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[54] **CHOKE CAP ALTITUDE KIT**

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[51] **Int. Cl.**^{2}... **F02D 11/08**

[58] **Field of Search**....... 123/119 F; 261/39 B, 39 E

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[57] **ABSTRACT**

A carburetor has a choke system including a bimetallic spring that biases the choke valve closed with a force that increases with decrease in temperature. A hot air tube connected from an exhaust manifold heat stove to the intake manifold flows hot air past the spring to warm it as the engine warms. An electrical heater is activated above a predetermined temperature to provide supplemental heat to the spring to pull off the choke faster than by use of the hot air alone. A further manifold vacuum actuated switch energizes the heater below the predetermined temperature whenever the manifold vacuum drops as a result of altitude changes below a level indicating insufficient hot air flow past the bimetallic spring to warm it.

11 Claims, 4 Drawing Figures

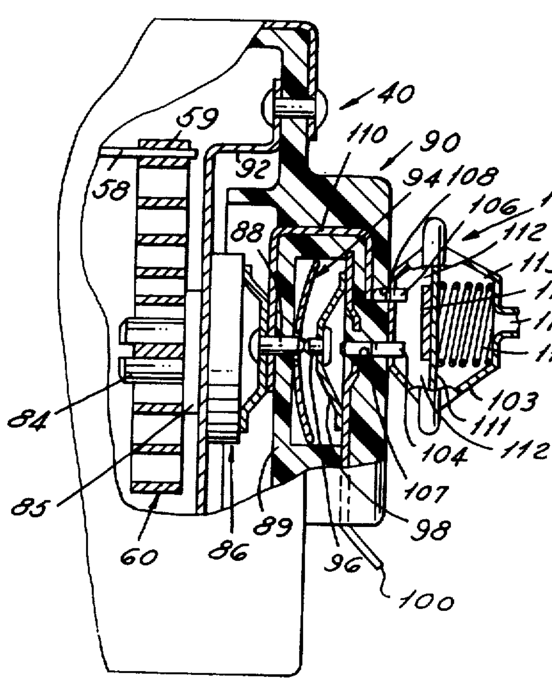

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FIG.1

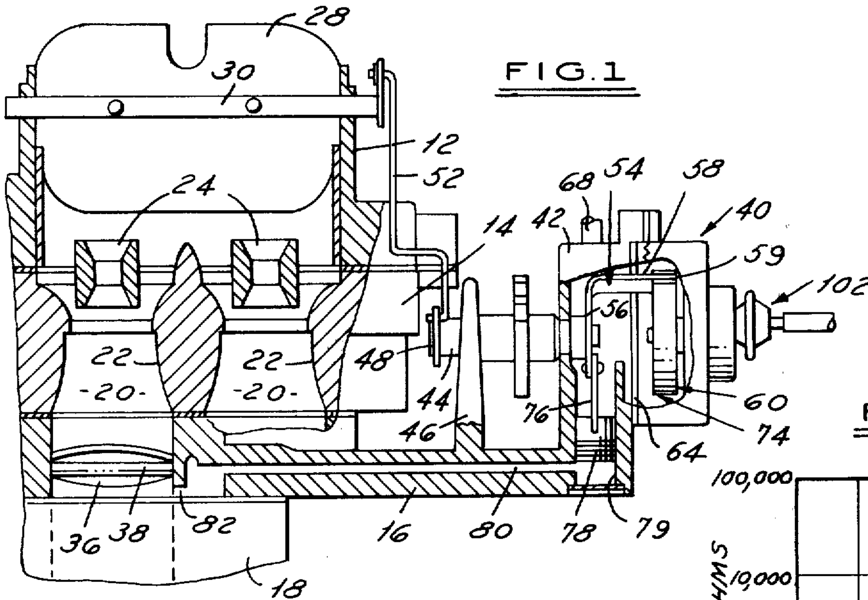


FIG.3

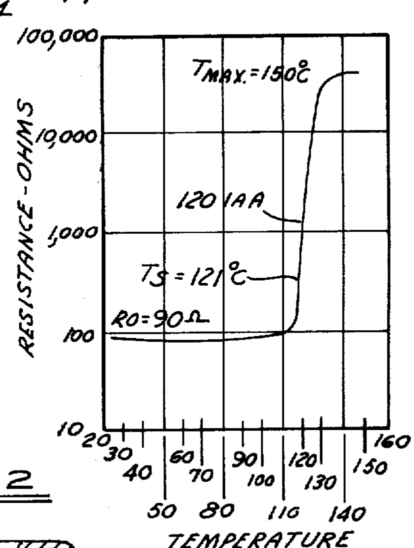


FIG.2a

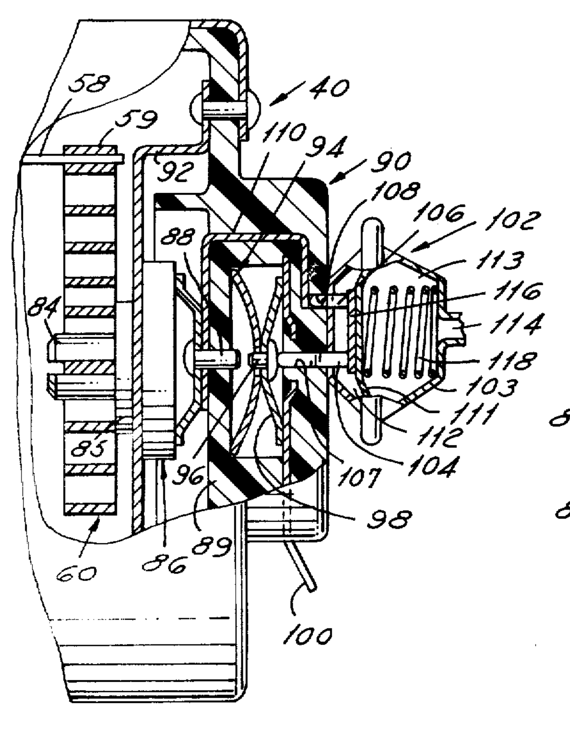
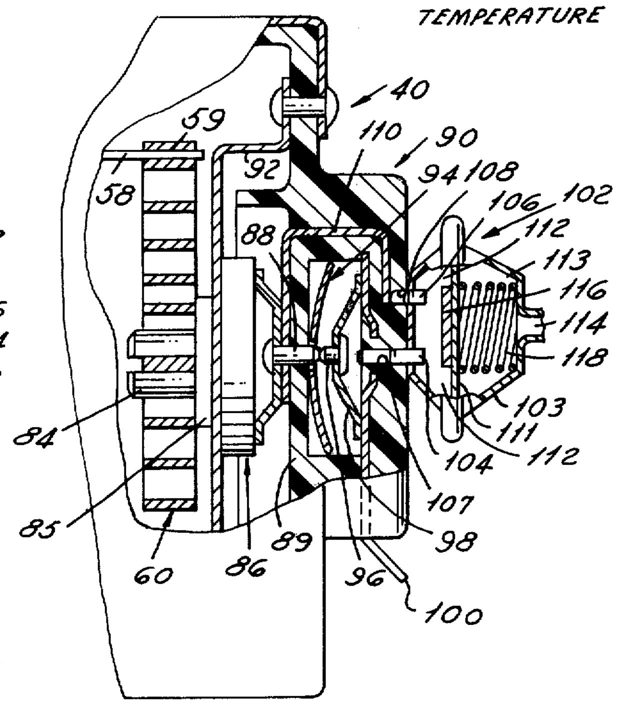


FIG.2



CHOKE CAP ALTITUDE KIT

This invention relates in general to a motor vehicle type carburetor. More particularly, it relates to a carburetor choke mechanism that provides the same cold engine operation regardless of changes in air density caused by changes in altitude.

