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(71) Applicant: **SUNBEAM CORPORATION LIMITED**
Wade Street
Campsie, NSW 2194(AU)

(72) Inventor: **Nejtek, George**
78 Townsend Street
Condell Park New South Wales 2200(AU)
Inventor: **Crimmins, Russell Ian**
16 Lismore Close
Bossley Park New South Wales 2176(AU)
Inventor: **Chotar, Anthony Paul**
96 Lucas Road
Burwood New South Wales 2134(AU)
Inventor: **Kerr, Gavin**
7 Yalunga Place
St Ives New South Wales 2075(AU)
Inventor: **Gray, David Allan**
15 Varner Street
Randwick New South Wales 2031(AU)

(74) Representative: **Pratt, David Martin et al**
Brookes & Martin High Holborn House 52/54
High Holborn
London. WC1V 6SE(GB)

(54) Engine speed governor.

(57) A governor for a carburettor (10) having a throttle valve (16) to control the speed of an engine, in which the governor comprises a pneumatic device (21) connected to the throttle valve and having a working chamber (22) vented by an orifice (26), a closure valve (27) for the orifice, and electrical means (Fig. 4 or Fig. 5) responding to engine speed and to a predetermined desired speed of the engine controlling operation of the closure valve to effect through said pneumatic device changes in engine speed to correspond it to the predetermined desired speed.

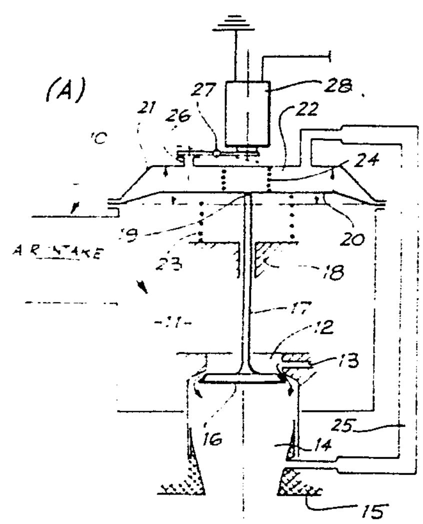

FIG.1

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ENGINE SPEED GOVERNOR

This invention relates to carburettors, and more particularly to engine speed governors incorporated therein.

The concept employed by governors, which seek to maintain engine speed with variation in load, is to effect automatic opening of the throttle valve in the carburettor with increased load and, therefore, falling engine speed, and automatic closing as the load is shed. If achieved effectively a manually selected speed of the engine can be maintained constant regardless of load charges. Centrifugal and pneumatic systems, i.e. using a flag or a diaphram, which have been proposed rely upon response to an engine condition which trails an initial dropin speed with increased load, and consequently react less than instantaneously. Furthermore, many of these systems require exposed linkages, and for stable operation under different conditions, such as barometric pressure and engine conditions, a richer mixture than at full load has to be maintained.

It is the prime object of the invention to provide an engine speed governor which substantially avoids the above drawbacks.

In accordance with the invention there is provided a carburettor incorporating a governor for speed control of an engine serviced by said carburettor, and comprising a passage for delivering working fluid from the carburettor, a throttle valve for controlling the volume of said fluid delivered by the carburettor, a pneumatic element associated with the carburettor and connected to said throttle valve and having a chamber to receive air of a pressure other than atmospheric pressure to effect movement of said throttle valve between open and closed positions, a control valve for controlling venting of said chamber via an orifice, and an electronic circuit responding to the speed of said engine to control operation of said control valve in order to return the engine speed to a predetermined speed whenever it varies therefrom.

The invention will be described in more detail with reference to the accompanying drawings in which:

Fig. 1(A) is a diagrammatic representation of a carburettor according to this invention showing it operational at an unloaded idling speed of a serviced engine of about 1500 RPM, and Fig. 1(B) shows graphically its operation;

Figs. 2(A) and (B) are similar representations to Figs. 1(A) and (B), with the engine unloaded at slow speed of approximately 2500 RPM and under governed conditions;

Figs. 3(A) and (B) are also similar representations with the engine loaded and at fast speed under governed conditions;

Fig. 4 is a block diagram of an electronic control circuit that may be used with the invention; and

Fig. 5 is a more detailed schematic drawing of another form of control circuit.

