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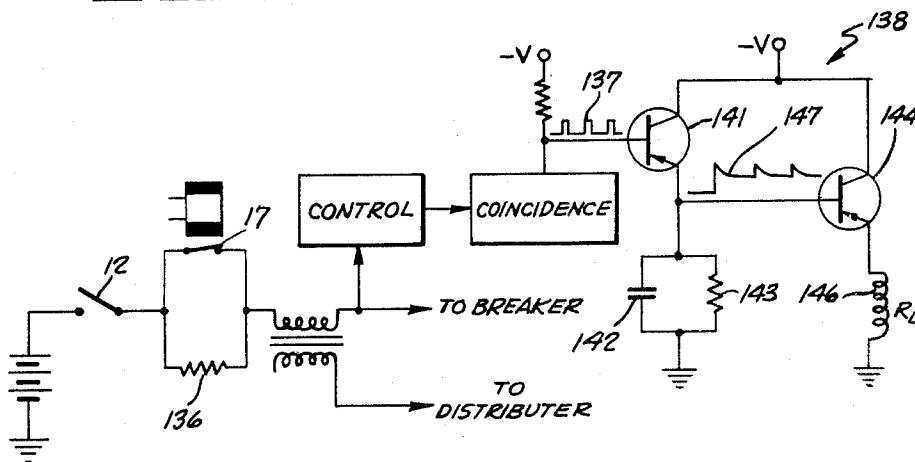
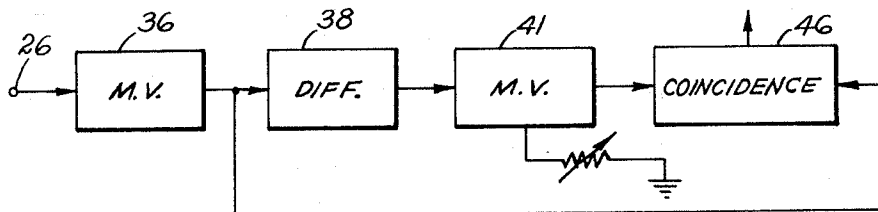
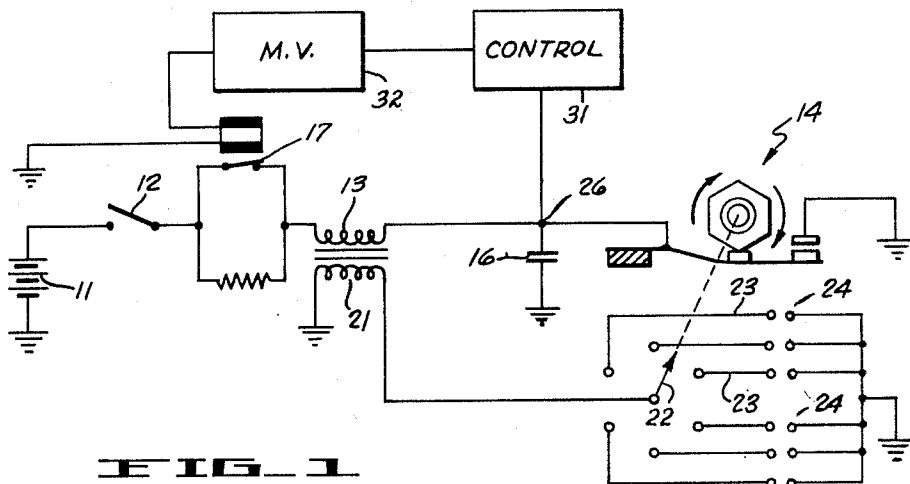
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3,153,746

