United States Patent [19]

Charron

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[54] **ENRICHMENT FUEL-AIR SUPPLY SYSTEM**

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[73] Assignee: **Ford Motor Company,** Dearborn, Mich.

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[52] **U.S. Cl.** ..... **123/127,** 123/41.13, 123/106, 123/108, 123/119 DB, 123/119 F, 123/103 E, 261/39 A, 261/51, 261/DIG. 18

[51] **Int. Cl.** **F02m 13/04,** F02m 1/10

[58] **Field of Search** ..... 123/41.13, 127, 119 DB, 123/103 E, 119 F, 106, 108; 188/298, 301; 261/DIG. 18, 39 A, 51

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Assistant Examiner—Dennis Toth
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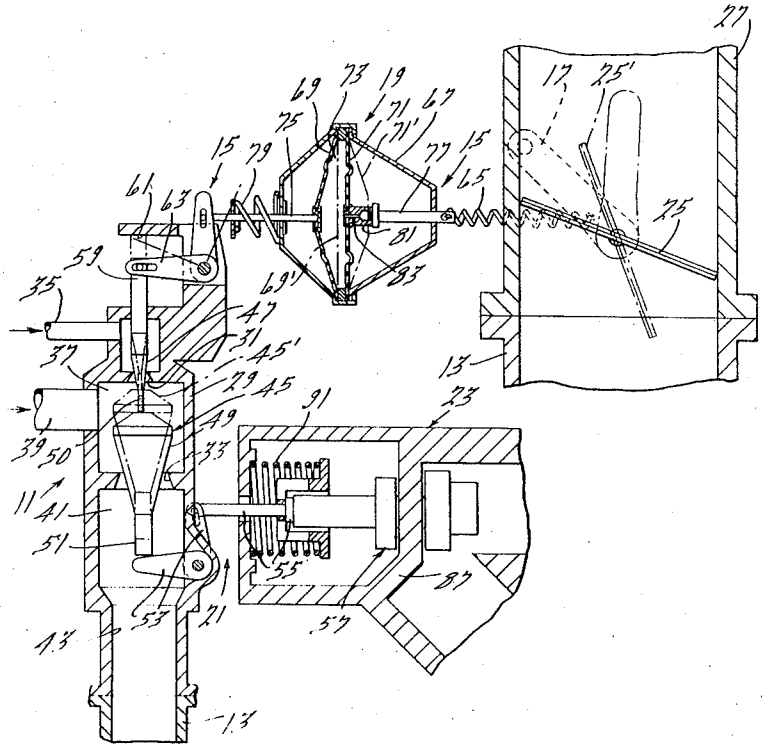
[57] **ABSTRACT**

An auxiliary fuel-air supply system for an internal combustion engine which supplements the fuel-air supply from the carburetor during engine warmup and acceleration. The response of the system depends upon the engine coolant temperature and the motion and position of the carburetor throttle plate. A valve governs the flow of this supplemental fuel-air mixture into the intake manifold.

11 Claims, 3 Drawing Figures



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3 Sheets-Sheet 1

FIG. 1.