Referring firstly to Fig. 1(A), it will be seen that the carburettor 10 consists of an air intake chamber 11 having a venturi 12 to one side whereat fuel is inducted or injected via a passage 13 whereby the resulting working fluid is induced into the throat 14 for delivery to the intake manifold 15 of an I.C. engine (not shown). A throttle valve 16 is axially moved along the throat 14 to control the flow of working fluid to the manifold 15. The throttle valve 16 may be of any kind, such as a poppet valve as shown, or a butterfly valve. The stem 17 of the poppet valve 16 is supported in a bearing and is connected at its distal end 19 to a flexible diaphragm 20 which with a sealing casing 21 defines an air chamber 22. Bias springs 23 and 24 of predetermined rate act upon the diaphragm 20 to maintain it in equilibrium. A vacuum line 25 connects the chamber 22 with the intake manifold 15 to create sub-atmospheric pressure within the chamber 22 during running of the engine serviced by the carburettor 10. It will be noted that as shown in Fig. 1(A) the chamber 22 is sealed and the reduced pressure therein permits the diaphragm 20 to move upwardly to close the poppet valve 16 upon the venturi 12. As is conventional, idling passages may be provided around the valve 16 for sufficient fuel intake to maintain the engine at idling speed. It will be appreciated that the carburettor 10 is depicted purely diagrammatically in Fig. 1(A) for simplicity of explanation. The carburettor housing may be of a variety of forms without departing from the spirit of the invention and may or may not enclose the casing 21.

An orifice 26 defined say by a grommet, allows the entry of air into the chamber 22 to prevent the creation of a vacuum. The orifice 26 is arranged to be closed by a flap valve 27 under control of an electro-mechanical relay 28. An electronic control circuit, as shown in either Fig. 4 or Fig. 5, and described hereafter, energises the relay 28 to attract the flap valve 27 and close the orifice 26, as shown in Fig. 1(A). Alternatively, with appropriate modification of the system attraction of the valve 27 may open the orifice 26. Selective manual throttle control for the engine is intended to be effected via the electronic circuitry. Suffice it to say that, with the preferred embodiment, whenever the engine speed is below the selected speed the relay 28 is de-energised and under the influence of a spring (not shown) the flap valve 27 will pivot to the position shown in broken outline to open the orifice 26. As a result the air pressure in the chamber 22 rises and the poppet valve 16 opens to allow increased flow of working fluid into the throat 14, due to the diaphragm 20 moving towards its position of equilibrium.

The engine condition shown by Fig. 2 assumes operator setting of engine speed at 2,500 RPM with an increased load imposed upon the engine, thus requiring generation of increasing torque. In a condition of stable torque the flap valve 27 under control of the solenoid 28 will be oscillating between open and closed conditions to maintain the position of the throttle valve 16 as stable as possible and the condition of the governor shown in Fig. 2(A) is purely transitory. As the load on the engine increases the flap valve 27 will be opened to increase fuel flow to the engine by further opening of the valve 16. With practically no hunting, due to the immediate response to the electronic control circuit to changes in engine speed, the valve 16 will finally stabilise at an increased open condition capable of restoring engine speed at the selected level with the increased load.

The condition shown by Fig. 3 relates to a fully loaded state of the engine which is travelling at its governed speed. This speed may be preset by the manufacturer or set by an operator of the engine. The throttle valve 16 is fully open, with the flap valve 27 open so that should additional load be imposed upon the engine no response occurs in the diaphragm 20 and valve 16. Each of the graphs, Figs. 1(B), 2(B) and 3(B), plot resulting torque against engine revolutions with rising and falling of torque, as indicated by the arrows x, to meet changing loads.

Whereas a vacuum line 25 has been previously described, the invention is not limited to any specific source for deriving reduced pressure in the chamber 22. It is only necessary that sufficient sub-atmospheric pressure exists in the chamber 22 to ensure movement of the diaphragm 20 to close the valve 16. The source may be derived from any part of the engine, or even from complimentary equipment. A significant advantage flows from the use of a check valve (not shown), either in the casing 21 or in the line 25, which will vent the chamber 22 during pressure rises during the engine stroke, thereby to derive a reasonably stable and adequate vacuum within the chamber 22. A conventional form of connection from the diaphragm 20 may be used to obtain the necessary opening and closing of a conventional pivotted butterfly throttle valve is use of such a valve is desired.