INTERNAL COMBUSTION ENGINE OVERSPEED CONTROL

Filed July 3, 1961

3 Sheets-Sheet 1



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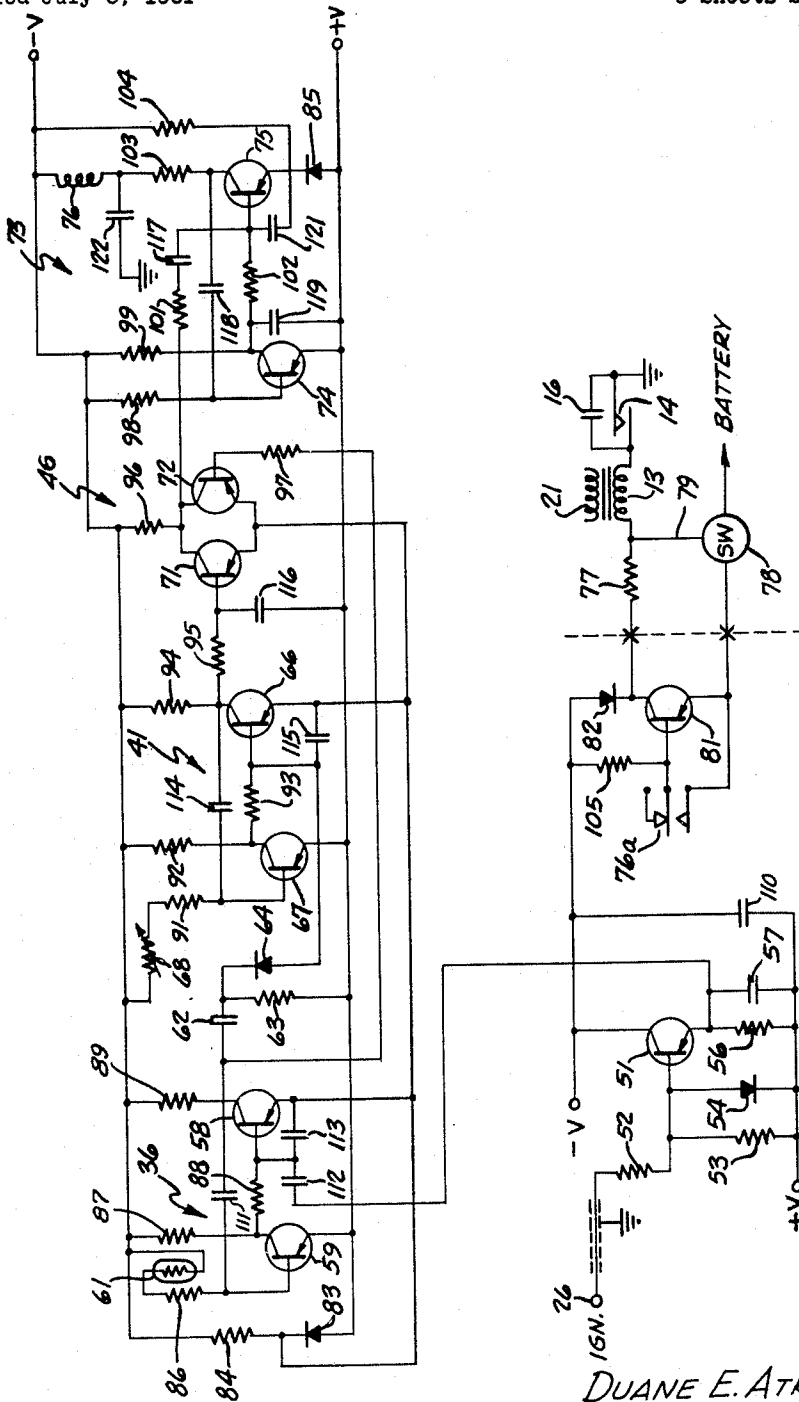
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3 Sheets-Sheet 2