More commercial carburetor chokes do not provide means for compensating for changes in air density with changes in altitude. Accordingly, when a car equipped with a conventional choke is operated in mountainous regions or at any level above that at which it was calibrated, the less dense air provides a richer mixture induction into the engine. The engine accordingly may load under acceleration, because less air now is available to combine with the liquid fuel droplets, resulting in less power output. In order to obtain the same acceleration, as at lower altitudes, therefore, the throttle plate is opened wider. This decays the lever of manifold vacuum as compared to that at the calibrated level.

An alternate way of looking at the same problem is that at higher than sea lever, or higher than the altitude at which the choke was calibrated, when the engine is accelerated, the air inducted is at less than atmospheric pressure. Accordingly, the pressure differential between the carburetor inlet and the engine combustion chamber is now less than when measured at the lower altitude. This again results in lower manifold vacuum levels as the altitude increases.

Most commercial carburetors have choke mechanisms containing a thermostatically responsive bimetallic coiled spring that exerts an increasing closing force on the choke valve as the temperature decreases below the normal engine operating level. This provides a richer mixture during cold engine operations, with the mixture being leaned progressively as the temperature increases. Most of the constructions slowly decrease the bimetal spring force and open the choke valve by flowing air warmed by the engine exhaust system past the coiled spring into the manifold.

It will be noted from the above, however, that since the manifold vacuum level lowers progressively as the altitude increases, the flow of hot air past the bimetallic spring will also decrease with altitude changes. During cold ambient driveaways, this can produce insufficient vacuum to pull enough hot air across the bimetal to insure maintaining the choke valve open. For example, if at the calibrated altitude, an acceleration is made that normally drops the manifold vacuum level to say 2 inch Hg., higher altitude requiring opening the throttle plate wider to obtain the same acceleration may drop the manifold vacuum to a nearly atmospheric pressure level. Little or no pressure differential, therefore, will exist between the hot air source and the manifold vaccum to cause flow of warm air past the bimetal spring to warm it. This results in a loading of the engine with a rich mixture to the point where it may stall because of the choke valve being in a position more closed than should be for the particular temperature setting.

It is an object of the invention, therefore, to provide a carburetor choke assembly with means to compensate for altitude changes to provide essentially the same choke operation regardless of air density changes.

It is another object of the invention to provide a carburetor choke construction with a supplemental heat source adjacent the conventional bimetal spring to heat the spring at times when the primary heat source becomes inadequate.

It is a still further object of the invention to provide a carburetor choke construction that includes, first, a thermostatically responsive bimetallic coiled spring that urges the choke closed with a force increasing with decreases in temperature from a predetermined level, secondly, a primary source of heat that is variable in output as a function of changes in engine operation to flow heat past the bimetallic spring to warm the same to oppose the choke closing force of the spring as a function of increasing engine temperature level, and, thirdly, a second heat source adjacent the spring that is operable in response to altitude changes varying the primary heat source flow to provide at all times an essentially constant supply of heat to the spring whereby the choke system will operate to provide the correct richness of the air/fuel mixture to the engine at all times during cold engine operation, regardless of changes in altitude.

Other objects, features and advantages of the invention will become more apparent upon reference to the succeeding detailed description thereof, and to the drawings illustrating the preferred embodiment thereof; wherein,

FIG. 1 is a cross-sectional elevational view of a portion of a two-barrel carburetor embodying the invention;

FIG. 2 is an enlarged view of a detail of FIG. 1; FIG. 2*a* is a view corresponding to FIG. 2 illustrating the parts in different operative positions; and,

FIG. 3 is a graph illustrating the operating characteristics of a detail shown in FIGS. 1 and 2.