The invention also contemplates the use of super-atmospheric pressure within the chamber 22 and a modified connection to a butterfly throttle valve will be required to achieve closure of such valve with downward displacement of the diaphragm 20. The modification to the butterfly valve need only be confined to the linkage connection thereto from the diaphragm 20. On the other hand, however, more substantial modification will be required in the case of use of a poppet valve 16. This can be achieved by locating the poppet valve 16 at the opposite side of the venturi 12, with corresponding relocation of the fuel passage 13, or can be achieved by modification of the control system. This is possible by arranging the equilibrium of the diaphragm 20 to correspond to a closed condition of the throttle valve 16 with reverse function of the flap valve 27. In such an instance the orifice 26 will be opened by the valve 27 during idling to allow for exhaust of pressurized air entering the chamber 22. Energisation and de-energisation of the relay 28 would then be achieved in a reverse sense from the electronic control circuit. An advantage accrues from the use of super-atmospheric air in the chamber 22 as no filtering of the orifice 26 will be necessary. On the other hand, where the flap valve 27 opens to allow the entry of atmosphere when the chamber 22 is subjected to sub-atmospheric pressure, filtering of the entering air is often necessary on many small engines likely to operate in foul atmospheres, such as experienced by domestic lawnmowers.

As a further alternative the throttle valve 16 may be made to open in response to application of sub-atmospheric, or super-atmospheric, air pressure from the line 25. The solenoid 28 will be arranged for operation to ensure closure of the orifice 26 with sub-atmospheric pressure, or opening thereof with super-atmospheric pressure.

One suitable form of electronic control circuit is shown in Fig. 4. The circuit input is connected to the ignition coil of the engine and pulses therefrom supplied to a tachometer 29 which produces an analogue signal on output line 30 applied to one side of a comparator 31. A reference voltage is derived by adjustment of the rheostat 32 through operator manipulation of a throttle control connected therewith and applied via line 33 to the other side of the comparator 31. An energising signal is delivered to the relay 28 only when the engine speed represented by the input voltage on line 30 rises above the selected speed indicated by the voltage on line 33. At all other times the relay 28 is de-energised.

Another form of control is shown in Fig. 5 where spark plug 34, ignition coil 35 and ignition module 36 together comprise the existing spark ignition system for the engine in which a magnetic field rotating with the crankshaft (not shown) passes the ignition coil 35 and this affects the low tension voltage VL to the ignition module 36 which itself then causes a sudden change in VL producing through the ignition coil 35, a high tension voltage VH for the spark plug 34. A diode D1 and capacitor C1 combine to give a semi-smoothed analogue voltage which is applied to the voltage regulator 37 to produce a regulated output voltage VR which is used to drive the remainder of the circuit. The voltage VL is also applied to the timing shaper 38 which provides an output which swings through the required level to reset a pulse generator 39 once for each crankshaft revolution. Resistor R1 and capacitor C2 are used in the pulse generator 39 to determine the pulse width of the outgoing signal and resistor R2 and capacitor C3 are used to determine the shape of the signal going to the positive input of a comparator 40 and which has a mean value which increases with crankshaft speed. As a result the comparator 40 continuously responds to the mean value of the applied pulses to achieve immediate reaction by the solenoid 28 to engine speed change with less hunting than would occur if the input signal was strictly analogue. The combination of variable resistor R3 and fixed resistor R4 and R5 can be used to set the specified value, and the upper and lower limits, of the voltage applied to the negative input of the comparator 40. This set voltage represents the desired speed for the engine governing. When the mean value of the voltage representing the actual engine speed at the positive input to the comparator 40 is greater than the voltage representing the desired speed at the negative input to the comparator 40 the output voltage of the comparator 40 goes high thus operating the control solenoid 28, and when the voltage representing the actual speed is less than the voltage representing the desired speed the comparator output drops to zero, thus releasing the control solenoid 28.

The invention will be found to have most merit when applied to small I.C. engines such as used with lawnmowers, marine craft, portable power tools and the like. Although it might be possible to control movement of the throttle valve 16 purely by electrical means in order to obtain a governing facility, the necessary amount of electrical power is not readily available in such small engines. By use of the invention instantaneous and reliable response is achieved with the limited electrical power available.