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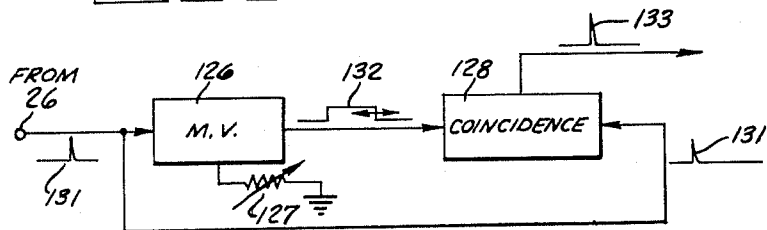
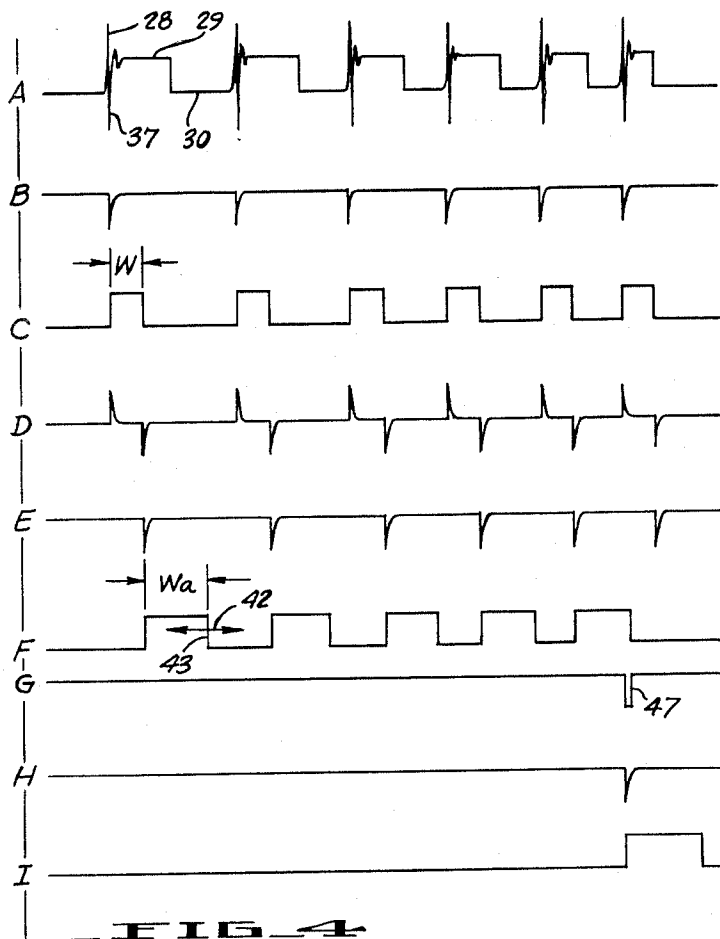
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INTERNAL COMBUSTION ENGINE OVERSPEED CONTROL

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3 Sheets-Sheet 3



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1

2

3,153,746 INTERNAL COMBUSTION ENGINE OVER- SPEED CONTROL

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Filed July 3, 1961, Ser. No. 121,588
4 Claims. (Cl. 317-5)

This invention relates generally to overspeed controls and more particularly to overspeed control for internal combustion engines.

In many applications, internal combustion engines are employed to drive auxiliary equipment. They are used to drive compressors, hydraulic pumps, generators and the like. Often the engine of a vehicle is used for the dual purpose of providing motive force to propel the vehicle and to drive auxiliary equipment such as hydraulic pumps, compressors, generators, etc.

Auxiliary equipment, in general, intermittently loads the engine. Auxiliary equipment is more efficiently operated at predetermined speeds, and thus during load conditions it is desirable to maintain a given speed. However, when the load on the auxiliary equipment is reduced or removed, the engine will rapidly overspeed. This not only damages the engine, but may also damage or destroy the auxiliary equipment.

Several types of overspeed devices are found in the prior art. In general, the prior art devices are devices requiring a mechanical connection to the engine. Some of these devices employ arrangements which operate by centrifugal forces. Others operate in response to variations in the intake manifold vacuum. In general, all of the prior art devices have a slow response. In many instances where the load is suddenly removed from the auxiliary equipment, the engine will build up speed more rapidly than correction takes place thereby permitting destructive speeds to be attained before the speed reduction can be effected.

Another disadvantage with such prior art devices is in that because such devices require mechanical or vacuum connections to the engine, it requires considerable installation time. As a result, overspeed systems of the prior art are relatively expensive to install.

It is a general object of the present invention to provide an improved overspeed control.

It is another object of the present invention to provide an overspeed control which may be easily and rapidly installed.

It is another object of the present invention to provide an overspeed control which has fast response.

It is still a further object of the present invention to provide an overspeed control which requires only electrical connections to the engine.

It is another object of the present invention to provide an overspeed control which responds instantaneously to changes in the breaker frequency.

The foregoing objects are, in general, achieved by limiting the engine speed by interrupting the ignition circuit when the time between two successive breaks of the breaker points is less than a preset value corresponding to maximum allowable engine speed.

These and other objects of the invention will become more clearly apparent from the following description when taken in conjunction with the accompanying drawing.

Referring to the drawing:

FIGURE 1 schematically shows an ignition system incorporating the present invention;

FIGURE 2 is a block diagram of a system suitable for providing the control of FIGURE 1;

FIGURE 3 is a detailed circuit diagram of an overspeed control circuit in accordance with the present invention;

FIGURE 4 shows the voltage waveforms at various parts of the circuit of FIGURE 3;

FIGURE 5 is a block diagram of a system employing a single multivibrator; and

FIGURE 6 schematically illustrates another system in accordance with the invention.