FIG. 1 is obtained by passing a plane through approximately one-half of a known type of two-barrel, downdraft type carburetor. The portion of the carburetor shown includes an upper air horn section **12**, an intermediate main body portion **14**, and a throttle valve flange section **16**. The three carburetor sections are secured together by suitable means, not shown, over an intake manifold indicated partially at **18** leading to the engine combustion chambers.

Main body portion **14** contains the usual air-fuel mixture induction passages **20** having fresh air intakes at the air horn ends, and connected to manifold **18** at the opposite ends. The passages are each formed with a main venturi section **22** containing a booster venturi **24** suitably mounted for cooperation therewith, by means not shown.

Air flow through passages **20** is controlled in part by a choke valve **28** unbalance mounted on a shaft **30** rotatably mounted on side portions of the carburetor air horn, as shown. Flow of fuel and air through each passage **20** is controlled by a conventional throttle valve **36** (only one shown) fixed to a shaft **38** rotatably mounted in flange portion **16**. The throttle valves are rotated in a known manner by depression of the vehicle accelerator pedal, and move from an idle speed position essentially blocking flow through passage **20** to a wide open position essentially at right angles to the position shown.

The rotative position of choke valve **28** is controlled by a semiautomatically operating choke mechanism **40**. The latter includes a hollow housing portion **42** that is formed as an extension of the carburetor throttle flange. The housing is apertured for supporting rotatably one end of a choke lever operating shaft **44**, the opposite end being rotatably supported in a casting **46.** A bracket or lever portion **48** is fixed on the left end portion of shaft **44** for mounting the end of a rod **52** that is pivoted to choke valve shaft **30.** It will be clear that rotation of shaft **44** in either direction will correspondingly rotate choke valve **28** to open or close the carburetor air intake, as the cause may be.

An essentially L-shaped thermostatic spring lever **54** has one leg **56** fixedly secured to the opposite or right-hand end portion of shaft **44.** The other leg portion **58** of the lever is secured to the outer end **59** of a coiled bimetallic thermostatic spring element **60** through an arcuate slot in an insulating gasket **64.**

Leg **56** is also pivotally fixed to the rod **76** of a piston **78.** The latter is movably mounted in a bore **79** in housing **42.** The under surface of piston **78** is acted upon by vacuum in a passage **80** that is connected to carburetor main induction passages **20** by a port **82** located just slightly below throttle valve **36.** Piston **78,** therefore, is always subjected to any vacuum existing in the intake manifold passage portion **18.**

The casing **42** is provided with a hot air passage **68** connected to an exhaust manifold heat stove, for example. The cylinder in which piston **78** slides is provided with bypass slots, not shown, in a known manner so that the vacuum acting on the piston will cause a flow of the hot air from passage **68** to passage **80.** More specifically, hot air will flow into the area round the spring coil **60** through a hole in gasket **64** and out through the slot to the bypass slots around piston **78.**

It will be clear that the thermostatic spring element **60** will contract or expand as a function of the changes in ambient temperature conditions of the air entering tube **68**; or, if there is no flow, the temperature of the air within chamber **74.** Accordingly, changes in ambient temperature will rotate the spring lever **54** to rotate shaft **44** and choke valve **28** in one or the other directions as the case may be.

As is known, a cold weather start of a motor vehicle requires a richer mixture than a warmed engine start because considerably less fuel is vaporized. Therefore, the choke valve is shut or nearly shut to increase the pressure drop thereacross and draw in more fuel. Once the engine does start, however, then the choke valve should be opened slightly to lean the mixture to prevent engine flooding as a resulting of an excess of fuel.

