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**[54] THROTTLE BLADE CONTROL SYSTEM FOR
MINIMIZING VARIATIONS IN IDLING SPEED
12 Claims, 4 Drawing Figs.**

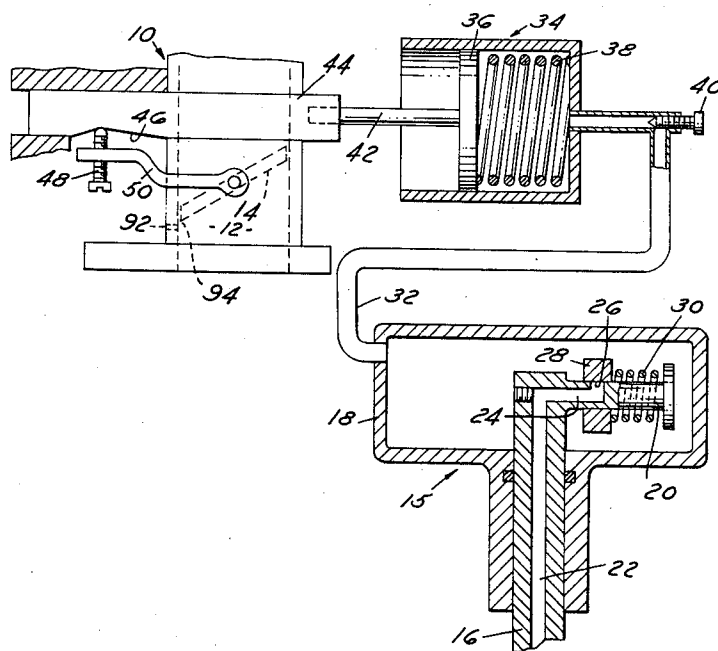
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[50] **Field of Search**..... 123/103
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ABSTRACT: A cam having an effectively V-shaped cam surface is positioned by engine intake manifold pressure modulated according to engine speed above a predetermined value to control the idling position of the carburetor throttle blade. Engine idling speed resulting from the system is constant within 60 r.p.m. for all conditions of engine temperature and the number of actuated engine driven accessories. The system also opens the throttle blade slightly during engine deceleration to improve exhaust emissions.



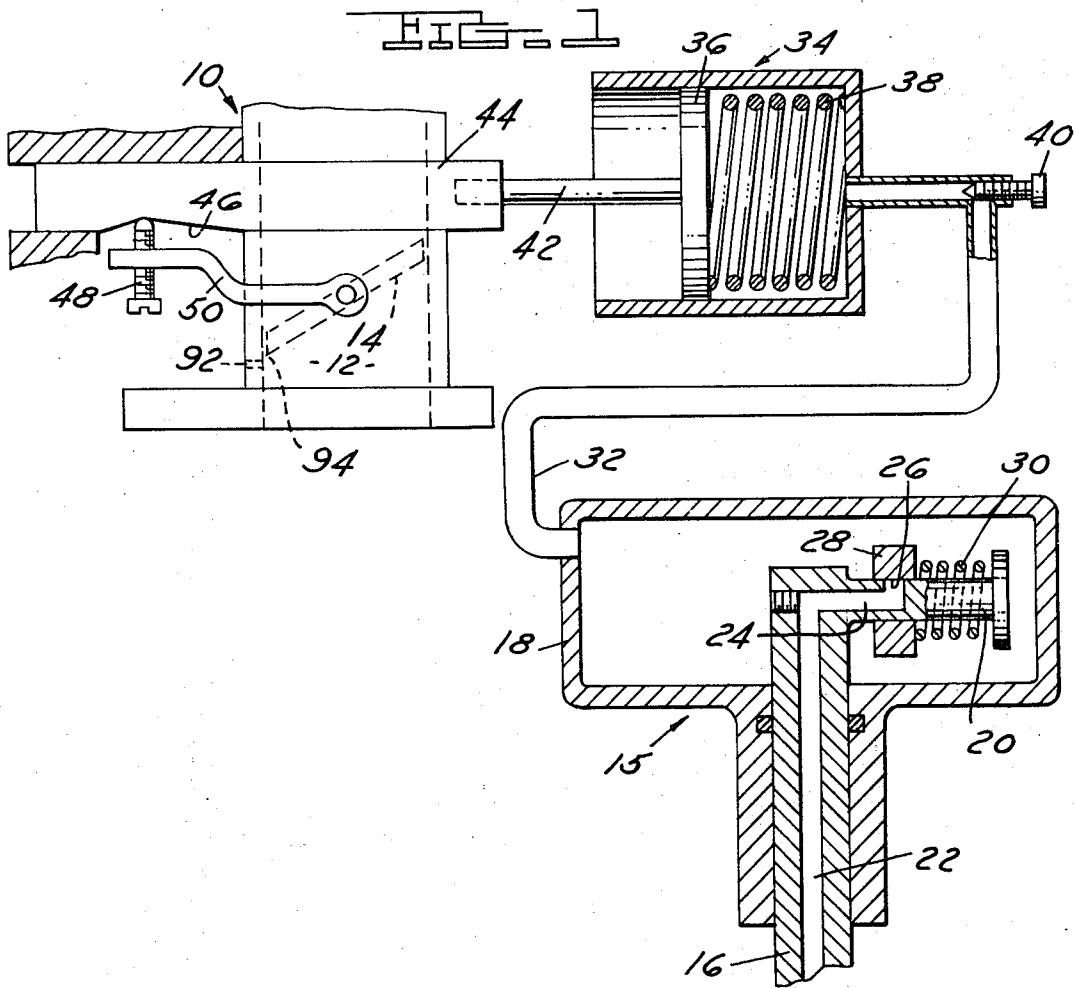
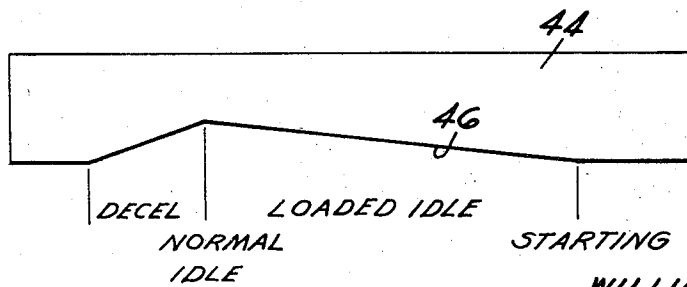


