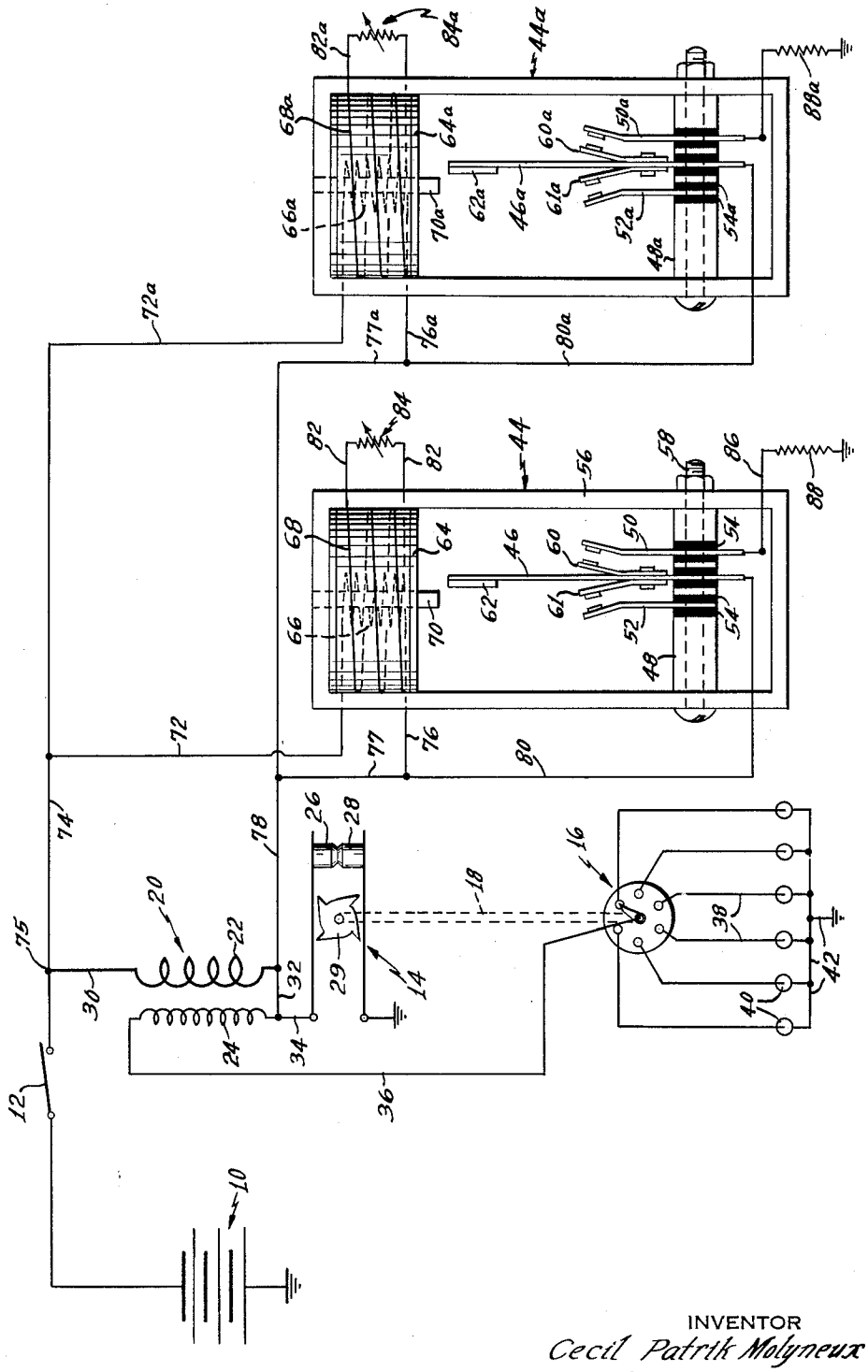
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SPEED LIMIT CONTROL AND FREQUENCY SENSITIVE SENSOR THEREFOR

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SPEED LIMIT CONTROL AND FREQUENCY SENSITIVE SENSOR THEREFOR

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9 Claims. (Cl. 123—118)

My invention relates to improvements in governors and controls, more particularly for spark ignition internal combustion engines.

This application is a continuation-in-part of my application Serial No. 139,106, filed January 17, 1950, for "Electromechanical Speed Governor," now Patent No. 2,611,352, granted September 23, 1952.