The choke mechanism described automatically accomplishes the action described. That is, on cold weather starts, the temperature of the air in chamber **74** will be low so that spring element **60** will contract and rotate shaft **44** and choke valve **28** to a closed or nearly closed position, as desired. Upon cranking the engine, vacuum in passage **80** will not be sufficient to move piston **78** to open the choke valve. Accordingly, the engine will be started with a rich mixture. As soon as the engine is running, high vacuum is passage **80** moves piston **78** downwardly and rotates shaft **44** a slight amount so that choke valve **28** is slightly opened so that less fuel is admitted to induction passage **20.** Shortly thereafter, the exhaust manifold stove air in line **68** will become progressively warmer and cause choke element **60** to unwind slowly and rotate shaft **44** and choke valve **28** to a more open position. Further details of construction and operation are not given since they are known and believed to be unnecessary for an understanding of the invention.

FIG. **2** shows thermostatic spring coil **60** centrally staked to a metal post **84.** The post is formed as an integral part of an aluminum disc **85.** The disc constitutes a heat sink or transfer member to evenly radiate heat to the coil from a heater element **86** to which it is secured.

Heater element **86** is a positive temperature coefficient (PTC) semiconductor in the shape of a flat ceramic disc. It is fixed on disc **85** and has a central spring-leg type current carrying contact lug **88.** The lug projects through a hole in a wall **89** of an insulated cover or choke cap **90.** The disc **85** is grounded through the cover to the cast choke housing by extensions and ground terminals **92.** Lug **88** is adapted to be engaged at times by the face of a bimetallic thermal switch **94.** The switch is of the overcenter spring type, and is sensitive to ambient temperature changes. The switch has a central hole through which projects a current carrying lug **96.** The lug **96** is fixed to a spring leg type conductor **98** connected to an electrical spade-like terminal **100.** The terminal would be connected to any suitable source of electrical energy, such as the vehicle alternator, so that current would be supplied as long as the vehicle is running.

The choke cap **90** also includes a vacuum switch **102** that is of the plug-in type. That is, switch **102** has a hollow housing **103,** through one side of which projects a pair of current carrying contact prongs **104, 106.** Prong **104** extends through an electrical socket **107** in cap **90** to a position adjacent the backside of contact lug **96.** It is spaced from the lug when the bimetal switch **94** is in the overcenter position shown, contacting lug **88.** When bimetal switch **94** moves overcenter to its alternate position, lug **96** engages prong **104** to conduct current through it. Prong **106** on the other hand extends through an electrical socket **108** as shown into engagement with a current carrying connector **110** fixed to lug **88,** to conduct current to heater **86** in a manner to be described.

The hollow interior of switch **102** is divided by an annular flexible diaphragm **111** into an air chamber **112** and a manifold vacuum chamber **113.** A vacuum tube **114** leads into chamber **113** and is connected at its other end, not shown, to a suitable manifold vacuum port similar to carburetor port **82,** for example.

Chamber **112** is vented to ambient pressure through a hole, not shown, in housing **102.** Attached to diaphragm **111,** on the air chamber side, is a contact bridge plate **116.** A preloaded spring **118,** in vacuum chamber **113,** biases the diaphragm **111** and contact plate **116** to a bridging position with respect to prongs **104** and **106.** The force of spring **118** is chosen to be such as to require a net manifold vacuum force of at least as high as 2 inches Hg., for example, in chamber **113** before the diaphragm will be drawn rightwardly and unbridge contacts **104** and **106** to break the circuit and open the switch.

Returning now to heater element **86** per se, it is a characteristic of the PTC heater that its internal resistance varies directly with the skin temperature of the element, from a predetermined switch point Ts. The change in the internal resistance is not a linear function of the elements' internal temperature but varies in the manner shown more clearly in FIG. **3.** When the PTC heater **86** is electrically energized, as by applying line voltage to its terminals from the alternator when either switch **94** or **102** closes, the Joule heat causes rapid self-heating of the PTC element. The heater resistance remains almost constant as it heats from room temperature. It increases as the PTC temperature nears the switching temperature Ts, or desired upper limit, at which point the resistance increases sharply, as shown. The electrical characteristics, of course, can be controlled by the chemical composition and process of making it.

