent collapse of the magnetic field around it, induces a high tension current in the secondary winding 12 of the coil 2. In the case of a single cylinder engine the high tension terminal of the secondary is connected directly with the "hot" terminal of a spark plug, and timing of spark plug firing is effected entirely by the breaker cam. In this instance, however, the secondary

is connected, by means of a high tension lead 13, with the crankshaft driven rotary electrode 14 of a distributor 15. As the electrode 14 rotates, it is brought into contact making juxtaposition with each of a number of stationary electrodes 16 in turn, to thus effect firing at the proper time of a spark plug 17 connected with each stationary electrode.

The apparatus of this invention, by which reverse rotation of the crankshaft is prevented, comprises, in general, normally open switch means 18 connected in parallel with the breaker points 4 and adapted to be closed in consequence of reverse rotation of the crankshaft. Because of its connection in shunt across the breakers 4, the switch means 18, when closed, maintains the flow of battery current through the primary winding 3, even at times when the breaker points are open, and thus prevents spark plug firing by preventing collapse of the flux field around the primary 3 and the consequent induction of a high tension current in the secondary 12.

The switch means 18, in the embodiment of the invention illustrated in FIGURE 1, comprises an arm 19 that is mounted for swinging movement in opposite directions to carry a movable contact 20 thereon into and out of engagement with a stationary contact 21. The stationary contact 21 is connected with the fixed breaker point 6 by means of a conductor 22, and the arm 19 is connected with the movable breaker point 5 by means of a conductor 23 which may comprise the engine itself to which the arm 19 is grounded.

A spring 24, reacting between the arm 19 and a relatively fixed part on the engine, biases the switch means to an open position in which it does not interfere with normal operation of the breakers 4. Upon reverse rotation of the crankshaft, however, the arm 19 is swung against its bias to a switch closed position in which the movable contact 20 is engaged with the fixed contact 21. Such closing of the switch means is effected by an annular driver 25 that embraces and frictionally engages the crankshaft driven part 11 and an actuator 26 which extends radially from the driver to have swinging motion as the driver is rotated by the part 11.

When the crankshaft driven part 11 is rotating in its normal direction, indicated by the arrow in FIGURE 1, the actuator 26 is maintained engaged against a stationary stop or abutment 27 while the part 11 rotates relative to the driver 25. However, in the event of reverse rotation of the crankshaft, the frictional engagement between the part 11 and the driver causes the latter to rotate with the part 11 in the direction to swing the actuator away from the stop 27, thus moving the outer end portion of the actuator along an inclined cam surface 28 on the contact arm 19 whereby the arm is cammingly or wedgingly swung against the bias of spring 24 to its switch closed position. When the actuator reaches the position at which it maintains the switch means 18 fully closed, it engages a shoulder 29 on the arm 19 that prevents further swinging of the actuator even though the crankshaft may continue to rotate in the reverse direction.

When the crankshaft is again rotated in the proper direction, friction between the part 11 and the driver 25 swings the actuator 26 back toward the stop abutment 27, permitting the switch arm 19 to open the switch means 18, thus enabling the breaker points to resume their normal functioning.

It will be observed that the stop 27 and the shoulder 29 are so disposed that only a small fraction of a revolution of the crankshaft driven part 11 is required to carry the actuator 26 from one to the other of the two positions defined by its engagement with them, and consequently the apparatus of this invention responds very rapidly to reverse rotation of the crankshaft and likewise permits the resumption of normal operation as soon as the crankshaft begins to rotate in the proper direction.

In the embodiment of the invention illustrated in FIGURES 2–4 the carrier 31 for the movable breaker point 5

also incorporates the relatively fixed contact of the switch means 18', and the relatively movable contact of the switch means is directly carried by the actuator, which is integral with the driver. In this embodiment of the invention the apparatus is shown incorporated in the distributor device 32 of an engine (the rotary and stationary electrodes not being shown) and the crankshaft driven rotatable part 11' is grounded to the engine in accordance with conventional practice. The fixed breaker point 6 is likewise grounded, and the carrier 31 for the movable breaker point 5 is insulated from the engine.

The movable breaker carrier 31, as best seen in FIGURE 4, is made of metal, bent to a substantially U-shape, and has the breaker point 5 mounted on its bight portion 33. A suitable shaft 34, having its axis parallel to that of the crankshaft driven part 11', and which extends through the end portions of the carrier legs remote from its bight portion, mounts the carrier for swinging motion by which its bight portion is carried toward and from the fixed breaker point 6 and its medial portion is carried toward and from the axis of the part 11'. Spanning the legs of the carrier intermediate their ends is a spring seat 35 against which the free end portion of the leaf spring 36 engages to bias the carrier toward the axis of the rotatable part 11'. The other end of the leaf spring is secured to a fixed part of the distributor by means of a fastener 37, which may also serve as a terminal for a conductor 22' connectable with one terminal of a primary coil winding. It will be observed that the leaf spring serves to electrically connect the carrier with the terminal 37.

A cam 10' may be formed integrally with the rotatable part 11' and cooperates with a cam follower 38 of insulating material which spans the medial portion of the breaker point carrier 31 and projects laterally therefrom toward the axis of the rotatable part. The cam 10', of course, effects swinging motion of the carrier to open and close the breaker points in timed relation to rotation of the crankshaft. An oil impregnated felt wiper 42 bears against the cam to lubricate its surface and reduce its friction with the follower 38.