The primary object of the present invention is to provide an improved governor which is not only inexpensive to manufacture but which can be connected into the engine or other systems to be governed by merely connecting up a few electric wires or making a few electrical connections.

A further object of the invention is to provide a governor which is non-electronic, which is free from damage by vibration and shock and which is adapted to effect a close control of the engine or other mechanism to be governed.

Another object of my invention is to provide a governor which is adapted to act upon the ignition system of a spark ignition engine in such a manner as to prevent the speed of the engine from exceeding a predetermined value.

Still another object of my invention is to provide a frequency sensing control unit which is compact and inexpensive, which may be used to control the operation of internal combustion engines and other mechanisms to which the improved control system is adaptable.

In my pending application referred to above, I have disclosed a control unit including a tuned reed having a resonance frequency set at or corresponding to the desired governing speed, the tuned reed being responsive to a frequency source proportional to the speed of the engine or other mechanism to be controlled. The reed of the control unit is driven by an electromagnet which takes its current from an electric frequency source, the reed being vibrated when the frequency source reaches that of the tuned frequency of the reed. The unit also includes an electric switch actuated by the vibration of the reed at its tuned frequency which in turn closes a circuit for actuating an electrical means to operate a suitable control or open a part of the ignition circuit of the ignition system of an internal combustion engine, thereby reducing the speed of the engine.

More specifically my application in this respect discloses a control including a relay which is actuated by the reed switch to open the ignition circuit through the contact breaker, thereby stopping the engine and preventing overspeeding.

The pending application also discloses means for preventing or reducing reed resonance response at frequencies other than that of the governing frequency of the reed, such means including an additional winding in the electromagnet provided for actuating the reed, the additional winding being connected across the battery to provide a steady DC magnetizing field which polarizes the electromagnet.

According to my present invention, I use a vibrating reed unit similar to that disclosed in my pending application, but I have discovered that a more effective control of the engine speed can be obtained by providing means responsive to the vibration of the reed at its natural frequency for bleeding off a portion only of the current intended for the spark plugs of the engine. The functioning of this means is preferably coordinated with that of the contact breaker of the ignition system in such a manner as to reduce the current supplied to the spark plugs of the engine and thereby prevents the engine from exceeding a desired maximum speed.

In a preferred construction, a circuit is provided for bleeding-off current from the spark coil of the ignition system, when the reed is vibrated at its tuned frequency, thereby reducing the current flow to the spark plugs of the engine.

The electrical frequency sensing system according to the present invention includes a bypass circuit provided with a switch operated by the reed, the circuit being connected into the ignition coil or other source of current to be reduced, and including a current limiting device, for example a resistance, in series with the reed-operated switch.

The governor and frequency-responsive or sensing system of the present invention includes other features and advantages described in detail hereinafter in connection with an illustrative embodiment shown in the accompanying drawing forming a part of this application.

In the drawing the single figure is a diagrammatic view in which the features of the present invention are illustrated in connection with the pertinent elements of a spark ignition internal combustion engine.

As shown in the drawing the elements comprise a battery **10**, an ignition switch **12**, a distributor including a contact breaker **14** and a current distributor **16**, the elements of the distributor being carried on a shaft **18**, and a spark coil **20** having primary and secondary windings **22** and **24**, respectively. The contact breaker **12** includes contacts **26** and **28**, which are alternately opened and closed by the breaker **14**. The contact **28** is connected to ground as shown to complete the circuit to the battery **10**, the ground in all instances shown in the drawing being the block of the engine or the body of the chassis carrying the engine, as in conventional practice.

The battery **10**, one side of which is grounded in accordance with conventional practice, is connected through the switch **12** by a wire **30** to one terminal of the primary winding **22**. The other terminal of the winding **22** is connected by a wire **32** to one terminal of the secondary winding **24** and to the contact **26** of the contact breaker **14** by a wire **34**. The other terminal of the secondary winding **24** is connected through a wire **36** to the ignition current distributor **16** for the passage of high tension current respectively through leads **38** to the six spark plugs **40** of the engine, these spark plugs being grounded to the engine block in a conventional manner as indicated diagrammatically by the connections **42**.

