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SPEED RESPONSIVE SWITCHING APPARATUS

Filed April 2, 1962

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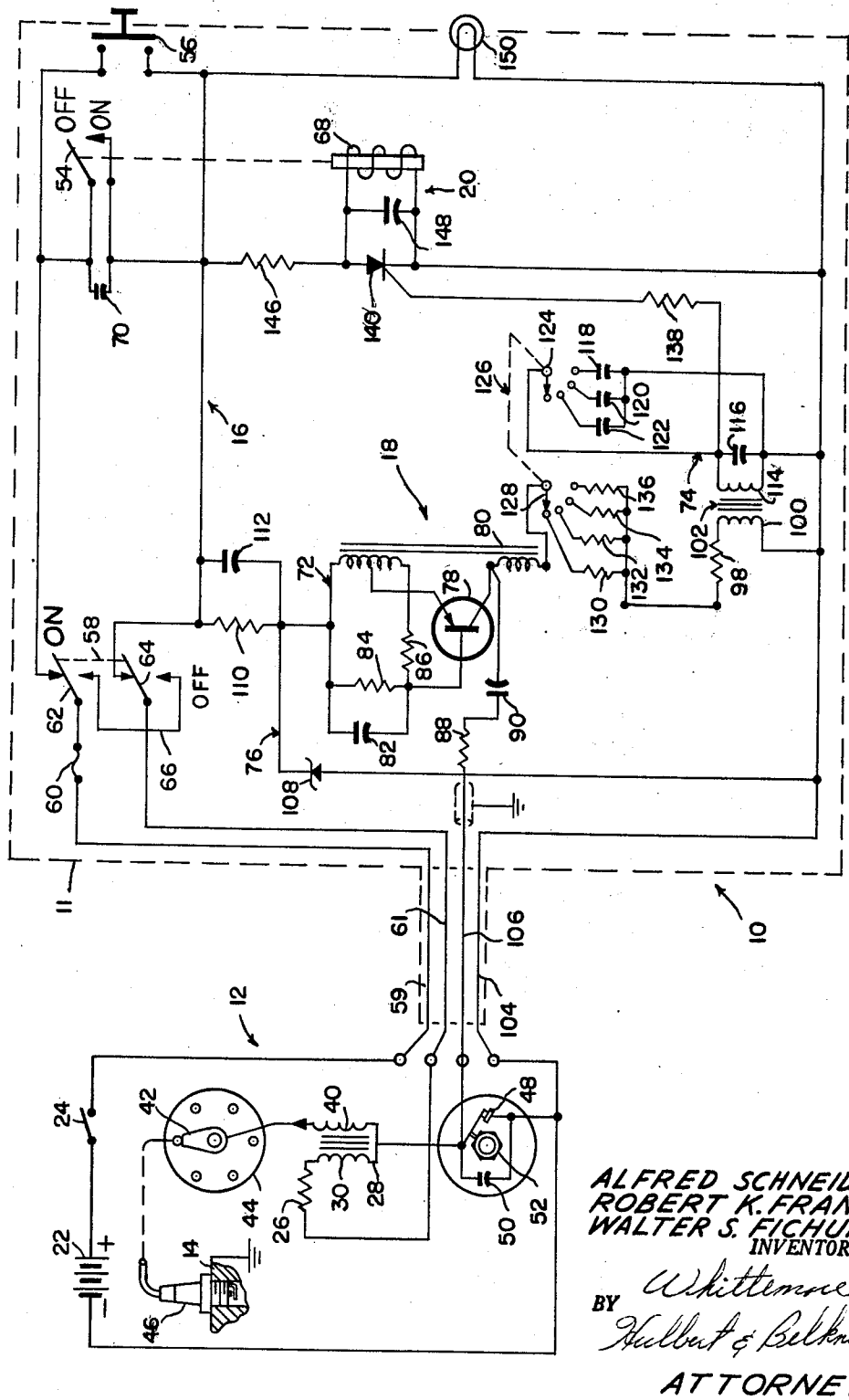