Whereas a preferred embodiment has been described in the foregoing passages it should be understood that other forms, modifications and refinements are feasible within the scope of this invention.

Claims

1. A carburettor (10) incorporating a governor for speed control of an engine serviced by said carburettor, and comprising a passage (14) for delivering working fluid from the carburettor, a throttle valve (16) for controlling the volume of said fluid delivered by the carburettor, a pneumatic element (21) associated with the carburettor and connected to said throttle valve and having a chamber (22) to receive air of a pressure other than atmospheric pressure to effect movement of said throttle valve between open and closed positions, a control valve (27) for controlling venting of said chamber via an orifice (26), and an electronic circuit (Fig. 4 or Fig. 5) responding to the speed of said engine to control operation of said control valve in order to return the engine speed to a predetermined speed whenever it varies therefrom.

2. A carburettor according to claim 1, comprising also a manual control (32 of R3) which when adjusted alters both the setting of the throttle valve and said predetermined speed.

3. A carburettor according to claim 1 or 2, wherein said electronic circuit includes a solenoid (28) for activating said control valve and a comparator (40) for receiving a first signal indicative of said engine speed and a second signal indicative of said predetermined speed to control energisation of said solenoid whenever said engine speed differs from said predetermined speed.

4. A carburettor according to claim 3, wherein energisation of said solenoid is effected to cause said control valve to close the orifice whenever said engine speed exceeds said predetermined speed.

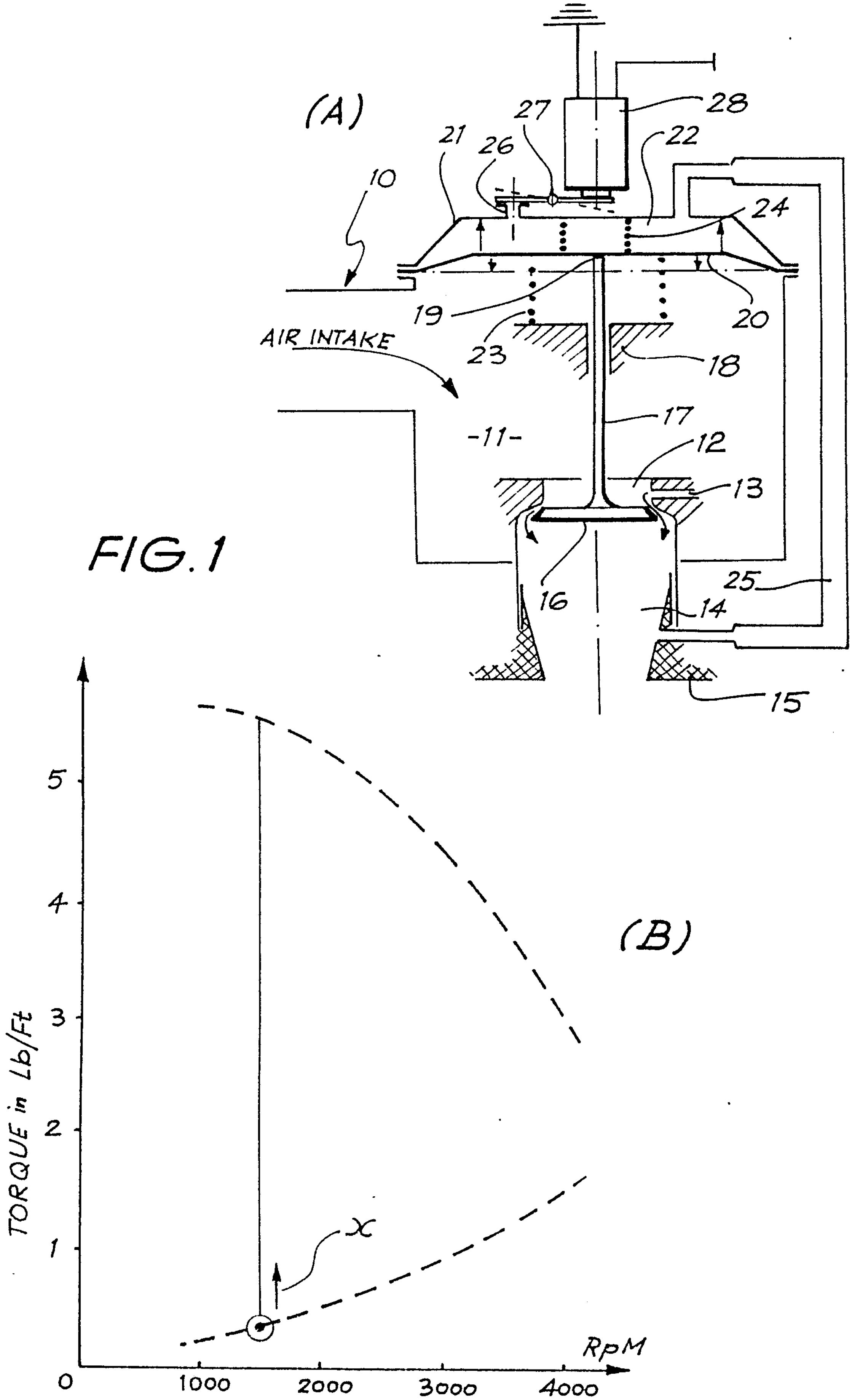
5. A carburettor according to claim 3, wherein said first signal is derived from the spark ignition system (34, 35 and 36) of said engine and is in the form of pulses whose means value represents said engine speed, and said second signal is a voltage whose amplitude is adjustable to indicate said predetermined speed.