It will be seen, therefore, that is is an inherent property of this semiconductor to obtain a very high impedance to current flow at high internal temperature, and that the semiconductor has an ability to maintain a high maximum temperature. The need for a cut off thermostat to protect against distortion of the bimetallic spring **60**, therefore, due to extreme temperature levels is thereby eliminated.

In this instance, therefore, the PTC device provides heat to bimetal spring **60** that is supplemental or substitutive to that provided by the primary exhaust manifold hot air system, depending upon whether switch **94** or **102** is closed. When current passes through the PTC element, a change in the internal temperature is noticed. This heat generated is transferred by conduction to spring **60** through the post **84** and by radiation to the spring from the heat sink **85.**

When the PTC internal temperature reaches the switching temperature Ts, say 180°F, as seen in FIG. **3,** the internal resistance is so high that the current flow is very low and essentially cut off. It will be seen, therefore, that the heat input to the PTC element by the current flow then is essentially balanced by the heat loss by the pTC to the environment and to the bimetal post **84.** Therefore, for all intents and purposes, the heat of the PTC remains at a constant level.

The overall operation is believed to be clear from the above description and the drawings, and therefore will not be repeated in detail.

In brief, below an ambient temperature level of 65°±F, as seen in FIG. **2**a, the bimetal switch **94** has flipped overcenter to a position disengaging the end of lug **96** from contact lug **88.** The PTC heater **86,** therefore, cannot be energized through switch **94** at this time. At this temperature level, closing of the choke valve is needed to provide the proper enrichment. Therefore, only a slow unchoking coordinated with the engine temperature rise is desired, which is normally provided by the slowly rising exhaust heated air passing through the choke housing. Therefore it is not desired at this time to energize the PTC heater unless the hot air should decrease below a minimum flow level.

As stated previously, due to altitude changes, there are times when the manifold vacuum decreases to a level so low during vehicle accelerative movements that the pressure differential is insufficient to draw enough hot air through the choke housing to warm the bimetal to follow the schedule of unchoking desired. It is at this time, when manifold vacuum drops below the 2 inches Hg. level, for example, that the switch **102** closes by the contact plate **116** bridging the two prongs **104** and **106.** This connects the alternator current to the PTC heater around the bimetal switch **94** to provide heat to the bimetal spring to compensate for that lost by the lack of heat flow from the exhaust hot air system. The closing of vacuum switch **102,** therefore, makes up or compensates for the inability of the hot air system to function as designed. The vacuum switch therefore bypasses the open bimetal switch **94** to separately and in parallel energize the PTC heater until such time as the manifold vacuum again rises over the 2 inches Hg. level (when the hot air flow is sufficient) sufficient to overcome the force of spring **118** and unbridge contacts **104** and **106.**

It will be clear that switch **102** will be so constructed and arranged as to be triggered into action whenever the manifold vacuum drops to a level indicating insufficient airflow through the choke housing. It will be clear of course that the particular level desired can be controlled by the choice of the preload of spring **118.**

Above 65°F, use of the exhaust hot air alone to determine choke pull-off is not generally satisfactory as the rate of warming of the bimetal by this air along is too slow, for good emission results.

Therefore, above 65°F, the bimetal switch **94** moves overcenter to the position shown in FIG. **2** engaging lugs **96** and **88** and energizing the PTC heater **86.** The overcenter action permits the spring legs of contact **98** to move to the left and disengage the current source from the vacuum switch prong **104.** The bimetal coiled spring **60,** therefore, will unwind as a function or both the exhaust manifold stove heat and the supplemental heat from the energized PTC element, which will permit the opening of the choke valve by airflow faster than were it being controlled by the primary heat source along. It will also be noted that above 64°F, the vacuum switch **102** is inoperative to supply current to the PTC element.