FIG. 2



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FIG. 3

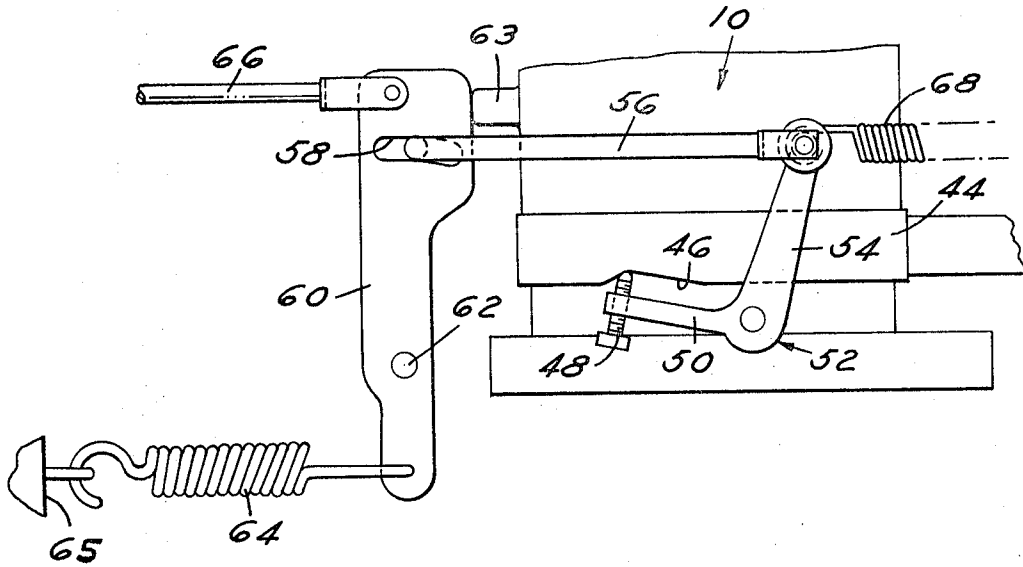
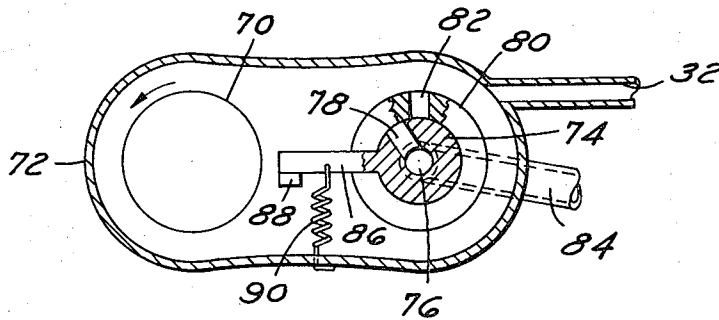