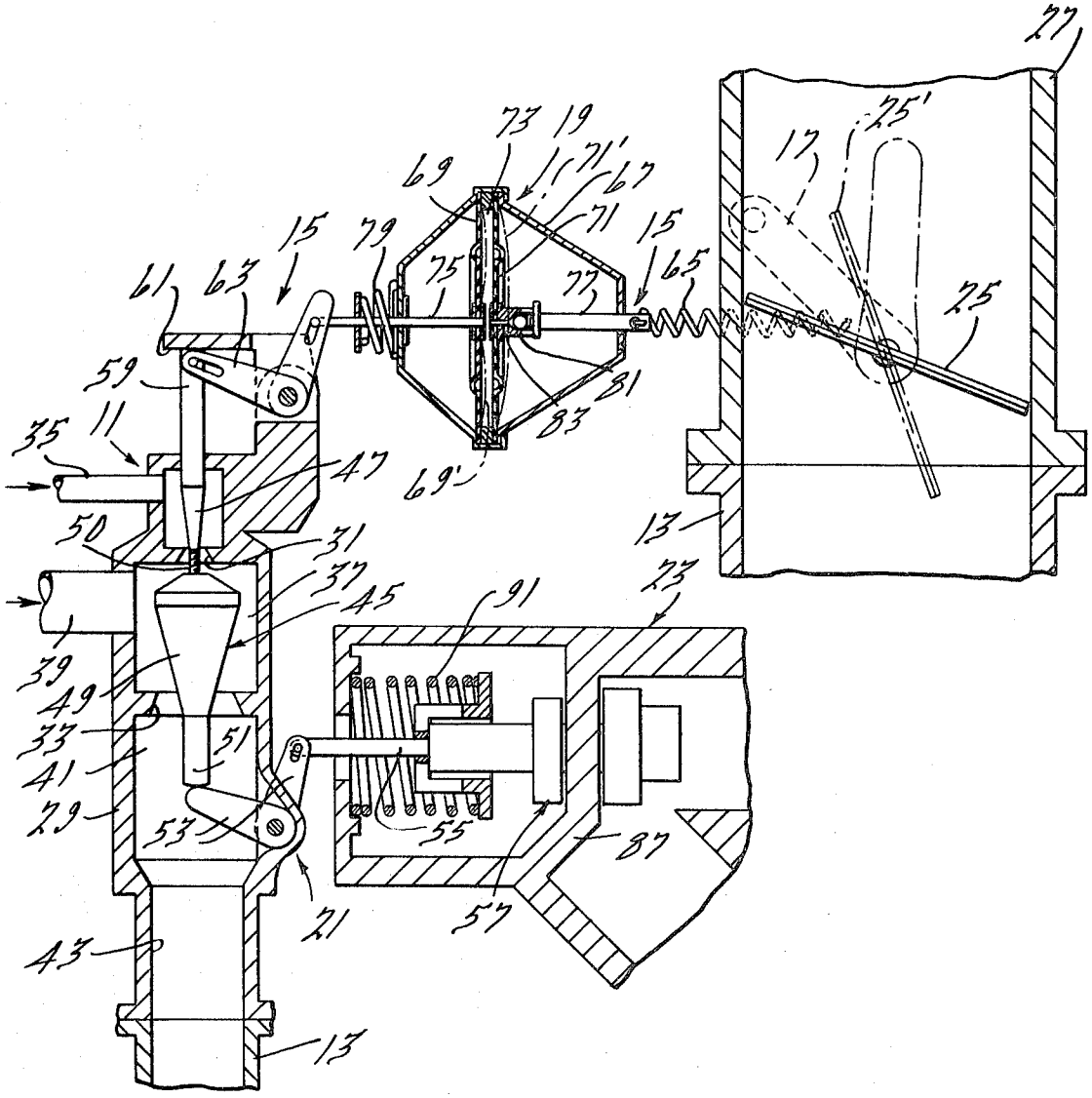

Fig. 2.