The primary or low voltage portion of the ignition circuit, FIGURE 1, includes serially connected battery 11, ignition switch 12, coil primary 13, and breaker contacts 14. In accordance with well known practice, a resistor may be connected in the series circuit to limit the current. A bypass contact is generally provided in the ignition switch to remove the resistor from the circuit during starting so that a relatively high energy spark is obtained under starting conditions. A capacitor 16 is connected in the primary circuit across the points to reduce arcing. In accordance with the present invention a normally closed switching element, such as the contacts 17 of a relay are also connected in series in the primary circuit.

The coil includes a secondary 21 connected to the distributor rotor 22 which serves to selectively connect the coil to the secondary leads 23 which lead to the spark plugs designated by the gaps 24.

Referring to FIGURE 4A, there is schematically shown a voltage waveform such as would appear at the point 26 of the primary circuit. When the breaker contacts are closed, the point 26 is connected to ground through the contacts and the voltage is near zero; a relatively high current flows through the circuit. During this time, the flux in the primary windings builds up. When the contacts are suddenly opened, the energy stored in the magnetic field of the coil is released and appears as heat energy at the selected spark plug gap. The capacitor 16 shunted across the breaker points suppresses arcing at the contacts by storing some of the energy released by the collapse of the magnetic field.

The voltage at the point 26 follows the voltage of the capacitor and goes through several periods of oscillations, shown at 28, FIGURE 4A, before it levels off at substantially battery voltage, shown at 29, FIGURE 4A. When the contacts are closed, the voltage at the point 26 again drops substantially to zero, shown at 30, FIGURE 4A.

In accordance with the present invention, a control circuit 31 is connected to receive the voltage waveform at the point 26. The control circuit serves to generate an output pulse, which is applied to a monostable multivibrator 32, when the time lapse between successive breaks of the breaker points is less than a preset value. The preset value, in general, serves to set the maximum operating speed of the engine. If the engine operates at a higher speed, the frequency of make and break of the breaker points increases and the time between adjacent pulses will be reduced to a value less than said preset value. When a pulse is generated by the control circuit 31, it serves to trigger the multivibrator 32 which, in turn, generates an output pulse. The output pulse may be amplified and applied to drive the relay. The relay contact 17 is then opened and the ignition circuit interrupted. The engine instantaneously loses speed, even under no load conditions, since no more combustion can take place.

Referring to FIGURE 2, a simplified block diagram of a control circuit for generating control pulses is illustrated. A monostable multivibrator 36 is connected to the point 26 and receives the waveform. The multivibrator is responsive only to negative going spikes such as the oscillatory portion shown at 37, FIGURE 4A. When the multivibrator is triggered, it generates output pulses having a constant pulse width W, such as shown in FIGURE 4C. The frequency of these pulses is dependent upon the frequency of the applied pulses 37.

3

The output of the multivibrator is differentiated in a circuit 38 and applied to another monostable multivibrator 41. The multivibrator 41 generates pulses having an adjustable pulse width W_a , FIGURE 4F. The variable pulse width is schematically indicated by the arrow 42 at the trailing edge 43 of the pulse. In essence then, the trailing edge 43 of the pulse output from the multivibrator 41, FIGURE 4F, can be made to occur at any selected time delay with respect to occurrence of the pulse 37 which triggers the multivibrator 36. The time between the leading edge of the pulse from the multivibrator 36 and the trailing edge of the pulse from the multivibrator 37 will represent a particular engine speed. In accordance with the present invention, the output from the multivibrator 41, FIGURE 4F, is applied to one input terminal of a coincidence circuit 46. The output of the multivibrator 36, FIGURE 4C, is applied to another input terminal of the coincidence circuit 46. If the pulse from the multivibrator 41 has not terminated when the pulse 37 triggers the multivibrator 36, there will be coincident application of positive voltages to the coincidence circuit. An output or control pulse 47, FIGURE 4G, is generated.

This, in effect, means that the time delay between two successive "breaks" of the breaker points is less than a preset value which is set by adjusting the position of the trailing edge of the pulse from the multivibrator 41. The output pulse from the coincidence circuit is employed to trigger the multivibrator 32 previously described which, in turn, serves to energize the relay and open contact 17 to turn off the engine.