From the foregoing, it will be seen that the invention provides a simple plug-in type vacuum switch that can be added to a conventional electric choke type carburetor construction to assure heating of the choke bimetal below a predetermined temperature level whenever the manifold vacuum drops below a predetermined level. Therefore, altitude changes producing lower manifold vacuum levels are compensated for by providing a substitutive heat source to the bimetal during low vacuum conditions that are indicative of insufficient hot airflow through the choke housing.

While the invention has been shown and described in its preferred embodiment, it will be clear to those skilled in the arts to which it pertains that many changes and modifications may be made thereto without departing from the scope of the invention.

We claim:

1. An automatic choke system for use with a carburetor having an air/fuel induction passage and

an unbalance mounted, air movable choke valve mounted for variable movement across the passage to control airflow through the passage,

thermostatic spring means operably connected to the choke valve urging the choke valve towards a closed position with a force increasing as a function of decreases in the temperature of the spring means from a predetermined level,

an intermittently operable heater device located adjacent the spring means operable to transfer its heat output to the spring means when operable to reduce the choke valve closing force of the spring means and permit opening of the choke valve by airflow through the passage against it,

engine vacuum responsive means operable below a predetermined temperature to selectively render the heater device operable and inoperable in response to changes in engine vacuum, a source of electrical energy, circuit means connecting the source to the heater device, temperature sensitive switch means in the circuit means operable to break and make the circuit as a function of temperature changes from a predetermined level,

and means mounting the vacuum responsive means to at times electrically connect the source to the heater device in another circuit that is parallel to the first-mentioned circuit connecting the source and heater device through the temperature sensitive means to thereby permit connection of the source to the heater device when the temperature sensitive means is operable to break the first-mentioned circuit bypassing the temperature sensitive means.

2. A choke system as in claim 1, the vacuum responsive means comprising a spring closed engine manifold vacuum opened switch.

3. A two phase automatic choke system for use with an internal combustion engine carburetor having an air/fuel induction passage open at one end and adapted to be connected to an engine intake manifold at the other end for subjecting the passage to varying manifold vacuum, the passage having a throttle valve rotatably mounted across the passage adjacent the other end for a variable movement between positions opening and closing the passage to control airfuel flow through it,

the choke including an unbalance mounted, air movable choke valve rotatably mounted across the passage adjacent the one end for variable opening and closing movements to control airflow towards the throttle valve,

a thermostatically responsive coiled spring operably connected to the choke valve and normally urging the choke valve towards a closed position with a force increasing with decreases in the temperature of the spring from a predetermined level,

a heat source transferring engine heat to the coiled spring comprising a hot air containing duct operably connected from the engine exhaust system at one end of the duct to the intake manifold at the other end of the duct past the coiled spring for warming the spring to reduce its choke valve closing force,

and supplemental intermittently operably heat means adjacent the coiled spring to transfer its heat thereto and responsive at times to a predetermined decay in manifold vacuum reducing the hot air flow through the duct to render operable the heat means to effect subsequent movement of the choke valve towards a position more open than the position effected by the hot air heat source alone,

the supplemental heat means including a source of electrical energy, a heater device located adjacent the thermostatic spring and operable to transfer its heat output to the spring to reduce the choke closing force and permit opening of the choke valve by airflow through the passage against it, temperature responsive means connecting the heater device to the source at all times above a predetermined temperature and disconnecting the heater device from the source below the predetermined temperature, and other means controlled by manifold vacuum to connect the source to the heater device below the predetermined temperature bypassing the temperature responsive device.

4. A choke system as in claim 3, the means controlled by vacuum comprising an electrical switch having a pair of spring bridged contacts when bridged connecting the heat source to the heater device, and a conduit connecting engine manifold vacuum to the switch whereby vacuum above a predetermined level acts to unbridge the contacts and open the connection between the heater device and source.

5. A choke system as in claim 4, the heater device comprising a self-limiting output temperature positive temperature coefficient heater characterized by increasing internal impedance with increases in internal temperature up to its limit limiting further current flow and heat buildup, thereby eliminating the need for a thermostatic cut-off switch to prevent heat damage to the spring.