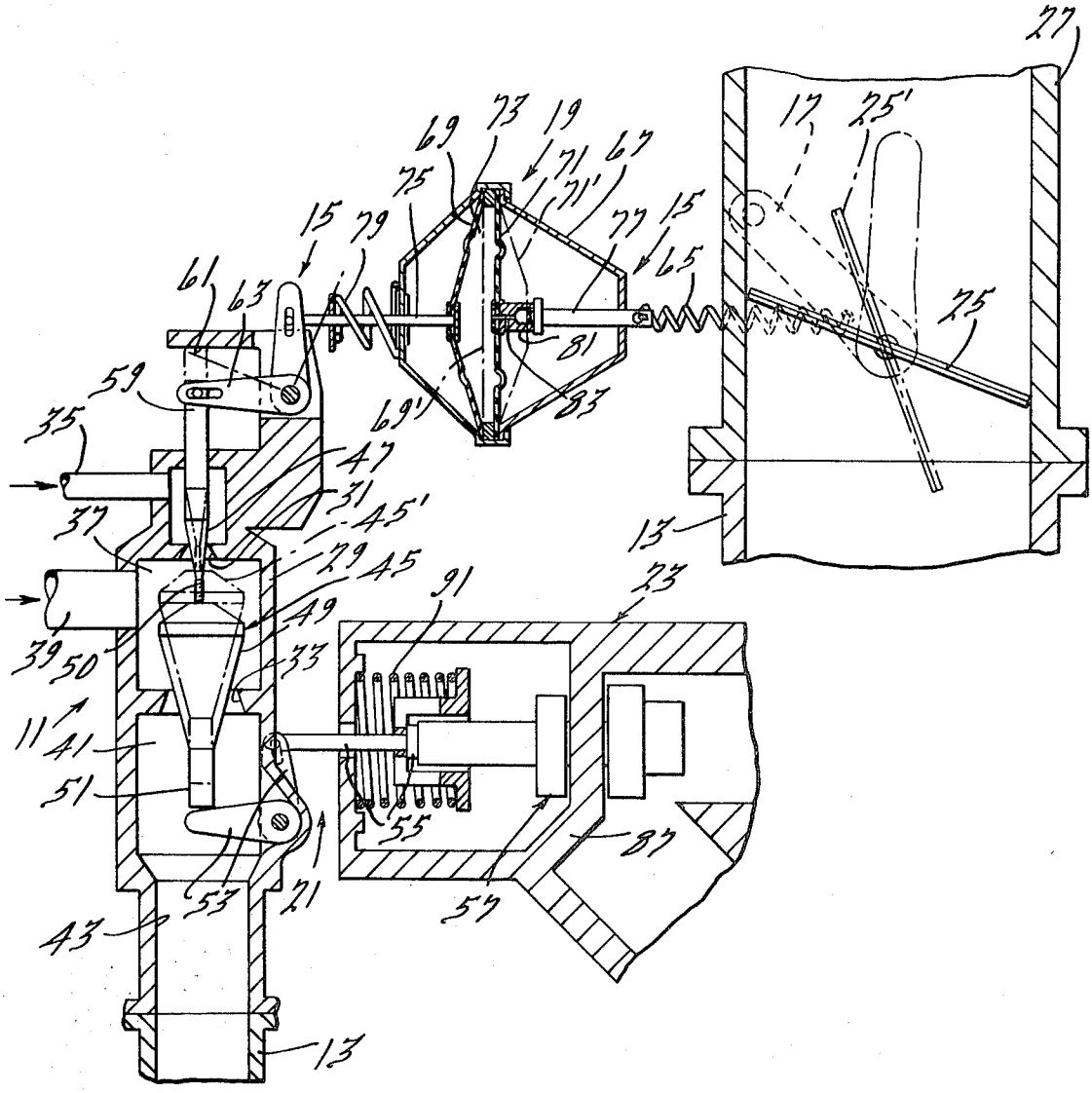
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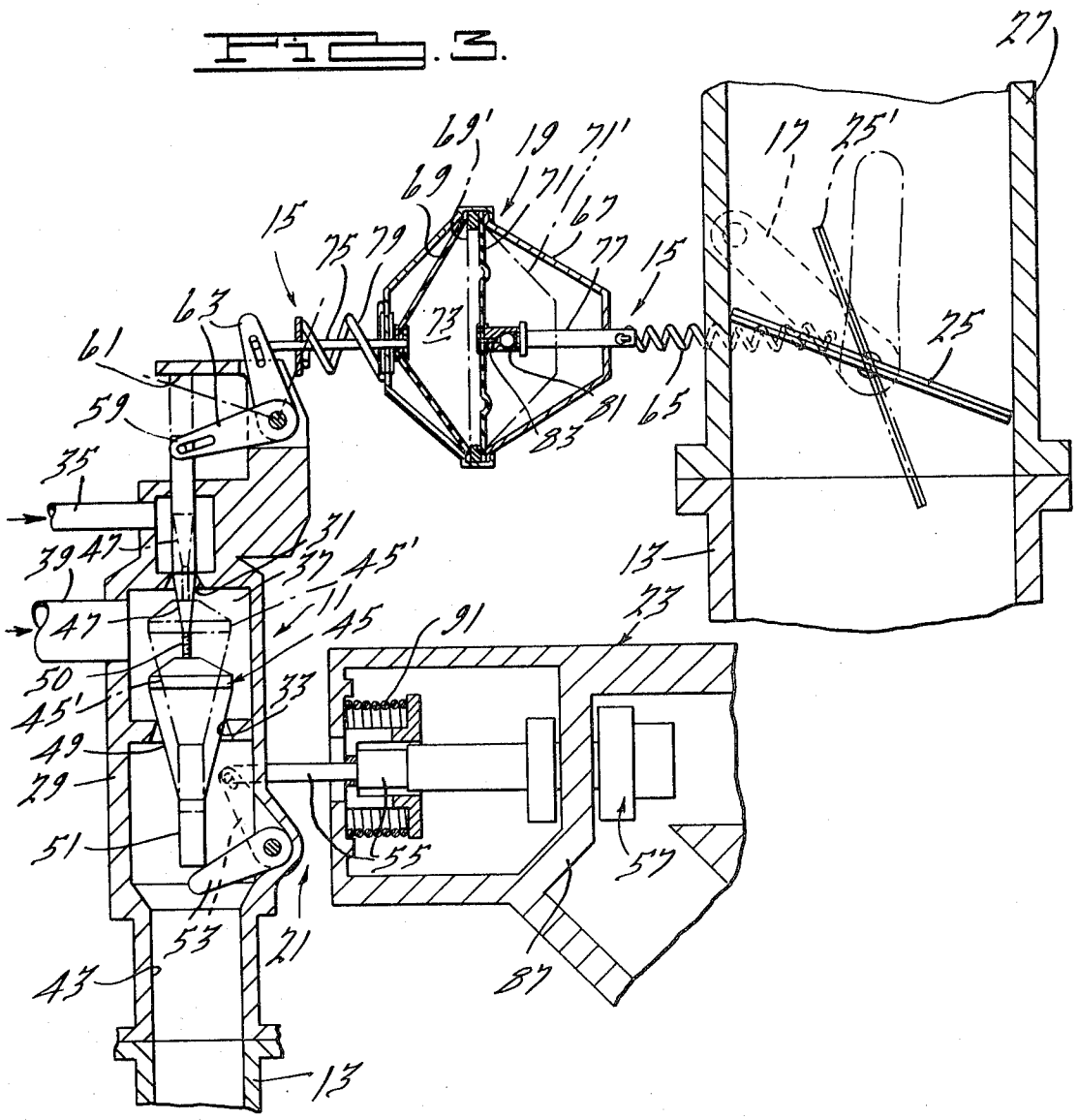
FIG. 3.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ENRICHMENT FUEL-AIR SUPPLY SYSTEM