FIG. 1

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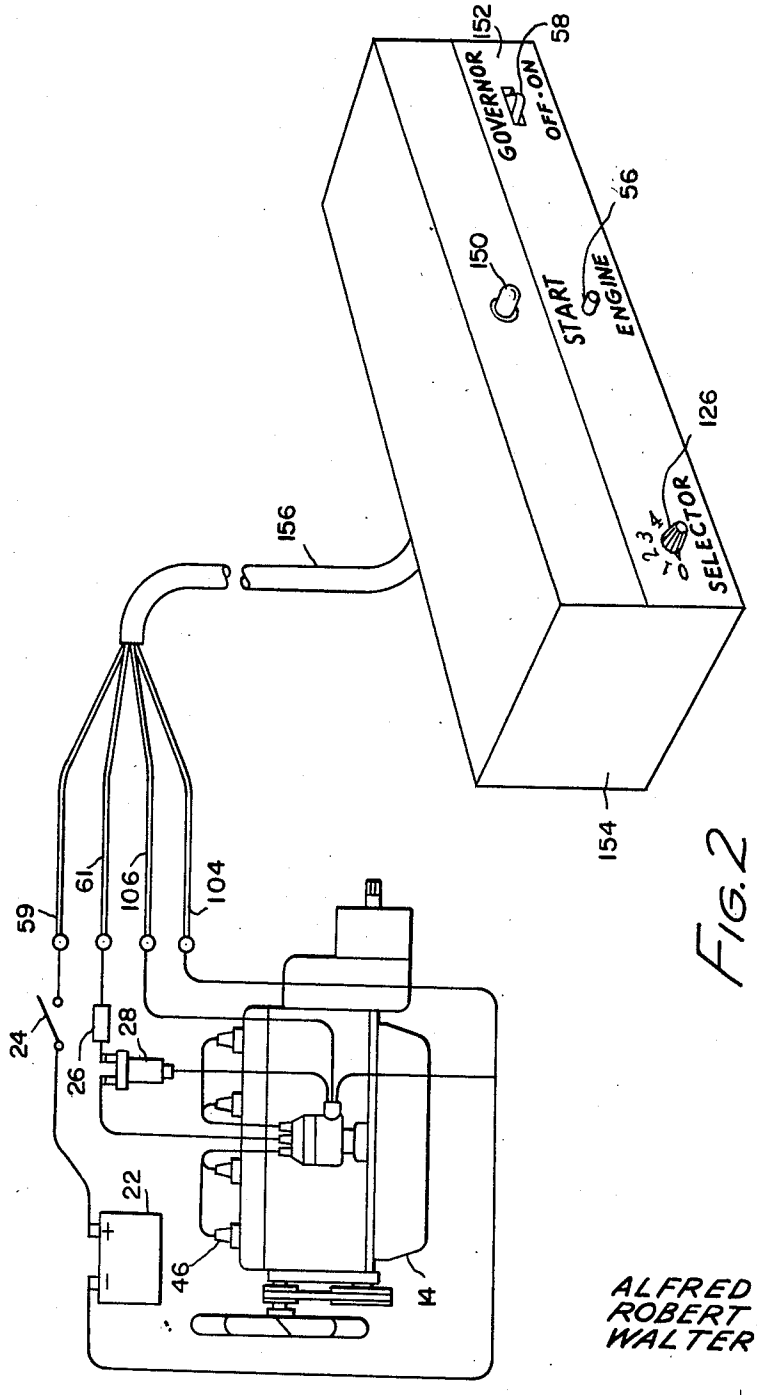


FIG. 2

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SPEED RESPONSIVE SWITCHING APPARATUS

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The invention relates to switching apparatus and refers more specifically to a speed responsive ignition cutout switch for use with internal combustion engines or similar devices.

In the past it has been the usual practice to provide auxiliary power take-off units operated in conjunction with internal combustion engines or the like with governing systems rather than providing the engines themselves with governing means. Thus the engine with which the auxiliary power take-off unit is operated may be permitted to run at excessive speeds should the governing system of the power takeoff unit fail. Similarly, engines being engineered or developed or during testing thereof on a dynamometer for example may be damaged due to running at excessive speeds since it is not economical to provide governing systems for engines in such situations.

It is therefore an object of the present invention to provide a speed responsive switch for shutting off an internal combustion engine or similar use.

Another object is to provide apparatus for use in conjunction with an internal combustion engine or similar device permitting operation of the device at speeds below a predetermined speed and operable to shut the device off when a predetermined speed is reached.