The driver 25', actuator 26' and movable contact 20' of the switch means 18' in this embodiment of the invention comprise integral parts of a single spring wire unit 40, best seen in FIGURE 4. The driver 25' is formed as a loop which snugly compressively embraces the rotatable part 11', while the actuator 26' comprises the medial portion of the wire, which extends radially outwardly from its driver portion and has an axially extending portion 41 by which the outer end portion of the unit is axially offset from its driver portion. The outer end portion of the spring wire unit provides the relatively movable switch contact 20', which is adapted to cooperate with the bight portion 33 of the breaker carrier 31 in grounding the movable breaker point 5 upon reverse rotation of the part 11'.

The offset portion 41 of the spring wire unit disposes its contact portion 20' between the legs of the carrier 31. During normal rotation of the part 11', the driver 25' is urged by friction to a position in which the medial actuator portion of the unit engages the insulating cam follower 38, the upper surface of which thus provides a relatively fixed abutment stop 27. In this condition, which is illustrated in FIGURE 2, no portion of the spring wire unit is in electrical contact with the carrier 31, and consequently the breaker points function in their normal manner. In this position of the actuator it does not interfere with cam propelled back and forth motion of the carrier, since the abutment surface 27 upon which the actuator rests extends substantially parallel to the actuator and can slide freely back and forth therebeneath.

When the part 11' rotates in the reverse direction, the frictional motion transmitting connection between it and the driver 25' swings the actuator 26' to a position in which the relatively movable contact 20' which comprises its end portion is engaged behind the bight portion 33 of the carrier 31. Since the radially outer end portion of the actuator is hook-like, the movable contact 20' remains in engagement with the relatively fixed contact provided by the bight portion of the carrier even during cam propelled swinging motion of the carrier in the direction to separate the breaker points, and in fact such breaker opening motion of the carrier merely serves to increase the contact pressure of the switch means, insuring that flow of battery current through the primary winding will be uninterrupted. The natural resilience of the spring wire, and the offset in the medial portion of the actuator, provide for yielding motion of the movable contact 20' with the breaker carrier as the latter swings.

From the foregoing description taken together with the accompanying drawings, it will be apparent that this invention provides simple, inexpensive and dependable means in the ignition system of a two-stroke cycle engine for preventing operation of the engine with its crankshaft rotating in the reverse of the desired direction, and that the apparatus of this invention is well adapted for both single cylinder and multi-cylinder engines.

What is claimed as my invention is:

1. In a two-stroke cycle engine having a crankshaft adapted for rotation in one direction and having an electrically conductive breaker point carrier actuated by a crankshaft driven cam and by which a movable breaker point is carried back and forth in timed relation to crankshaft rotation, into and out of engagement with a grounded fixed breaker point, to thus effect spark plug firing, means for preventing spark plug firing when the crankshaft rotates in the opposite direction, comprising: a grounded crankshaft driven rotatable part; a conductive annular driver embracing said rotatable part and frictionally engaging the same so as to have a tendency to rotate therewith; a conductive actuator projecting radially from the driver to be swung thereby in opposite directions depending upon the direction of crankshaft rotation; cooperating means on the actuator and said breaker point carrier providing a pair of contacts engageable upon swinging of the actuator due to rotation of the crankshaft in said opposite direction to short circuit the breaker points and thus prevent spark plug firing; and means providing an abutment insulated from the carrier against which the actuator engages when the crankshaft rotates in said one direction, and by which the actuator is held in a position in which said contacts are spaced apart while said part rotates relative to the driver.

2. The apparatus of claim 1, further characterized by the fact that said actuator is resilient and has a hook-like portion which engages the carrier when the crankshaft rotates in said opposite direction so that movement of the breaker point carrier in the direction to carry the movable breaker point out of engagement with the fixed breaker point effects tighter engagement of said contacts.

3. In a two-stroke cycle engine having a crankshaft adapted for rotation in one direction during normal operation of the engine and having ignition breaker points actuated by the crankshaft to open and closed positions in timed relation to crankshaft rotation and the opening and closing of which effects spark plug firing, means for preventing operation of the engine in the opposite direction of crankshaft rotation, said means comprising: switch means comprising a pair of contacts, one of which is movable between a defined switch closed position, in which it is engaged with the other contact, and a defined switch open position, in which it is separated from the other contact; conductor means electrically connecting said switch means in a circuit with the breaker points whereby the breaker points are rendered ineffective to produce spark plug firing when said movable contact is in one of its said defined positions, but are normally operative when said movable contact is in its other position; a part constrained to rotation with the crankshaft; and an annular driver frictionally embracing said part so

as to tend to rotate therewith and having a motion transmitting connection with the movable contact of the switch means whereby rotation of said part in the direction corresponding to said opposite direction of crankshaft rotation moves the movable contact of the switch means to its said one position, and rotation of said part in the opposite direction moves said movable contact to its said other position, the frictional connection between said part and the driver permitting the crankshaft to continue substantially unimpeded rotation in one direction after the contact reaches one of its said defined positions while

the driver remains stationary as long as the crankshaft does not begin to rotate in the other direction.

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