BACKGROUND AND SUMMARY OF THE INVENTION

Increasingly stringent motor vehicle exhaust emission regulations, coupled with performance and economy requirements, impose difficult demands on today's internal combustion engine components, particularly carburetors. Special problems are encountered during engine warmup. Historically, the solution was to generously enrichen the air-fuel mixture to compensate for the retarding effect that colder than normal operating temperatures have upon fuel vaporization. Such enrichment was simply provided with a conventional choke plate often linked to a thermo-sensitive bimetal spring. Under anticipated vehicle exhaust emissions regulations, fuel-air mixture enrichment sufficient to initiate and maintain engine combustion in a cold climate may not be achievable with a choke device such as described.

This invention provides apparatus for enriching the combustible mixture under cold starting and engine warmup conditions that is more precisely controllable than the traditional thermostatically controlled choke plate. The invention also provides a response of a measured or limited time duration to transient engine conditions such as acceleration. Furthermore, the invention provides an enrichment fuel-air supply system which is auxiliary or supplementary to the traditional engine carburetor.

An enrichment fuel-air supply system that supplements the carburetor of an internal combustion engine constructed in accordance with this invention includes a passage or chamber which receives fuel and air for producing a combustible mixture. A valve having a movable member regulates the flow of fuel and air into the passage or chamber. The fuel-air mixture is discharged from the chamber into the intake manifold independently of the engine carburetor. A linkage interconnects the movable member of the valve to a lever displaceable with the carburetor throttle plate. The linkage includes a time delay mechanism which upon actuation of the throttle lever in one direction acts similarly to a solid link and then incrementally lengthens the linkage as a function of time permitting the valve member controlling entrance of enrichment fuel and air to return to its preactuation position without the necessity of return movement of the throttle lever and plate to its preactuation position.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view of an enrichment fuel-air supply system constructed in accordance with the invention showing the relationship of the system elements in a cold, idling engine. The phantom lines represent the position of the elements immediately following an acceleration;