6. A carburettor according to claim 5, wherein said predetermined speed is a speed selected by an operator through a throttle control electrical resistor (R3).

7. A carburettor according to any one of the preceding claims, wherein the pressure of said air is sub-atmospheric.

8. A carburettor according to any one of the preceding claims, wherein the pressure of said air is super-atmospheric.

9. A carburettor according to any one of the preceding claims, wherein said control valve is a pivoted flap valve (27).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AIR INTAKE
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TORQUE in Lb/Ft
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RpM
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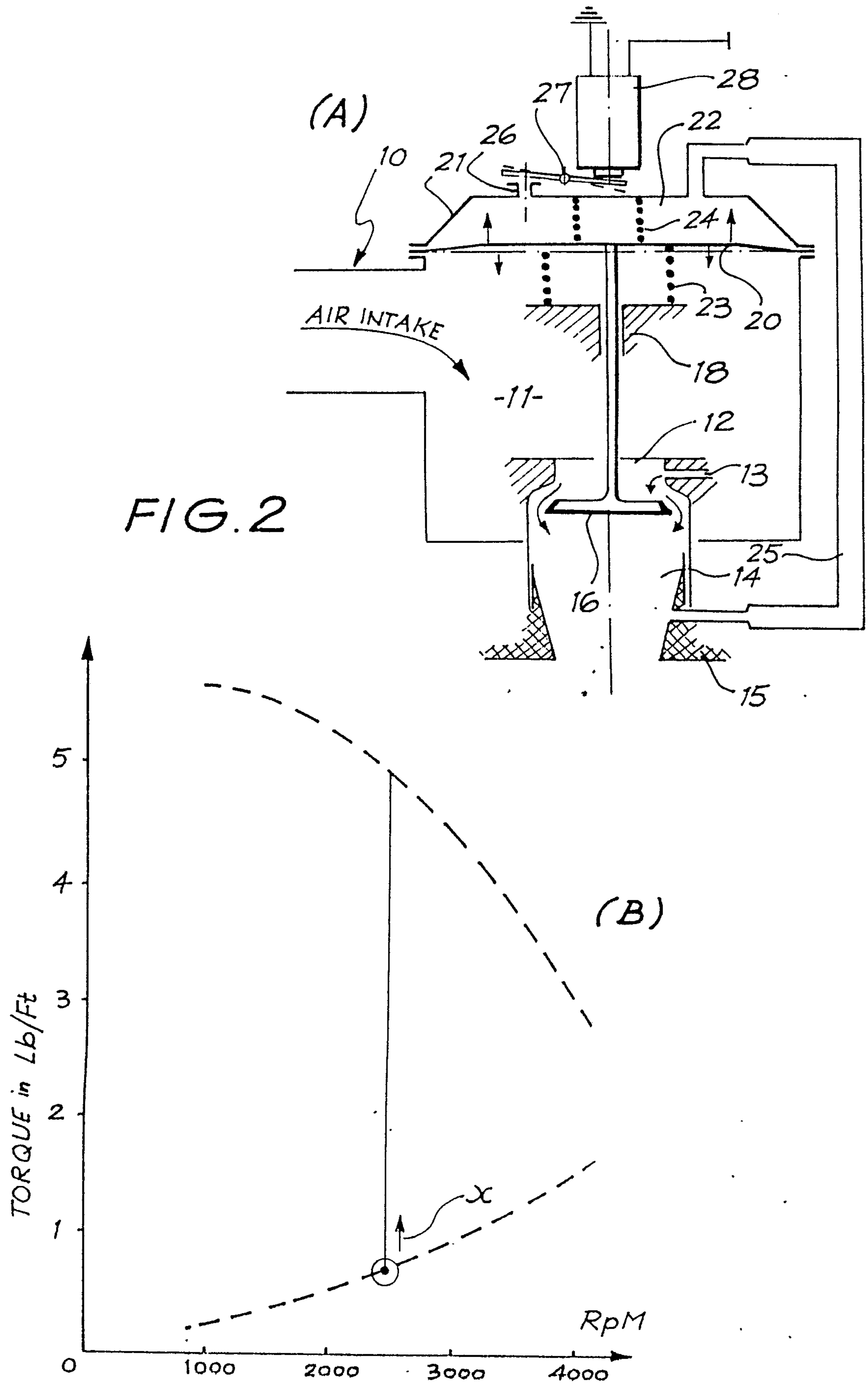
FIG.1