The control or governing mechanism associated with the engine ignition system comprises one or more frequency sensing or frequency-responsive devices, two of which are shown at **44** and **44***a*. These devices have exactly the same structure, except for a difference in the natural tuned frequency of their reeds. Therefore, the reference characters applied to the elements of the device **44** will be the same for the device **44***a*, except that they will include the letter "*a*," the devices **44** and **44***a* being connected in parallel into the ignition circuit of the engine.

The device **44** includes a tuned spring metal reed **46**, the lower portion of which is clamped in a mounting **48** between a contact arm **50** and a similar bumper arm **52**, all three elements being held rigidly in the mounting **48** and insulated from each other and the mounting by means of blocks of insulating material **54**, as shown. The

mounting 48, together with the elements 46, 50 and 52 rigidly carried thereby, is rigidly set in the lower portion of a frame 56 of magnetizable metal and secured therein by a bolt 58. The frame 56 preferably has the rectangular shape shown and is of relatively heavy metal. The reed 46 carries a pair of similar, oppositely-mounted contact arms 60 and 61 facing the contact arm 50 and bumper 52, respectively, while the upper end of the reed 46 carries an armature 62.

The frequency sensing device 44 or sensor also includes an electromagnet 64 having primary and secondary windings 66 and 68, the winding 66 being inside the winding 68 directly surrounding a magnetically permeable metal core 70 fixed in the upper part of the metal frame 56 and extending below the electromagnet to a position adjacent to the upper part of the armature 62 carried by the reed 46. The core 70 may be used to support the electromagnet 64 in the frame 56, or the cover of the electromagnet may be secured to the sides of the frame 56.

The primary winding 66 includes a considerable number of turns, preferably 2½ times the turns of the secondary winding 68. One terminal of the primary winding 66 is connected through wires 72 and 74 into the outlet of the switch 12 and to the connection 30 to the inlet terminal of the primary coil 22 at the point 75. The other terminal of the primary coil 66 is connected by wires 76, 77 and 78 into the opposite or outlet terminal of the primary coil 22. The wire 77 is also connected through a wire 80 with the lower end of the tuned reed 46 thereby providing a connection from the contact arm 60 to the wire 32 connecting the coils or windings of the spark coil, which is in turn connected through the wire 34 to the contact 26 of the contact breaker 14.

The secondary winding 68 is wound over the primary winding 66 and in the same direction, its terminals 82 being short circuited through a variable resistance or calibrating resistor 84. The secondary winding 68 provides a damping effect on the primary winding 66 and is particularly effective for producing a counteracting current in the electromagnet.

The contact arm 50 of the device 44 is electrically connected through a wire 86 and a resistor 88 to ground, so that when the contact arm 60 on the reed 46 opposite the arm 50 is engaged, a controlled current will flow through the resistor 88 to ground. The bumper arm 52 is not an electrical connection but is merely provided as a stop for the reed 46 opposite the arm 50, so that when the reed is vibrating at its tuned frequency, its amplitude at the arms 60 and 61 will be limited to the spacing of the upper ends of the arms 50 and 52 with respect to the arms 60 and 61. It is important that the bumper arm 52 have no electrical connection with the arm 50 or the wire 86, because at the governing frequency when the reed 46 is vibrating, the operation must be such that the circuit between the arms 50 and 56 is closed just previous to the opening of the breaker point contacts 26 and 28 of the distributor. The reed 46, therefore, is provided with only one switch.

The second device or unit 44*a* is provided as a safety measure and its reed 46*a* is preferably tuned to a slightly higher frequency than the reed 46. In other respects, the unit is the same as the unit 44 and is connected in parallel therewith as indicated by the wiring arrangement.