Another object is to provide apparatus fo use in conjunction with an internal combustion engine including an ignition circuit having on-off contacts in series therewith, means for developing an electrical signal proportional to engine speed and means for maintaining the on-off contacts closed during operation of the engine at a speed below a predetermined speed which means is responsive to the signal proportional to engine speed for opening the on-off contacts at a predetermined engine speed to cut off the engine.

Another object is to provide speed responsive ignition cutout apparatus as set forth above wherein the means for providing a signal proportional to engine speed comprises a blocking oscillator connected across the engine ignition circuit breaker points and a resonant circuit connected across the output signal of the blocking oscillator.

Another object is to provide speed responsive ignition cutout apparatus as set forth above wherein the means for maintaining the on-off contacts closed comprises a relay solenoid and the means for opening the on-off contacts includes a controlled rectifier in parallel with the relay solenoid and responsive to the output signal of the resonant circuit to short the solenoid at the predetermined engine speed.

Another object is to provide speed responsive switching apparatus which is simple in construction, economical to manufacture and efficient in use.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, illustrating a preferred embodiment of the invention, wherein:

FIGURE 1 is a schematic diagram of speed responsive ignition cutout switching apparatus constructed in accordance with the invention.

FIGURE 2 is a diagrammatic illustration of an internal combustion engine having the speed responsive ignition cutout switching apparatus illustrated in FIGURE 1 connected thereto.

With particular reference to the figures of the drawing one embodiment of the present invention will now be disclosed in detail.

As shown in FIGURE 1 the speed responsive switching apparatus **10** enclosed in the dashed line **11** is connected in the usual ignition circuit **12** of an internal combustion engine **14**. The speed responsive switching apparatus **10** includes the switching means generally indicated by **16** connected in series with the ignition circuit **12** as shown in FIGURE 1 and the circuit **18** for developing an electrical signal proportional to engine speed. The apparatus **10** further includes the control means **20** for maintaining the switching means **16** in a condition to complete the ignition circuit **12** at engine speeds below a predetermined engine speed and operable to break the ignition circuit at a predetermined engine speed.

In operation of the engine **14** the ignition circuit **12** is completed through the switching means **16** and is maintained completed by the control means **20** until a predetermined engine speed is reached. At the predetermined engine speed the control means **20** is responsive to the signal proportional to engine speed developed by the circuit **18** to open the ignition circuit **12**. The engine **14** is thereby shut off and damage thereto due to overspeed is prevented.

More specifically, the ignition circuit **12** of the engine **14** includes the battery **22**, the ignition switch **24**, a ballast resistor **26** and the ignition coil **28** having the primary winding **30** and the secondary winding **40** connected in series with the rotor **42** of the distributor **44**. The distributor **44** is in the usual manner connected to a plurality of spark plugs **46**, as shown best in FIGURE 2, which are secured in the engine **14**. The ignition circuit **12** further includes the distributor breaker points **48** and the condenser **50** connected in parallel with each other between the ignition coil **28** and the negative side of the battery **22**, as shown best in FIGURE 1.

The ignition circuit as shown in FIGURES 1 and 2 and described above is entirely conventional. The operation of the ignition circuit **12** will not therefore be considered in detail. For the purposes of the present invention, however, it is pointed out that if the ignition circuit **12** is broken that the engine **14** will be shut off. Further, it will be noted that in the usual operation of the ignition circuit **12** that a pulsed signal having a frequency proportional to engine speed will be present across the breaker points **48** due to the opening and closing of the breaker points **48** by the cam **52** which is rotated at a speed proportional to engine speed.

The switching means 16 as shown best in FIGURE 1 is connected in series with the ignition circuit 12. The switching means 16 includes the parallel combination of relay solenoid operated on-off contacts 54 for maintaining the ignition circuit 12 complete only at speeds below a predetermined speed, a manually actuated push button switch 56 for initially completing the ignition circuit 12 and a double pole double throw switch 58 for selectively placing the speed responsive switching apparatus 10 in the ignition circuit.

The switch 58 is connected as shown best in FIGURE 1 so that with the poles 62 and 64 thereof in the ON position shown in FIGURE 1 the parallel combination of the on-off contacts 54 and push button switch 56 is connected in series in the ignition circuit 12 between the ignition switch 24 and the ballast resistor 26. With the poles 62 and 64 of the switch 58 in the down or OFF position, the speed responsive switching apparatus 10 is disconnected from the ignition circuit 12 which is at this time completed through the conductor 66. Thus it will be seen that the switch 58 as indicated in FIGURE 2 is a governor or speed responsive switching apparatus ON-OFF switch.