FIG.2



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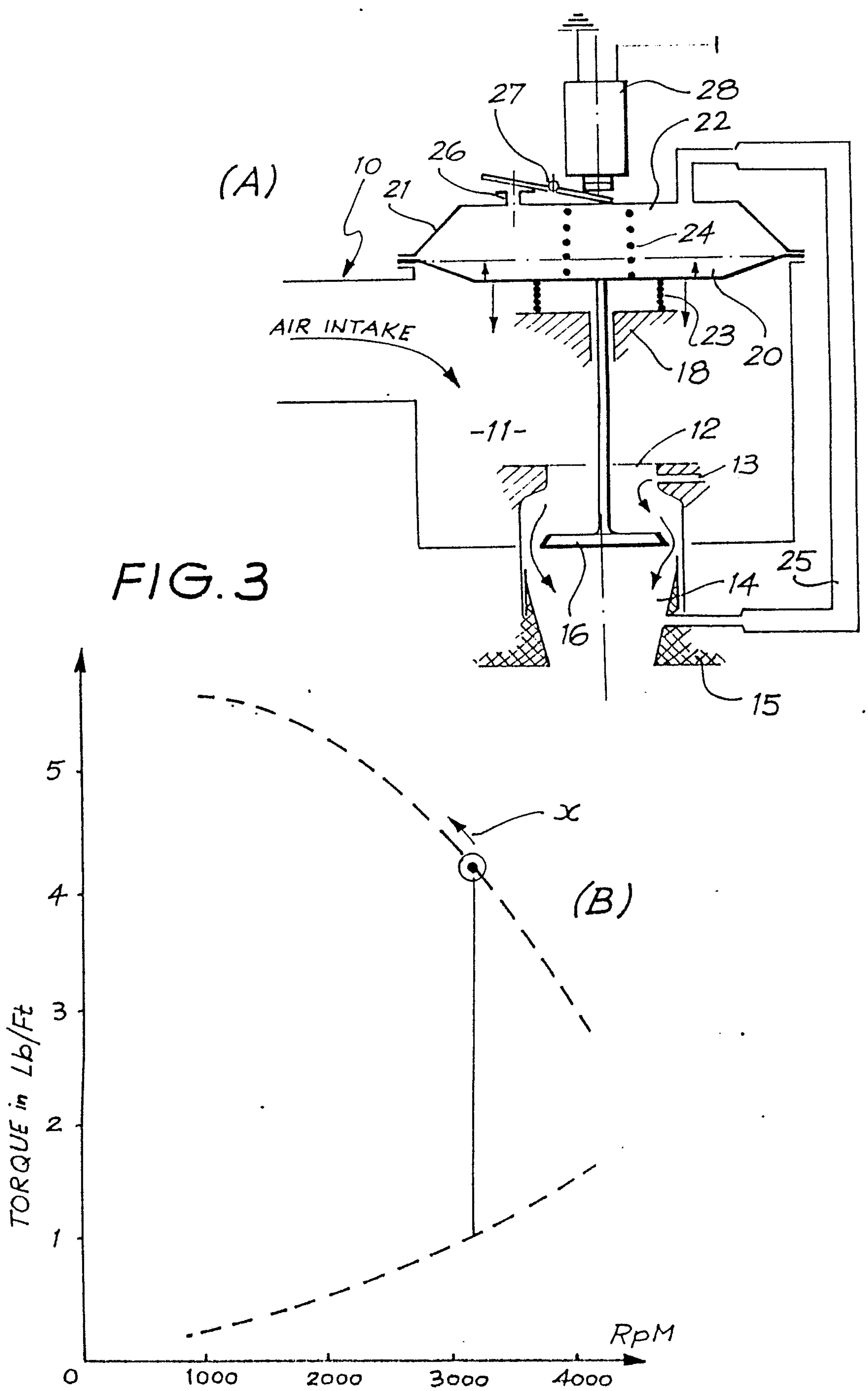