When the pulse from the multivibrator 32, FIGURE 4I, is completed, the relay contact 17 will again close and the circuit will serve to observe the time lapse between the next successive breaker point breaks. If the next two pulses are spaced a time period less than the preset time period corresponding to a given engine speed, a control pulse will again be generated and the contact again be opened afterwards. It has been found in practice that if the multivibrator 32 generates pulses having a duration of 100-1000 milliseconds, the engine speed will be substantially reduced before completion of the pulse.

Referring now to FIGURES 3 and 4, there is shown a circuit in accordance with the invention which was assembled and operated. The point 26 is connected to a pulse shaping circuit which includes transistor 51. The amplitude of the pulse 37 applied to the base of the transistor is attenuated by the voltage divider comprising resistors 52 and 53. The diode 54 is connected to bypass positive going pulses. Thus, only the negative spike 37 will change the current flowing between emitter and collector in transistor 51. The transistor is connected to a storage circuit comprising resistor 56 and capacitor 57. A negative pulse serves to charge up the storage circuit and develops a shaped pulse of the type shown in FIGURE 4B. The storage circuit is capacitively coupled to the base of the transistor 58 which together with the transistor 59 and associated circuitry forms a monostable multivibrator, previously referred to as the multivibrator 36. A thermistor 61 is connected in the circuit for temperature compensation.

The collector of the transistor 58 is connected to a differentiating circuit including capacitor 62 and resistor 63. The output of the multivibrator 36 is shown in FIGURE 4C and the differentiated pulses are shown in FIGURE 4D. The diode 64 serves to pass only negative pulses shown in FIGURE 4E. It is connected to the base of the transistor 66 which together with the transistor 67 and associated circuitry forms a monostable multivibrator, previously described as multivibrator 41. The output at the collector of transistor 66 of this multivibrator is shown in FIGURE 4F. The variable resistor 68 serves to control the position of the trailing edge 43 (pulse duration), as shown in FIGURE 4F. The collector of transistor 66 is connected to the base of the transistor 71 which together with the transistor 72 and associated circuitry form a coin-

4

cidence circuit, previously referred to as coincidence circuit 46. The output pulse from the coincidence circuit is applied to a one-shot multivibrator 73 which includes transistors 74 and 75 and associated circuitry. The collector of the transistor 75 is connected in series with the energizing coil 76 of a relay whose contacts 76a (shown in the lower part of the figure) are in circuit with the primary ignition circuit.

On the lower right-hand side of FIGURE 3, there is schematically illustrated breaker points 14, capacitor 16, coil primary 13, coil secondary 21, and a current limiting resistor 77. A conventional ignition switch 78 is shown with a bypass lead 79 which, as previously described, is employed during start.

The relay contacts, rather than being connected directly into the primary circuit, are connected to control a transistor 31 which acts as the switch. Thus, when the relay is energized, the base of the transistor is shunted to its emitter thereby effectively providing an infinite impedance path in the series primary ignition circuit. When the relay is not energized, the transistor provides a low impedance path. The diode 82 is provided to reduce inductive loads.

As previously described, the overspeed control shown in FIGURE 3 was constructed and operated. The values and identification of the various components employed in the circuit, which proved extremely effective to prevent overspeed, were as follows:

Voltages:

+V= 12 v.
-V=-12 v.

Transistors:

51	-----	2N404
58	-----	2N404
59	-----	2N404
66	-----	2N404
67	-----	2N404
71	-----	2N404
72	-----	2N404
74	-----	2N404
75	-----	2N404
81	-----	2N441

Diodes:

54	-----	IN2069
64	-----	IN2069
82	-----	IN2069
83	-----	IN2069
85	-----	IN2069

Resistors:

52	-----	ohms	220K
53	-----	do	15K
56	-----	do	22K
63	-----	do	22K
68	-----	do	0-25K
77	-----	do	.3
84	-----	do	2.2K
86	-----	do	2.2K
87	-----	do	2.2K
88	-----	do	3.3K
89	-----	do	1K
91	-----	do	15K
92	-----	do	2.2K
93	-----	do	3.3K
94	-----	do	1K
95	-----	do	10K
96	-----	do	2.2K
97	-----	do	10K
98	-----	do	33K
99	-----	do	2.2K
101	-----	do	47K
102	-----	do	3.3K
103	-----	do	470
104	-----	do	2.2K
106	-----	do	50

Capacitors:

Microfarads

16	-----	0.1
57	-----	0.1
62	-----	.022
110	-----	.500
111	-----	.33
112	-----	.022
113	-----	.0047
114	-----	.22
115	-----	.022
116	-----	0.1
117	-----	.022
118	-----	.25
119	-----	.022
121	-----	.001
122	-----	.22

Thermistor—known by manufacturer's specification as Veco 21D2 (100 at 25° C.)