FIG. 4



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THROTTLE BLADE CONTROL SYSTEM FOR MINIMIZING VARIATIONS IN IDLING SPEED

SUMMARY OF THE INVENTION

The increasing number of engine driven accessories found in modern vehicles requires the vehicle engine to produce widely varying amounts of power while idling. In the past, these varying amounts of power have been provided by permitting the engine to idle anywhere within a relatively wide speed range that ranged from as high as 900 r.p.m. under no load conditions to less than 500 r.p.m. with an automatic transmission engaged and several accessories such as the air conditioner compressor, alternator and power steering pump in operation. Individual control systems linked to major accessories such as the air conditioning compressor have been proposed to narrow this idling range but the large number of accessories has rendered such individual systems impractical; these individual systems also opened the throttle blade by a fixed incremental amount and thus did not take into account varying equipment, load and atmospheric conditions.

In addition to the improvement in operating convenience, careful control of vehicle idling speed has become necessary to reduce the undesirable exhaust emissions from the engine. Emission control also requires opening the throttle blade slightly during vehicle deceleration. Such results can be achieved with the individual systems of the prior art, but material assembly and maintenance costs of the resulting installations are prohibitive.

This invention provides a control system that maintains engine idling speed substantially constant regardless of the loads placed on the engine by engine driven accessories. The system also opens the throttle blade slightly during engine deceleration to improve exhaust emission. In an internal combustion engine having an induction passage for delivering air to a combustion chamber of the engine and a throttle blade for controlling flow through the induction passage, the throttle blade control system of this invention comprises a sensing mechanism responsive to the rotational speed of the engine and a throttle blade positioning mechanism connected to the throttle blade and controlled by the sensing mechanism. The sensing mechanism includes an engine speed responsive valve mechanism that is connected to the induction passage downstream of the throttle blade. Included in the throttle blade positioning mechanism are a cam movable by the sensing mechanism and a cam follower riding on the cam and connected to the throttle blade. The cam has an effectively V-shaped cam surface. During normal idling the cam follower contacts the cam surface anywhere along one side of the V surface depending on the engine load. During deceleration the cam follower rides on the other side of the V surface to open the throttle blade slightly and thereby improve engine exhaust emission.

A typical speed sensing mechanism comprises a shaft rotating with the engine and having a centrifugal weight mounted on a radially extending sleeve attached to the shaft. A passage drilled axially into the shaft communicates with the engine induction passage and with a passage in the sleeve. The passage in the sleeve communicates with a port in the wall thereof. A spring mounted on the sleeve urges the centrifugal weight radially inward toward the shaft. The weight normally covers the port in the sleeve but centrifugal forces applied thereto by shaft rotation move the weight off of the port when engine rotational speed exceeds a predetermined point and thereby transmit engine intake manifold pressure into a housing surrounding the rotating sleeve. At speeds above the predetermined point, which typically is the minimum desired idling speed, the weight modulates the amount of manifold pressure applied to the housing. A conduit connects the housing interior with a vacuum motor that positions the cam.

In an alternative arrangement, a magnet is connected to an arm that in turn is connected to a shaft having an axial passage communicating with the intake manifold. The magnet is spring loaded into a position adjacent a second shaft rotated by the

engine. As the rotational speed of the second shaft increases, magnetic forces exerted on the magnet pivot the shaft attached thereto to expose a port of the axial passage to the housing interior. Intake manifold pressure reaching the housing interior is applied to a vacuum motor to position the cam.

A lost motion device preferably is included in the linkage connecting the accelerator pedal with the throttle blade to relieve loads between the cam follower and the cam surface. During engine deceleration at relatively high engine speeds, increased port exposure applies virtually all of the low manifold pressure to the vacuum motor, which moves the cam to a position where the cam follower contacts the cam on the opposite side of the cam surface. The cam follower then opens the throttle blade slightly to improve exhaust emission.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a control system in which the sensing mechanism comprises a centrifugal weight mounted on a rotating shaft. A bar having a cam profile cut into one side thereof serves as the cam in the FIG.

FIG. 2 shows the profile of the cam surface and identifies the portions of the cam surface contacted by the cam follower during various operational modes.

FIG. 3 is a schematic showing the hardware used to connect the accelerator pedal to the cam follower through a lost motion device that reduces loads on the cam.