In the operation of the control system shown in the drawing, the closing of the ignition switch 12 starts the engine and the contact breaker 14 alternately opens and closes the contacts 26 and 28 at a rate corresponding to the speed of the engine, since the shaft 18 is driven directly by the engine, in accordance with conventional practice. A pulsating current is, therefore, produced having a frequency which varies directly with the speed of the engine. This pulsating current therefore flows through the primary winding 66 of the electromagnet 64 via wires 74, 72, to the winding 66 and via wires 76, 77, 78, 32, 34, the contact breaker 14 and to ground. The electromagnet 64 is, therefore, energized at the frequency created by the engine ignition system and the electromagnet 64 acts upon the armature 62 of the reed 64 through the metal core 70. However, the reed 46 will not vibrate until the speed of the engine produces a frequency corresponding to the preselected tuned frequency of the reed 64. When the frequency of the pulses in the electromagnet 64 equals that of the mechanical fundamental frequency of the reed 46, the latter vibrates and intermittently closes a circuit through the contact arms 50 and 60, which permits current to flow through the wire 86 and the resistor 88 to ground, thereby producing the effect of bridging the contacts 26 and 28 of the contact breaker. The contact arms 50 and 60 are arranged to open after the opening of the breaker contacts 26 and 28, thereby causing a delay in collapse of the magnetic field of the ignition coil 20 and therefore a change in both the timing and potential energy of the spark ignition system. This action reduces the spark potential at the spark plugs thus delaying the ignition of the fuel. It also changes the timing point of the engine cycle at which the fuel charge is ignited, and in this way limits the power output of the engine.

When the reed 46 and the pulses in the ignition system are in resonance, the reed intermittently closes the switch formed by the contact arms 50 and 60 every time the breaker contacts 26 and 28 close and takes the engine speed control away from the breaker of the ignition circuit. Since the reed 46 has a tuned frequency corresponding to the frequency of the pulses of the ignition system at the maximum desired speed of the engine, the control system will limit the speed of the engine, since the closing of the contact arms 50 and 60 causes the collapse of the magnetic field of the primary winding 22 which controls the induced voltage to the secondary winding 24 and therefore reduces the high voltage at the spark plugs, thereby controlling or limiting the speed of the engine.

The resistor 88 through which the contact arm 50 is connected to ground should, in the case of most engines, have a value of about 10 to 18 ohms. In a particular instance, this resistor was rated at 12 ohms. The resistance of the resistor 88 should be such as to quench but not break the engine spark, that is the resistor 88 should be such as to reduce the voltage normally supplied to the spark plugs from the ignition coil, but not cut it off entirely.

The operation of the control system shown in the drawing may be illustrated more specifically in connection with a particular engine speed, for example, suppose that it is desirable to limit the speed of a six cylinder, four cycle automotive engine to 3,000 R. P. M. Since the engine is a four cycle engine, the contact breaker 14 will actuate its contacts once for every two strokes for each cylinder or three times per revolution. This value, times 3,000 R. P. M. for the engine, gives 9,000 electrical impulses per minute in the electromagnet 64, or 150 impulses per second. The reed 46 is selected or made with a natural or set frequency of 150 impulses per second so that it will vibrate at an engine speed of 3,000 R. P. M. and prevent the engine from exceeding that speed. Substantial vibration of the reed at a subharmonic frequency of 75 is avoided by the secondary winding 68. The reed 46 will, therefore, not vibrate sufficiently at the subharmonic frequency to close a circuit between the contact arms 50 and 60. The frequency response of the reed 46 may be varied to some extent by adjusting the resistance 84.

In some special situations, the operator of a vehicle equipped with the system of the present invention may willfully operate the engine in such a manner as to override the control unit 44 by cutting out the ignition system and bringing it back in at a frequency above that of the reed 46. For example, on a steep hill, an operator might cut off the ignition system of his engine and then turn on

the current again when the contact breaker is operating at a frequency corresponding to a frequency above that of the reed **46**. This type of operation may be avoided by including the second unit **44***a* in parallel with the unit **44**, the unit **44***a* including a tuned reed **46***a* having a mechanical fundamental frequency higher than that of the reed **46**. For example, if the reed **46** has a mechanical fundamental frequency of 150 cycles per second, the reed **46***a* may have a frequency of 155 or 160, which would still prevent the engine from obtaining an excessively high speed, the unit **44***a* functioning in exactly the same manner as the unit **44**.

Experience in the use of units like the units **44** and **44***a* has shown that the vibration of the tuned reed at its fundamental frequency provides adequate power and sufficient contact dwell to effectively close the circuit between the contact arms **50** and **60**. If the frequency of the magnetic field produced by the electromagnet **64** pole piece **70** and frame **56** approaches and reaches the frequency of the reed **46**, the frequency of vibration of the reed does not change materially but the length of dwell of the reed contact arm **60** on the contact arm **50** increases because of the bending of the reed due to its flexibility. This increase in the length of dwell where the contacts of the arms **50** and **60** are closed just after the closing of the breaker points increases the amount of current or the length of time current flows through the wire **86** and resistor **88** after the opening of the breaker points, thereby insuring sufficient loss of power in the ignition circuit to hold the engine to the selected maximum speed.