Relay—known by manufacturer's specification as SIGMA 11F 1,000G-SIL.

The embodiment of the invention described above employs two multivibrators to obtain a "delayed" pulse for application to a coincidence gate. Although this is the preferred embodiment, it is understood that a single multivibrator can be used to obtain the delayed pulse in response to an input pulse.

Referring to FIGURE 5, the pulse from the point 26 is applied to a multivibrator 126 which has an adjustable pulse width as indicated schematically by the variable resistor 127. The output pulse from the multivibrator 126 is applied to the coincidence circuit 128, which may be of the type previously described. The pulse from the point 26 is applied to the other terminal of the coincidence circuit 128. When a break pulse 131 occurs before a multivibrator pulse 132 terminates, an output control pulse 133 is generated.

In the embodiments of the invention described above, the engine will be off for a period of time which is dependent upon the pulse width of the pulses applied to the relay and the time constants of the components associated with the contacts. The action of the overspeed control is to turn the motor off and on at some rate dependent upon the setting of the accelerator.

The circuit shown in FIGURE 6 includes means serving to continuously provide input to the control circuit when the primary circuit is opened by the control pulse. This is achieved by connecting a resistance across the contact 17, FIGURE 1, or across the emitter collector contacts of the transistor 81, FIGURE 3, or across whatever element is being used to interrupt the primary of the ignition circuit. The value of the resistor 136, FIGURE 6, is selected such that it will not give enough current to give rise to a spark but will give a voltage at the point 26.

As a result, the control circuit will continuously monitor the engine speed even when contacts 17 are open. As a result, control pulses 137 are continuously generated when the timing between breaker point openings is less than a predetermined value corresponding to desired overspeed. These pulses are applied to a storage circuit 138 which serves to keep the relay energized as long as control pulses 137 are being generated.

The circuit 138 includes a transistor 141 having its base connected to receive the control pulses. The transistor is connected in an emitter follower circuit with a storage or charging circuit including capacitor 142 and

resistor 143. The output from the emitter follower stage is applied to a second emitter follower stage having transistors 144 including relay coil 146 in the emitter circuit.

The action of the storage circuit is to allow the capacitor to charge rapidly in response to the emitter current and to discharge slowly through the resistor whereby the voltage at the base of transistor 144 is of the form shown at 147. The pulses 147 are such that they will serve to maintain the relay energized continuously as long as control pulses are generated.

A further advantage with the circuit of FIGURE 6 is that when a control circuit of the type shown in FIGURES 2 or 3 is employed, the output of the first multivibrator can be integrated to give an indication of r.p.m.

I claim:

1. An overspeed control of the character described for internal combustion engines including an electrical circuit having an ignition circuit including breaker points, comprising means for generating a break pulse when the breaker points break, means responsive to said break pulse for generating a second pulse, said second pulse being delayed from said break pulse, and means serving to form a control signal when the delayed pulse has a pulse portion in time coincidence with the next break pulse.

2. Apparatus as in claim 1 wherein additional means are provided responsive to said control signal for interrupting the ignition circuit.

3. An overspeed control of the character described for internal combustion engines including an electrical circuit having an ignition circuit including breaker points, comprising means serving to generate break pulses in response to breaker point openings, means responsive to said break pulses serving to generate second pulses having a preselected pulse width, said second pulses being delayed from said break pulses, means adapted to receive said break and second pulses and serving to generate a control signal when the break and second pulses have portions in time coincidence, and means responsive to said control signal serving to interrupt the ignition circuit.

4. An overspeed control of the character described for internal combustion engines including an electrical circuit having a primary circuit including breaker points, means responsive to a control signal for interrupting the primary circuit, a resistor connected across said interrupting means, said resistor having a value such that it does not serve to provide ignition for the engine, means for generating a break pulse when the breaker points open, means responsive to said pulse for generating a pulse having a variable pulse width, means serving to form control pulses when said variable pulse width pulse has a portion in time coincidence with the next break pulse, and means for receiving said control pulses and forming said control signal.

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