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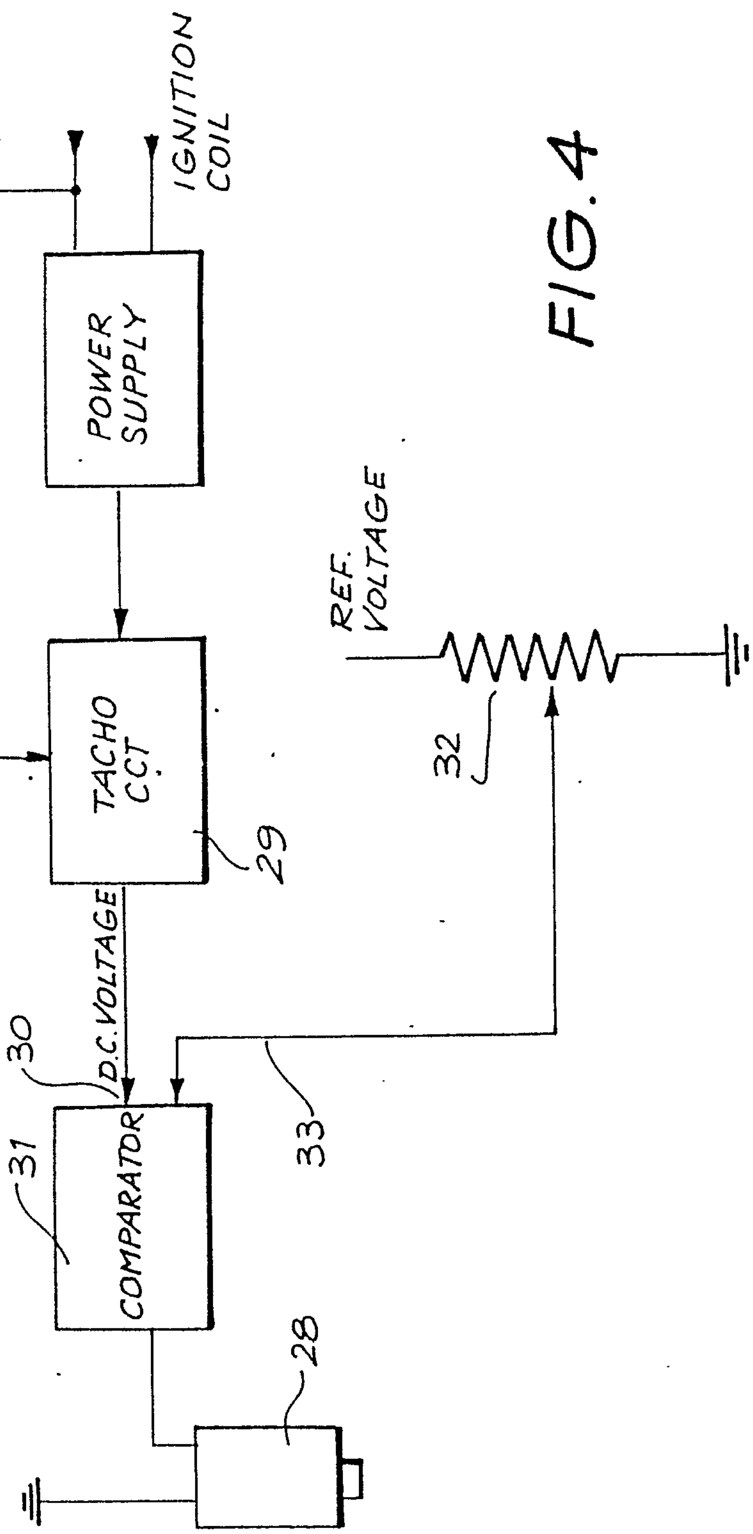
FIG. 3