FIG. 2 is a cross sectional view of the enrichment fuel-air supply system showing the relationship of the system elements in a partially warmed, idling engine. The phantom lines represent the position of the elements immediately following an acceleration;

FIG. 3 of the drawing is a cross sectional view of the enrichment fuel-air supply system showing a relationship of the elements in a fully warmed idling engine. The phantom lines represent the position of the elements immediately following an acceleration.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An enrichment fuel-air supply system constructed in accordance with this invention includes three principal components. The first is a valve assembly **11** which regulates flow of enrichment fuel and air to the intake manifold **13.** The second is a time delay linkage assembly **15** interconnecting the valve assembly and the carburetor throttle lever **17.** The linkage assembly includes a dual diaphragm vacuum decay device **19** which acts similar to a solid link upon throttle advance and which progressively lengthens following throttle actuation to release linkage tension, thereby permitting the movable elements of the valve assembly **11** to return to their preactuation positions. The third principal component is a thermostatically controlled valve element abutment assembly **21** responsive to coolant temperatures within the engine block **23.** With the exception of the throttle plate **25** and throttle lever **17** pivotally mounted to carburetor housing **27** all of the above components and elements are auxiliary or external to the components of a conventional internal combustion carburetor.

The valve assembly **11** includes a housing **29** in which two calibrated orifices **31** and **33** are formed. Fuel enters the housing through inlet **35** and passes through the orifice **31** into a first passage or chamber portion **37** where it is mixed with air entering into the chamber from inlet **39.** The mixture passes through orifice **33** into a second passage or chamber portion **41** where it is further mixed and conducted into the intake manifold **13** through conduit **43.** A movable valve element **45** is received within the housing and has upper and lower tapered portions **47** and **49** which cooperate with orifices **31** and **33,** respectively, to vary the restriction or effective openings thereof. Valve portions **47** and **49** are relatively adjustable by means of a threaded connection **50.** The movable valve element **45** has an end portion **51** extending downwardly from the lower tapered portion **49** which is engageable with lever **53** of abutment assembly **21.** The lever **53** is pivotally mounted to the housing **29** and pin joined to movable piston element **55** of the thermostat **57.** The upper end **59** of the movable valve element **45** is engageable with a portion **61** of the housing to form an abutment limiting the upward travel of the movable valve element and defining a maximum opening for orifices **31** and **33.**

The linkage assembly **15** includes in addition to the dual diaphragm vacuum decay device **19,** a motion transfer lever **63** pivotally connected to housing **29** and a tension spring **65.** The lever **63** interconnects the vacuum decay device **19** and the movable valve element **45.** The spring **65** interconnects the throttle lever **17** and the valve element **45.**

The dual diaphragm vacuum decay device **19** includes an outer housing **67** having two flexible diaphragms **69** and **71** extending across its major diameter and forming a pneumatic chamber **73.** A rod **75** is connected to diaphragm **69** and is joined at its protruding end to lever **63** with a pin-and-slot connection. Rod **75** is biased by compression spring **79** toward a maximum protracted position or leftwardly as viewed in FIG. **1.** An oppositely directed rod **77** is connected to diaphragm **71** and is joined at its protruding end to spring **65.** Rod **77** includes a check valve assembly **81** which closes a passage to the pneumatic chamber **73** when the

chamber is under tension, as during opening of throttle plate **25**. The check valve assembly opens when the chamber is under compression between the armatures **75** and **77**, as during throttle closing, to permit a rapid reduction in chamber volume. A small bleed hole **83** continuously vents the chamber **73** to the atmosphere and permits a controlled passage of air. The vent provides the vacuum decay function of the device **19**, which will be explained later in greater detail.

The thermostatic abutment assembly **21** includes a conventional thermostat assembly **57** mounted within a wall **87** of the engine block **23**. The thermostat includes a movable piston element **55** which increasingly extends or protrudes from the remainder of the thermostat as the temperature of the coolant within the engine block rises. The movable thermostat element is biased by spring **91** toward a retracted or minimum extending position. The movable piston element is pinjoined to lever assembly **53**, a portion of which provides an abutment for the end **51** of the movable valve element **45**. When the engine is cold the thermostat element **55** is fully protracted and the abutment of lever assembly **53** is in its uppermost position.