While the control system of the present invention has been described and illustrated in connection with the control of the speed of a spark ignition internal combustion engine, it may be applied to control other mechanisms where it is possible to provide a frequency reference or source proportional to the speed of the mechanism, as for instance by the use of a tachometer, and where it is possible to bleed-off a portion of the electric current supplied for operating or for controlling the operation of the mechanism. In controlling such a mechanism, the wires **72** and **77** are connected into the frequency reference or source and the wire **80** is connected into the current supply to the mechanism or the control therefor, so that, when the contacts of the arms **50** and **60** are engaged, a portion of the current will be bled off through the resistor **88** at the predetermined desired maximum speed for the mechanism.

The control system or over-speed governor of the present invention is of relatively light weight and relatively inexpensive to manufacture compared to known governors. An important advantage is the fact that it may be connected by two wires into an existing electrical system of a spark ignition engine. It may be connected into other mechanisms, controls or motors with not more than three wires. This avoids the trouble and expense of using known types of governors like the fly ball governor. Furthermore, the control units of the present invention do not include the use of any electronic tubes and therefore avoids the disadvantages which would result from the breakage of such tubes or having them burn out.

I claim:

1. A control system for limiting the speed of an internal combustion engine having an ignition system including a spark coil, a contact breaker and a distributor driven by the engine, spark plugs, a source of electric current, and electrical connectors forming an ignition circuit for the system, said control system comprising a tuned reed having a fixed end and a free end, the reed having a predetermined tuned frequency corresponding to the frequency produced by the contact breaker at the maximum desired speed for the engine, an armature mounted on the free end of the reed, electric means mounted adjacent the armature on the free end of the reed for producing a magnetic field adapted to act on the armature to vibrate the reed at said frequency, means including electrical connectors for supplying electrical impulses from the circuit of the ignition system to said electric means at the frequency produced by the contact breaker of the ignition system, a normally open switch operatively associated with the reed and adapted to be closed upon vibration of the reed at said tuned frequency during operation of the engine, an electrical conductor connected into a part of the ignition circuit leading to the spark plugs of the engine and into one side of said switch for conducting electric current to said switch, and a second electric conductor having a resistance therein connected into the other side of said switch for bleeding electric current from the ignition circuit when said switch is closed, thereby reducing the current supplied to the spark plugs of the ignition system when said reed is vibrated at said tuned frequency and closes said normally-open switch.

2. A control system as claimed in claim 1, in which said normally-open switch includes a single fixed contact terminal, and a movable contact carried by the reed adapted to engage the contact of the fixed terminal when the reed is vibrated at said predetermined frequency.

3. A control system as claimed in claim 1, including a second tuned reed having the same associated elements as and connected into the ignition system in parallel with the tuned reed referred to in claim 1, said second tuned reed having a predetermined tuned frequency higher than that of the other tuned reed.

4. A speed governor for limiting the speed of an internal combustion engine having an ignition system including a spark coil, a contact breaker and a distributor driven by the engine, a source of electric current, and electrical connectors forming an ignition circuit for the system, said governor comprising a tuned reed having a fixed end and a free end, the reed having a predetermined tuned frequency corresponding to the frequency produced by the contact breaker at the maximum desired speed for the engine, an armature mounted on the free end of the reed, an electromagnet including a winding mounted adjacent the armature on the free end of the reed for producing a magnetic field adapted to act on the armature to vibrate the reed at said frequency, electrical connectors connecting the ends of said winding respectively into said source of electric current and into the circuit of the contact breaker for supplying electrical impulses from the circuit of the ignition system to said electromagnet at the frequency produced by the contact breaker of the ignition system, a normally-open switch operatively associated with the reed and adapted to be closed upon vibration of the reed at said tuned frequency during operation of the engine, an electrical conductor connected into the inlet of the secondary winding of the spark coil and into one side of said switch for conducting electric current to said switch, a second electric conductor connected into the other side of said normally-open switch for bleeding electric current from the spark plugs when said switch is closed, and a resistor of predetermined value in said second electric conductor.