FIG. 4 is a plan view of an alternate speed sensing mechanism that utilizes a spring loaded magnet positioned adjacent a rotating shaft.

DETAILED DESCRIPTION

Referring to FIG. 1, a carburetor indicated generally by the numeral 10 is mounted on a conventional engine induction passage (not shown) in a conventional manner. Carburetor 10 contains an induction passage 12 that communicates with a passage in the intake manifold to deliver air and fuel to a combustion chamber of the engine. A throttle blade 14 is mounted movably in induction passage 12 to control flow through the induction passage.

An engine speed sensing mechanism is indicated generally by numeral 15. Mechanism 15 comprises a shaft 16 driven by rotating components of the engine and projecting into a small housing 18. The shaft has a radially extending sleeve 20 fastened to its upper end and located rotatably within housing 18. A passage 22 runs axially through shaft 16 and communicates with a short passage 24 that opens into the interior of housing 18 through a port 26 in the wall of sleeve 20. The other end of passage 22 communicates with induction passage 12 at a point below the closed position of throttle blade 14. A weight 28 is mounted slidably on sleeve 20 and a spring 30 normally urges the weight toward the shaft to a position where the weight covers port 26 to block communication between passage 24 and the interior of housing 18.

A conduit 32 connects the interior of housing 18 with a vacuum motor 34. Vacuum motor 34 contains a movable diaphragm 36 that is spring loaded by a spring 38 toward the left in FIG. 1. Conduit 32 contains an air bleed adjusting screw 40 that provides manual adjustment of the amount of manifold pressure applied to the right side of diaphragm 36.

The left side of diaphragm 36 is connected by a rod 42 to a cam 44. Cam 44 has a cam surface 46 on one side thereof, and a cam follower 48 rides on cam surface 46. Cam follower 48 is connected adjustably to an arm 50 that in turn is connected to the shaft supporting throttle blade 14. As shown more clearly in FIG. 2, cam surface 46 is effectively V-shaped with the point of the V being the normal or unloaded idling position, the side of cam surface 46 to the left of the unloaded idling position being the deceleration portion and the side to the right of the normal idle position being the loaded idle position. The right edge of the loaded idle portion is the starting position.

Operation of the control system shown in FIGS. 1 and 2 takes place in the following manner. When the engine is not operating, atmospheric pressure exists in passage 22 and in the chamber on the right side of diaphragm 36. Spring 38 thus moves cam 44 to the left in FIG. 1 to a position where cam follower 48 contacts cam surface 46 at the starting point (See FIG. 2). Cam follower 48 is adjusted so the throttle blade is open to a position greater than that of the normal idling position and conducive to good starting characteristics of the engine.

When the engine has been started, intake manifold pressure appears in passage 22. Shaft 16 is driven by a rotating component of the engine such as the engine cam shaft. Weight 28 and spring 30 are selected so the rate of rotation of shaft 16 at a normal engine idling speed of approximately 600 r.p.m. moves weight 28 radially outward along shaft 20 to expose partially port 26. A modulated amount of the intake manifold pressure appearing in passage 22 thus is applied to the interior of housing 18 and by conduit 32 to the right chamber of vacuum motor 34. Screw 40 is adjusted to modulate still further the vacuum signal in the right chamber of motor 34 so diaphragm 36 positions cam 44 where cam follower 48 contacts the cam surface at the normal idling point.

When a load is placed on the idling engine by engaging the automatic transmission or actuating an air conditioning compressor, for example, the rotational speed of the engine tends to decrease. The corresponding decrease in the rotational speed of shaft 16 permits spring 30 to move weight 28 radially inward so weight 28 covers an increased amount of port 26. The pressure signal reaching the right chamber of vacuum motor 34 thus is reduced and spring 38 moves cam 44 to the left. Cam follower 48 then contacts cam surface 46 at a point in the loaded idle range of FIG. 2, which increases the amount of opening of throttle blade 14. The increased opening increases the amount of power delivered by the engine and this increased power provides an engine idling speed only a few r.p.m. below the normal idling speed.

Increasing the amount of power demanded from the engine at idling by actuating additional items of engine driven equipment operates by the same techniques to supply the additional power with only minimal decreases in engine r.p.m. Cam surface 46 is designed so simultaneous operation of all engine driven components moves cam 44 to the point where cam follower 48 contacts cam surface 46 approximately at the starting point. In most installations, this movement can be accomplished with a decline in engine r.p.m. of less than 30-60 r.p.m.; engines not equipped with the system of this invention display declines of over 300 r.p.m. under the same conditions.