IGNITION COIL
POWER SUPPLY
PULSES
TACHO CCT
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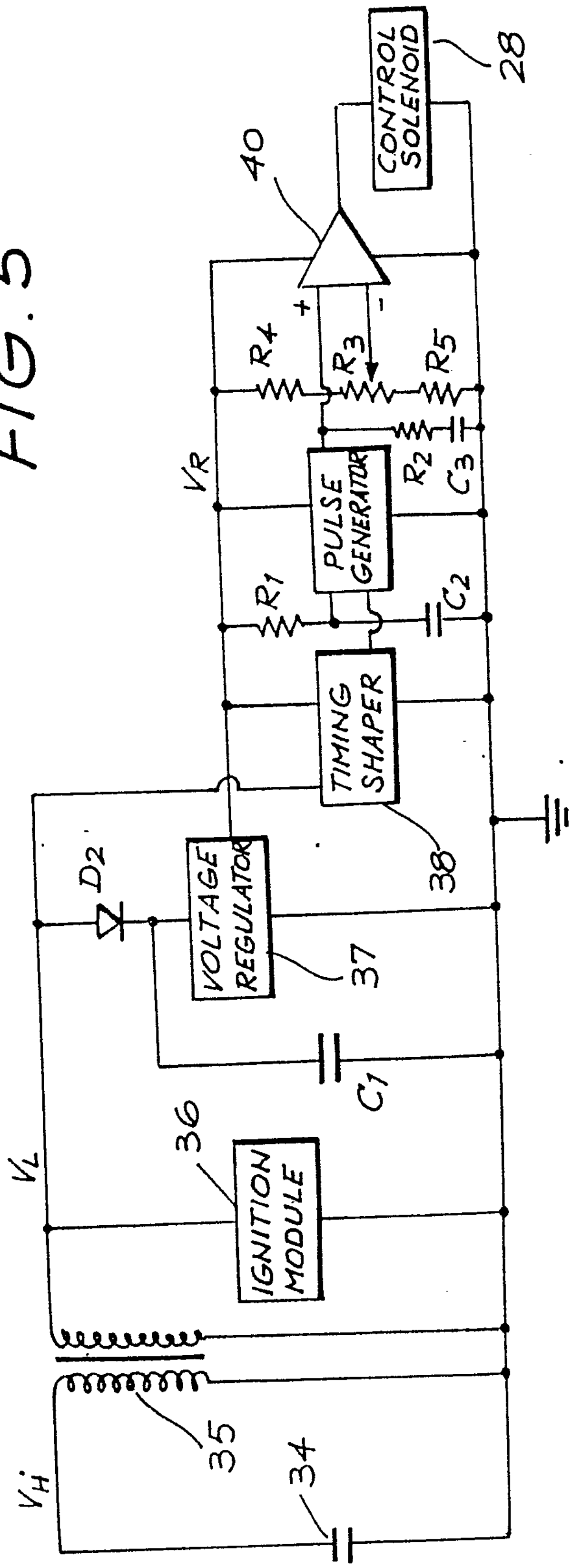
D.C. VOLTAGE
30
COMPARATOR
31
REF. VOLTAGE
32
33
28

FIG. 4

FIG. 5



CONTROL SOLENOID
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R4
R3
R5
R2
C3
VR
PULSE GENERATOR
R1
C2
TIMING SHAPER
38
D2
VOLTAGE REGULATOR
37
C1
VL
36
IGNITION MODULE
35
34
VH