OPERATION

The enrichment fuel-air supply system described above functions to supplement or replace the choke system, the fast idling system and/or the power valve system of a typical internal combustion engine carburetor so that vehicle emissions are more precisely controllable.

During engine idle and under a partially warmed coolant temperature, the flexible diaphragm **69** is positioned as shown by solid lines in FIG. **2** of the drawings. Diaphragm **71** is in the unloaded or unstressed position also shown by solid lines in FIG. **2**.

When the throttle plate is opened to the position shown in phantom lines designated **25'**, the flexible diaphragm **71** moves rightwardly to the position **71'**. Upon initial rightward displacement of diaphragm **71**, the check valve **81** closes and chamber **73** is substantially sealed (except for air bleed hole **83**). A partial vacuum is created within chamber **73** causing atmospheric pressure to displace diaphragm **69** rightwardly to the position **69'** and to lift the valve assembly **45** to a less restricted position shown in phantom as **45'**. The decrease in restriction causes increased fuel and air flow through conduit **43** to enrichen the overall combustible mixture being delivered to the combustion chambers. Immediately following throttle opening when the system elements have assumed the positions shown in phantom in FIG. **2**, the vacuum decay device **19** is under tension between springs **65** and **79**. Air bleeds into chamber **73** through passage **83** to relieve the partial vacuum until diaphragm **69** and valve assembly **45** have assumed their preactuation positions as shown by their solid line representations in FIG. **2**. The air bleed passage **83** is calibrated to give a desired vacuum decay period. When the throttle blade **25** is once again closed, the check valve **81** opens to permit relatively unrestricted collapse of the chamber **73** as diaphragm **71** returns from its phantom line position **71'** to its preactuation position shown by the solid line representation. A lightweight spring (not shown) may be provided to assist the return diaphragm **71** and rod **77** to its preactuation position.

Prior to the throttle actuation described in the preceding paragraph, enrichment fuel was being provided to intake manifold **13** during engine warmup to supplement that provided by the carburetor **27**. Immediately following throttle actuation the enrichment flow through conduit **43** is increased by the change in position of valve **45** to supplement or replace the accelerator pump and/or power valve systems of the conventional carburetor. The valve then slowly returns to its preactuation position even though the throttle plate retains its open position **25'**.

FIG. **3** of the drawings shows the relationship of the system elements during engine idle when the coolant within block **23** is fully warmed. The thermostat piston **55** is fully protracted and the valve assembly **45** is in its lowermost position with the orifices **31** and **33** fully restricted. No enrichment fuel or a minimum of fuel is being provided to supplement the carburetor. Upon throttle actuation from the closed position to the open position **25'** shown in FIG. **3**, the system functions as described previously with reference to FIG. **2** and the system elements assume the phantom line positions designated **71'**, **69'** and **45'**. Enrichment fuel is then provided to intake manifold **13** through conduit **43** to supplement that provided by the carburetor. Chamber **73** is under tension and enlarges as air is bled through passage **83** to relieve the partial vacuum therein until the valve assembly **45** again reaches its preactuation, closed (solid line) position.

FIG. **1** of the drawings shows the relationship of the system elements during engine idle when the coolant within block **23** is cold. The thermostat piston **55** is fully retracted and valve assembly **45** is fully raised by abutment lever **53** resulting in maximum fuel and air flow through orifices **31** and **33**. Opening the throttle plate **25** to position **25'** results in a very limited movement of the diaphragm **69** and **71** to position **69'** and **71'**, respectively, because the valve assembly **45** at idle is in its fully raised position engaging abutment **71**. Thus, when the engine is cold the enrichment fuel system provides maximum enrichment at idle and during acceleration.

MOdifications and alterations will occur to those skilled in the art which are included within the scope of the following claims.

I claim:

1. In an internal combustion engine including:

a carburetor having a pivotable throttle plate and a lever displaceable with the throttle plate,

an intake manifold,

a source of fuel,

a source of air,

an enrichment fuel-air supply system supplementary to said carburetor,

chamber means receiving said fuel and air for intermixing therein,

valve means having a movable member regulating flow of fuel and air from said sources to said chamber means,

conduit means interconnecting said chamber means and said intake manifold,

linkage means interconnecting the movable element of said valve means to the lever displaceable with said throttle plate,

said linkage means including a time delay mechanism which upon opening actuation of the throttle lever acts similarly to a solid link and which following ac-

tuation incrementally lengthens as a function of time permitting the movable valve element to return to its prior position without return movement of the throttle lever and plate to its position prior to the opening actuation.