With the switch 58 in the up or ON position as shown in FIGURE 1, the push button switch 56 is operable to complete the ignition circuit 12 and to further energize the relay solenoid 68 in the control means 20 as will be considered in more detail subsequently. The on-off relay contacts 54 then provide a holding circuit around the push button switch 56 to maintain the relay solenoid 68 energized and the ignition circuit 12 completed at engine speeds below a predetermined engine speed after release of the push button switch 56, as will be considered in more detail subsequently.

The capacitor 70 is placed across the terminals of the on-off contacts 54 to protect them in case the predetermined speed is reached at an instant of time at which the contacts 54 are opened when the ignition breaker points 48 are closed. Thus arcing across the contacts 54 due to high ignition coil back electromotive force appearing thereacross on the contacts being opened is prevented.

The circuit 18 for developing a signal proportional to engine speed includes the blocking oscillator 72, a resonant circuit 74 and a voltage regulating circuit 76. The blocking oscillator 72 includes the transistor 78, the transformer 80, sensitivity decoupling capacitor 82 and the blocking oscillator sensitivity resistors 84 and 86, and the signal input resistor 88 and coupling capacitor 90. The load circuit for the blocking oscillator 18 comprises the fixed value load current limiting resistor 98 in series with one of the resistances 130, 132, 134 and 136 and the primary winding 100 of the transformer 102. The blocking oscillator 72 is connected across the breaker points 48 of the ignition circuit 12 through the conductor 104 and the shielded conductor 106.

The voltage regulating circuit 76 includes the zener diode 108, the voltage regulator series dropping resistor 110 and the regulated voltage filter capacitor 112 connected between the switching means 16 and the blocking oscillator 72 as shown best in FIGURE 1. The voltage regulator circuit 76 provides a substantially constant voltage level to insure proper operation of the blocking oscillator 72.

The resonant circuit 74 includes the secondary winding 114 of the transformer 102 and the capacitor 116 connected in parallel therewith. In addition, the capacitors 118, 120 and 122 are placed in circuit with the capacitor 116 and one portion 124 of the multi-position selector switch 126 so as to be alternatively and selectively placed in parallel with the resonant circuit 74 whereby the resonant frequency of the circuit 74 may be varied to provide ignition circuit cutout at selected engine speeds as will be considered in more detail subsequently.

The other portion 128 of the selector switch 126 is operable simultaneously with the portion 124 thereof to place the resistors 130, 132, 134 and 136 alternatively

in series with the fixed current limiting resistor 98 of the blocking oscillator. Thus, the amplitude of the signal from the blocking oscillator at resonant frequency of the circuit 74 is maintained substantially constant at the different selectable resonant frequencies thereof.

In operation it will be understood that the blocking oscillator circuit 72 and the voltage regulating circuit 76 are conventional. Their operation will therefore not be considered in detail except as it pertains to the present invention. Thus, in the usual manner of a blocking oscillator, a single pulse of electrical energy will be fed through the primary winding 100 of transformer 102 as a result of each pulse received by the blocking oscillator circuit 72 due to the periodic opening of the breaker points 48 in ignition circuit 12.

At a predetermined engine speed the pulses provided by the blocking oscillator in the primary of the transformer 102 will be at the resonant frequency of the circuit 74, or a multiple thereof, and will thus cause the circuit 74 to resonate. When blocking oscillator pulses occur at resonance of the circuit 74, the circuit 74 will produce a substantially higher alternating current voltage through the current limiting resistor 138 to cause the controlled rectifier 140 of the control means 20 to conduct.

The exact engine speed at which the resonant circuit 74 is caused to produce an alternating current of sufficient magnitude to cause the controlled rectifier 140 to conduct will be determined by the setting of the multiposition selector switch 126 since this determines the particular capacitance of the resonant circuit and the amplitude of the blocking oscillator signal passed through the transformer primary coil 100. The magnitude of the signal in the primary coil 100 is of course critical since a signal in the coil 100 even at the proper frequency which is of a magnitude below a predetermined magnitude will be insufficient to cause the controlled rectifier 140 to conduct. Thus, at each of the engine speeds selected by switch 126 at which it is desired for the cut-out control means 20 to operate, a proper amount of attenuation is performed by that resistor of the group 130, 132, 134, 136 which is selected by switch 126 such that when engine cut-out speed is reached the critical voltage is present to provide sufficient current through resistor 138 to trigger the controlled rectifier.