5. A speed governor as claimed in claim 4, in which said normally-open switch includes a single fixed contact arm, and a contact carried by the reed adapted to engage the contact of said arm once for every cycle of the reed following the closing of the contact breaker contacts, when the reed is vibrated at said predetermined tuned frequency.

6. An overspeed governor for a mechanism to which electric current is supplied through an electrical conductor from a current source, the mechanism being responsive to a reduction in the current supplied thereto for reducing the speed of the mechanism, a tuned reed having a fixed end and a free end, the reed being adapted to be vibrated at a predetermined tuned frequency, an armature mounted on the free end of the reed, electric means mounted adjacent the armature for producing a magnetic

field adapted to act on the armature to vibrate the reed, a source of pulsating electric current including means responsive to the speed of the mechanism to be governed for increasing and decreasing the frequency of the pulsing current proportionately with the increase and decrease respectively of the speed of said mechanism, said reed having a predetermined tuned frequency corresponding to the frequency of the pulsating current at the maximum desired speed for the mechanism, electrical conductors for supplying electric current impulses from said pulsating current source to said electric means for energizing said electric means, a normally-open switch operatively associated with the reed and adapted to be closed upon vibration of the reed at said predetermined tuned frequency, an electrical conductor connected into the current supply conductor for said mechanism and into one side of said normally-open switch for conducting electric current thereto, an electric conductor connected into the other side of said normally-open switch and to ground, and a resistor in said last-mentioned electric conductor, said tuned reed being adapted to be vibrated at its predetermined tuned frequency to close said normally-open switch and thereby bleed-off through said resistor a part of the electric current normally being supplied to said mechanism, thereby preventing the mechanism from exceeding said predetermined desired speed.

7. A speed governor for limiting the speed of an internal combustion engine having an ignition system including a spark coil, a contact breaker and a distributor driven by the engine, a source of electric current, and electrical connectors forming an ignition circuit for the system including a connection between the spark coil and the contact breaker, said governor comprising a tuned reed having a fixed end and a free end, the reed having a predetermined tuned frequency corresponding to the frequency produced by the contact breaker at the maximum desired speed for the engine, an armature mounted on the free end of the reed, an electromagnet including a winding mounted adjacent the armature on the free end of the reed for producing a magnetic field adapted to act on the armature to vibrate the reed at said frequency, electrical connectors connecting the ends of said winding respectively into said source of electric current and into the circuit of the contact breaker for supplying electrical impulses from the circuit of the ignition system to said electromagnet at the frequency produced by the contact breaker of the ignition system, a current bleed-off circuit leading from the connection to the contact breaker, a normally-open switch in said current bleed-off circuit and operatively associated with the reed and adapted to be closed upon vibration of the reed at said tuned frequency during operation of the engine, and a resistance of predetermined value in said current bleed-off circuit.

8. A speed governor as claimed in claim 7 in which said resistance has a value of from about 10 to 18 ohms.

9. A control system for limiting the speed of an internal combustion engine having an ignition system including a spark coil provided with primary and secondary windings, a contact breaker and a distributor driven by the engine, spark plugs, a source of electric current, and electrical connectors forming an ignition circuit for the system including a connector from the current source to the primary winding of the spark coil, an electrical connection between said windings and the contact breaker and a connection between the outlet of the secondary winding and the spark plugs, said control system comprising a tuned reed having a fixed end and a free end, the reed having a predetermined tuned frequency corresponding to the frequency produced by the contact breaker at the maximum desired speed for the engine, an armature mounted on the free end of the reed, electric means mounted adjacent the armature for producing a magnetic field adapted to act on the armature to vibrate the reed at said frequency, means for supplying electrical impulses from the circuit of the ignition system to said electric means at the frequency produced by the contact breaker of the ignition system including an electrical conductor supplying current from the current source to one side of said electric means and an electrical conductor from the other side of said electric means connected into the connection to the contact breaker, a current bleed-off circuit extending from the connection to the contact breaker, a normally-open switch in said current bleed-off circuit and operatively associated with the reed and adapted to be closed upon vibration of the reed at said tuned frequency during operation of the engine, and a resistance in said current bleed-off circuit, said current bleed-off circuit being adapted to bleed-off a part of the electric current normally going to the spark plugs when said switch is closed, thereby reducing the current supplied to the spark plugs when said reed is vibrated at said tuned frequency and closes said normally-open switch.

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