2. In an internal combustion engine including:
a carburetor having a pivotable throttle plate and a lever displaceable with the throttle plate,
an intake manifold,
a source of fuel,
a source of air,
an enrichment fuel-air supply system supplementary to said carburetor,
chamber means receiving fuel and air for intermixing therein,
valve means having an element movable to increase and decrease flow of fuel and air from said sources to said chamber means,
conduit means interconnecting said chamber means and said intake manifold,
linkage means interconnecting the movable element of said valve means to the lever displaceable with said throttle plate,
said linkage means including a vacuum decay component which progressively lengthens following throttle opening actuation to return the movable member of said valve means to its preactuation position.

3. An enrichment fuel-air supply system according to claim 2,
said vacuum decay component including
a housing,
a pair of movable elements forming a variable volume substantially sealed air chamber within the housing,
check valve means closeable to prevent entry of air into said chamber and openable to permit escape of air from said chamber,
an air bleed passage from the atmosphere to said chamber permitting limited entry of air into said chamber when the pressure within the chamber is less than atmospheric.

4. An enrichment fuel-air supply system according to claim 2,
means to vary the position of the movable element of said valve means in response to changes in engine temperature.

5. An enrichment fuel-air supply system according to claim 3,
means to vary the position of the movable element of said valve means in response to changes in engine temperature.

6. An enrichment fuel-air supply system according to claim 2,
a thermostat sensing the coolant temperature of the engine,
said thermostat including an element movable in response to changes in coolant temperatures,
variable position abutment means limiting the range of displacement of the movable element of said valve means,
said abutment means being connected to said movable thermostat element.

7. An enrichment fuel-air supply system according to claim 3,
a thermostat sensing the coolant temperature of the engine,
said thermostat including an element movable in response to changes in coolant temperatures,
variable position abutment means limiting the range of displacement of the movable element of said valve means,
said abutment means being connected to said movable thermostat element.

8. An enrichment fuel-air supply system according to claim 2,
said vacuum decay component including
a housing,
a pair of flexible diaphragms forming a variable volume substantially sealed air chamber within said housing,
first rod means secured to one of said diaphragms extending in a given direction,
second rod means secured to the other of said diaphragm extending in the opposite direction,
said vacuum decay component connected to the remainder of said linkage means by said rod means,
a check valve being closeable to prevent entry of atmospheric air into said chamber and openable to permit escape of compressed air from said chamber,
an air bleed passage from the atmosphere to said chamber permitted limited and controlled entry of air into said chamber when the pressure within said chamber is less than atmospheric.

9. An enrichment fuel-air supply system according to claim 4,
said vacuum decay component including
a housing,
a pair of flexible diaphragms forming a variable volume substantially sealed air chamber within said housing,
first rod means secured to one of said diaphragms extending in a given direction,
second rod means secured to the other of said diaphragm extending in the opposite direction,
said vacuum decay component connected to the remainder of said linkage means by said rod means,
a check valve being closeable to prevent entry of atmospheric air into said chamber and openable to permit escape of compressed air from said chamber,
an air bleed passage from the atmosphere to said chamber permitted limited and controlled entry of air into said chamber when the pressure within said chamber is less than atmospheric.

10. An enrichment fuel-air supply system according to claim 6,
said vacuum decay component including
a housing,
a pair of flexible diaphragms forming a variable volume substantially sealed air chamber within said housing,
first rod means secured to one of said diaphragms extending in a given direction,
second rod means secured to the other of said diaphragm extending in the opposite direction,
said vacuum decay component connected to the remainder of said linkage means by said rod means,
a check valve being closeable to prevent entry of atmospheric air into said chamber and openable to permit escape of compressed air from said chamber,

an air bleed passage from the atmosphere to said chamber permitted limited and controlled entry of air into said chamber when the pressure within said chamber is less than atmospheric.

11. An enrichment fuel-air supply system according to claim **10,** said linkage means including a spring loadable in tension.

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