The control means 20 includes the relay solenoid 68 and the controlled rectifier 140 in parallel as previously indicated. The control means 20 further includes the current limiting resistor 146 and the capacitor 148 which capacitor is operable to protect the rectifier 140 from the inductive voltage of the relay coil 68 on deenergization of the relay coil. As shown best in FIGURE 1 the lamp 150 is connected in parallel with the series combination of the resistor 146 and the controlled rectifier 140, capacitor 148 and the relay coil 68 in parallel. Lamp 150 provides a visual indication of completion of the ignition circuit 12 through the on-off contacts 54 or the push button switch 56.

As indicated best in FIGURE 2 the selector switch 126, push button or engine start switch 56, ON-OFF switch 58 and indicator lamp 150 may be located on the control panel 152 of an enclosing case 154 positioned at a remote location from the engine 14 and ignition circuit 12. The speed responsive switching apparatus 10 enclosed in the case 154 is then connected to the ignition circuit 12 by means of a cable 156 having the conductors 59 and 61, 104 and 106 therein as shown best in FIGURE 2.

Thus in over-all operation with the ON-OFF switch 58 in the OFF position the ignition circuit 12 and engine 14 operate in the usual manner of an internal combustion engine and electric ignition circuit. At this time the speed responsive switching apparatus 10 is not in the ignition circuit.

With the ON-OFF switch 58 in the ON position as shown in FIGURE 1 the engine may be started by press-

ing the push button switch **56** to complete the ignition circuit **12** therethrough. On pressing of the push button switch **56** the relay solenoid **68** is energized through the resistor **146** to close the on-off relay contacts **54** whereby the ignition circuit **12** is maintained closed after release of the push button switch **56** as long as the relay solenoid **68** is energized. At this time the on-off contacts **54** not only complete the ignition circuit **12** but further provide a holding circuit for the energization of the relay solenoid **68**.

As the engine **14** gains speed the frequency of the pulses felt by the blocking oscillator **72** increases in proportion to the engine speed as previously indicated. The output pulses of the blocking oscillator **72** through the primary winding **100** of transformer **102** thus also increase in frequency in accordance with the speed of rotation of the engine **14**.

At the engine speed determined by the position of the selector switch **126** the resonant circuit **74** will resonate whereby a substantial current will flow through the resistor **138**. The controlled rectifier **140** will at this time be caused to conduct thus shorting out the relay solenoid **68**. The relay solenoid **68** is thus deenergized and the on-off contacts **54** held closed thereby are permitted to open. The ignition circuit **12** of the engine **14** is thus broken and the engine stopped.

It is therefore seen that in accordance with the invention there has been provided extremely simple and efficient speed responsive switching apparatus operable to cut the engine **14** off at a selected predetermined speed.

While one embodiment of the invention has been specifically disclosed, it will be understood that other embodiments and modifications thereof are contemplated. Thus it will be understood that the means for cutting off the engine **14** may take the form of an electronic or electro-mechanical device for shutting off the fuel or air flow of the engine or a switch operable to turn on a brake at the predetermined engine speed. Further it will be understood that other means for sensing the speed of the engine are possible such as, for example as may be accomplished through a direct connection with or without series impedance to the ignition coil. The ignition ballast resistor or one or more spark plugs or an indirect connection such as a capacitive, inductive or magnetic pickup device placed in the electric or magnetic field of any of the above indicated ignition components. It is therefore the intention to include all such embodiments and modifications of the invention as are defined by the appended claims within the scope of the invention.