When the engine is accelerated by opening the throttle blade into the road load condition, cam follower 48 leaves the cam surface 46. Normal road load operation thus is not affected by the mechanism of this invention.

When the engine is decelerating from a high rotational speed, significant improvements in exhaust emissions are achieved by maintaining the throttle blade in a slightly open position. The system of this invention provides these improvements in the following manner. At engine speeds above idling speed, weight 28 moves radially outward on shaft 20 to expose completely port 26. When the engine begins decelerating, relatively unmodulated amounts of the low manifold pressure are applied through port 26 to the right chamber of vacuum motor 34, and this low pressure draws cam 44 to the right in FIG. 1 until cam follower 48 contacts cam surface 46 on the decel portion thereof. Cam follower 48 thus acts through arm 50 to open slightly throttle blade 14. As engine speed approaches normal idling speed, the rising manifold pressure and the modulating effect on the pressure of weight 28 as the weight moves across port 26 move cam 44 back to the point where cam follower 48 contacts surface 46 at the normal idling point or in the loaded idling portion, depending on operating conditions.

The lost motion mechanism shown in FIG. 3 preferably is included in the linkage connecting the vehicle accelerator

pedal with the throttle blade to reduce loads between cam surface 46 and cam follower 48. Referring to FIG. 3, arm 50 is part of an L-shaped lever 52 that has a second arm 54. A rod 56 fastened to arm 54 rides in an elongated slot 58 of a lever 60 that is pivotally mounted by stud 62 to the carburetor body. A tension type throttle return spring 64 connects the lower part of lever 60 to an anchor point designated by numeral 65. The upper part of lever 60 is connected by a rod 66 to the accelerator pedal. A tension spring 68 having a relatively low spring rate connects arm 54 to another anchor point (not shown) so spring 68 normally urges lever 52 in a clockwise direction in FIG. 3.

During normal road load operation, rod 56 contacts the right side of slot 58. Depressing the accelerator pedal draws rod 66 to the left to hold rod 56 at the right side of slot 58 where it remains for normal road load operation. When the accelerator is released, lever 60 pivots clockwise under the influence of throttle return spring 64. Spring 68 rotates lever 52 clockwise to maintain cam follower 48 in contact with cam surface 46 and thereby positions rod 56 near the left end of slot 58. As the engine decelerates to its normal idling range, cam follower 48 slides to the normal or loaded idle point of cam surface 46 under the influence of vacuum motor 34. Spring 64 thus provides a high amount of throttle return force but this force is isolated from the contact between cam 48 and cam surface 46.

Turning to the alternate sensing mechanism shown in FIG. 4, a rotating ferromagnetic shaft 70 is driven through conventional gearing by a rotating member of the engine. Shaft 70 projects into a housing 72 and has at least a pair of magnetic poles formed on its cylindrical surface located within housing 72.

Housing 72 also surrounds a pivoting shaft 74 that contains an axial passage 76. Shaft 74 is shown as being sectioned in FIG. 4, and passage 76 actually does not extend through the top of shaft 74 but opens into the housing through a radial port 78. A sleeve 80 surrounds shaft 74 and has a radial port 82 positioned slightly clockwise of the normal rest position of port 78.

Port 82 communicates with the interior of housing 70 and the bottom of passage 76 communicates via a passage 84 with induction passage 12 at a point below the closed position of the throttle blade. An arm 86 has one end fastened to shaft 74 and projects toward rotatable shaft 70. A magnet 88 is fastened to the end of arm 86 and is positioned adjacent the magnetized portion of shaft 70. A tension spring 90 connects arm 86 to the wall of the housing.

During engine operation, counterclockwise rotation of shaft 70 exerts a magnetic force on arm 86 that tends to pivot shaft 74 in a clockwise direction. Pivoting movement of shaft 74 is resisted by spring 90, which is selected to provide partial alignment of ports 78 and 82 at normal or unloaded engine idling speed. Modulated engine manifold pressure then is conducted from passage 76 through ports 78 and 82 to the interior of housing 72 and to vacuum motor 34. Operation of the vacuum motor positions the throttle blade as described above.

Improved response to load changes can be achieved by connecting passage 22 to induction passage 12 through a port 92 located just below the trailing edge 94 of throttle blade 14. Greater changes in pressure per change in engine load occur at the location of port 92 and these changes are applied by the system of this invention to diaphragm 36 where the changes provide proportionately greater movement of the diaphragm per change in engine speed.

A circular cam having an effectively V-shaped cam surface can be substituted for the linear cam shown. A closely wound spring attached to a weight can be substituted in the speed sensing mechanism in place of the weight and port arrangement shown. Centrifugal forces on the spring separate its coils to apply modulated manifold pressure to the housing.

Thus this invention provides a system for maintaining engine idling speed substantially constant regardless of the loads and atmospheric conditions encountered by the engine during

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idling. The system is relatively inexpensive to build and assemble to the engine and also improves exhaust emissions by holding the throttle blade open slightly during deceleration. Additionally, the system eliminates the conventional fast idle cam associated with most present day vehicles.

I claim:

1. In an internal combustion engine having an induction passage for delivering air to a combustion chamber of said engine and a throttle blade for controlling flow through said induction passage, an idling speed control system comprising sensing means responsive to the rotational speed of said engine, said sensing means including an engine speed responsive valve means connected to the induction passage downstream of the throttle blade,

throttle blade positioning means controlled by said sensing means for maintaining the throttle blade in a position where said engine idles at a substantially constant speed regardless of the load placed on the engine by engine driven accessories, said throttle blade positioning means including a vacuum motor connected to said speed responsive valve means, a cam means movable by said vacuum motor, and a cam follower connected to said throttle blade, said cam follower riding on said cam means to position the throttle blade according to engine manifold pressure as modulated by engine speed.

2. The engine of claim 1 in which the speed responsive valve means comprises a shaft rotating with the engine, centrifugal weight means mounted on said shaft, spring means normally urging said weight means toward the axis of said shaft, and a valve actuated by said weight means, said valve being opened to connect the induction passage downstream of said throttle blade to the vacuum motor when shaft rotational speed exceeds a predetermined value.

3. The engine of claim 2 in which the amount of opening of said valve is modulated by increasing vehicle speed above said predetermined value to modulate the amount of manifold pressure applied to said vacuum motor.

4. The engine of claim 3 in which the cam means has an effectively V-shaped cam surface, said cam follower producing normal engine idling speed when contacting the cam surface at the point of the V and increasing the opening of the throttle blade when moved in either direction away from the point of the V.

5. The engine of claim 4 in which the sensing means connects the vacuum motor to a point in the induction passage located just below the idling position of the trailing edge of the throttle blade.

6. The engine of claim 5 in which the shaft has a radially extending sleeve attached thereto, said weight means being

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located movably on said sleeve, said shaft having a passage communicating with the induction passage downstream of the throttle blade, said passage opening into said sleeve, said sleeve having a port therein that connects with the passage, said spring means being a coil spring located on said sleeve and having one end fastened to the sleeve and the other end fastened to said weight means, said spring resisting radial movement of said weight means, said weight means exposing said port when shaft rotational speed exceeds a predetermined value.

7. The engine of claim 1 in which the cam means has an effectively V-shaped cam surface, said cam follower producing normal engine idling speed when contacting the cam surface at the point of the V and increasing the opening of the throttle blade when moved in either direction away from the point of the V.

8. The engine of claim 1 in which the sensing means connects the vacuum motor to a point in the induction passage located just below the idling position of the trailing edge of the throttle blade.

9. The engine of claim 1 in which the speed responsive valve means comprises a shaft rotating with the engine, said shaft having a magnetized portion, a pivotable shaft having a magnet positioned adjacent said magnetized portion of said rotating shaft, and a valve mechanism actuated by said pivotable shaft that opens when said pivotable shaft is pivoted by the rotating magnetic field produced by rotation of said rotating shaft, said valve mechanism connecting the induction passage downstream of said throttle blade to the vacuum motor.

10. The engine of claim 9 in which the valve mechanism comprises a passage in said pivotable shaft communicating with said induction passage downstream of said throttle blade, said pivotable shaft having a radial port communicating with the passage, and a sleeve surrounding said pivotable shaft, said sleeve having a radial port communicating with said vacuum motor, said pivotable shaft pivoting under the force applied thereto by the rotating magnetic field to overlap said ports with each other and thereby connect the induction passage with the vacuum motor.

11. The engine of claim 10 in which the cam means has an effectively V-shaped cam surface, said cam follower producing normal engine idling speed when contacting the cam surface at the point of the V and increasing the opening of the throttle blade when moved in either direction away from the point of the V.

12. The engine of claim 11 in which the sensing means connects the vacuum motor to a point in the induction passage located just below the idling position of the trailing edge of the throttle blade.

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