What we claim as our invention is:

1. In combination with an internal combustion engine having an ignition circuit including a battery and a primary ignition coil winding in series with the parallel combination of distributor breaker points and the series combination of the ignition secondary coil winding and the distributor rotor which is intermittently connected to a plurality of spark plugs, a speed responsive engine cutout device comprising a double pole, double throw switch, the poles of which are connected in series in the ignition circuit between the battery and primary ignition coil winding, means for shorting said poles together in one position thereof, solenoid actuated on-off contacts and a push button switch in parallel, means for connecting the on-off contacts and push button switch in parallel across the poles of the double pole, double throw switch in the other position thereof, a relay solenoid for actuating the on-off contacts and a controlled rectifier in parallel with each other and connected in series in the ignition circuit and with the parallel combination of the on-off contacts and push button switch, a blocking oscillator connected across the distributor breaker points having an output circuit, a resonant circuit in the output circuit of the blocking oscillator resonant at selected frequencies representative of different engine speeds as sensed by the blocking oscillator and means for connecting the resonant circuit to the controlled rectifier for shorting out the relay solenoid on resonance of the resonant circuit whereby the on-off contacts are permitted to open and the engine is cut off at a predetermined engine speed.

2. Structure as set forth in claim 1 wherein the output circuit of the blocking oscillator includes a transformer and the resonant circuit comprises the secondary winding of the transformer and a capacitor in parallel, and further including a plurality of additional capacitors and means for selectively connecting the additional capacitors in parallel with the resonant circuit to selected predetermined resonant frequencies for the resonant circuit.

3. Structure as set forth in claim 2 and further including a plurality of separate resistors in the output circuit of the blocking oscillator adapted to be selectively connected in series with the primary winding of the transformer and wherein the means for selectively connecting separate capacitors in parallel with the resonant circuit includes means operable simultaneously therewith to selectively vary the resistance in series with the primary winding of the transformer.

4. A speed responsive engine cut-out switch for use in conjunction with an internal combustion engine or similar device having an ignition circuit comprising on-off contacts in series with the ignition circuit, a blocking oscillator for developing a pulse output signal having a pulse repetition frequency which is proportion to the speed of the engine, a resonant circuit connected to receive the output signal of the blocking oscillator, and means connected to the resonant circuit and operably associated with the on-off contacts responsive to a condition of resonance in the resonant circuit for opening the on-off contacts in the ignition circuit.

5. Structure as set forth in claim 4 wherein the resonant circuit includes the secondary winding of a transformer having a primary winding in series with the output circuit of the blocking oscillator and a capacitor connected across the secondary winding of the transformer.

6. Structure as set forth in claim 5 and further including means operably associated with the resonant circuit for selectively varying the value of the capacitor connected in parallel with the secondary winding of the transformer and for simultaneously varying the resistance in series with the primary winding of the transformer.

7. Structure as set forth in claim 4 wherein the means responsive to the resonant circuit for opening the on-off contacts comprises a parallel circuit in series with the resonant circuit including a controlled rectifier, a capacitor and an actuating solenoid for the on-off contacts connected in parallel.

8. A speed responsive engine cut-out switch for use in conjunction with an internal combustion engine or similar device having an ignition circuit comprising on-off contacts adapted to be placed in series with the ignition circuit, a push-button switch for bypassing said on-off contacts during engine starting, means connected to said engine for developing a series of pulses at a repetition frequency proportional to engine speed, a resonant circuit connected to receive said pulses, means operably associated with said on-off contacts and connected to said resonant circuit for holding said on-off contacts closed after said push-button switch is actuated and responsive to the resonant circuit for opening the on-off contacts on resonance of said resonant circuit and switch means for alternatively shorting said on-off contacts out of said ignition circuit and for placing the on-off contacts in series therein.

9. Structure as set forth in claim 8 wherein the means for developing a series of pulses the repetition frequency of which are proportional to engine speed comprises a blocking oscillator.

10. Structure as set forth in claim 9 wherein the blocking oscillator has an output circuit including the primary winding of a transformer therein and the resonant circuit includes the secondary winding of the transformer and a capacitor connected in parallel with the secondary winding of the transformer.

11. Structure as set forth in claim 10 and further including means operably associated with the resonant circuit and the output circuit of the blocking oscillator for simultaneously selectively varying the value of the capacitor connected in parallel with the secondary winding of the transformer and for varying the resistance in series with the primary winding of the transformer.

12. Structure as set forth in claim 8 wherein the means for holding the on-off contacts closed and for opening the on-off contacts comprises a parallel circuit in series with the resonant circuit including a controlled rectifier, a capacitor and an actuating solenoid for the on-off switch connected in parallel and responsive to the resonant circuit.

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