6. A two phase automatic choke system for use with an internal combustion engine carburetor having an air/fuel induction passage open at one end and adapted to be connected to an engine intake manifold at the other end for subjecting the passage to varying manifold vacuum, the passage having a throttle valve rotatably mounted across the passage adjacent the other end for a variable movement between positions opening and closing the passage to control air/fuel flow through it,

the choke system including an unbalance mounted, air movable choke valve rotatably mounted across the passage adjacent the one end for variable opening and closing movement to control airflow towards the throttle valve,

a thermostatically responsive coiled spring operably connected to the choke valve and normally urging the choke valve towaards a closed position with a force increasing with decreases in the temperature of the spring from a predetermined level,

first power means operably connected to the choke valve and sensitive to engine manifold vacuum for moving the choke valve from an initially closed position towards an open position in opposition to the spring and in response to operation of the engine from a start to a running condition,

the first power means including a vacuum operated movable piston means, and a first heat source transferring engine heat to the spring and comprising a hot air containing duct operably connected from the engine exhaust system at one end of the duct to the intake manifold at the other end of the duct past the spring for warming the spring to reduce its choke valve closing force,

supplemental electrically controlled, temperature responsive heat means in a parallel arrangement with the first power means heat source for effecting subsequent movement of the choke valve towards a position more open than the position effected by the first power means alone,

the supplemental means including a source of electrical energy, a positive temperature coefficient (PTC) heater device located adjacent the spring and operable to transfer its heat output to the spring to reduce its choke closing force and permit opening of the choke valve by airflow through the passage against it, temperature responsive switch means operable above a predetermined ambient air temperature to connect the source to the heater device to energize the heater device, the internal resistance of the heater device above a predetermined heater temperature level increasing to a level restricting further heat buildup beyond a predetermined level, thereby preventing overheat damage to the spring, and an engine manifold vacuum controlled switch connected in parallel to the temperature responsive device between the heater device and source for bypassing the temperature responsive switch means below the predetermined temperature to energize the heater device, the switch being spring closed to complete a circuit between the source and heater device, and opened by manifold vacuum above a predetermined level applied thereto, the latter level indicating sufficient pressure differential between the hot air source and manifold vacuum to draw sufficient hot air past the spring to warm the same.

7. An automatic choke system for use with a carburetor having an air/fuel induction passage and

an unbalance mounted, air movable choke valve mounted for variable movement across the passage to control airflow through the passage,

thermostatic spring means operably connected to the choke valve urging the choke valve towards a closed position with a force increasing as a function of decreases in the temperature of the spring means from a predetermined level, a first source of heat flow adjacent the spring means to warm the spring means to reduce the choke valve closing force of the spring means and permit opening of the choke valve by airflow through the passage against it, the first heat flow source providing a variable flow of heat, and a second intermittently operated source of heat adjacent the spring means rendered operable in response to a decay below a predetermined level in the flow of heat from the first source to transfer heat to the spring means and compensate for the decay in heat flow from the first source.

8. A choke system as in claim **7**, the first heat source comprising a hot air tube connected at one tube end to air at ambient pressure adjacent the engine exhaust system and at the other tube end to the engine intake manifold, with the air flow through the tube being exposed to and heating the spring means at a rate varying as a function of the vacuum changes.

9. A choke system as in claim **8**, the second source of heat comprising an electrically controlled heater device, a source of electrical energy, an electrical circuit connecting the heater device to the source, and a manifold vacuum controlled on-off switch in the circuit operable at times upon decay of manifold vacuum below a predetermined level to actuate the switch to an on position and energize the heater device.

10. A choke system as in claim **7**, the switch comprising a unitized removable plug-in prong type switch for easy disconnection of the switch from the circuit, the heater device including a socket type receptacle for receiving the prongs of said switch.

11. A choke system as in claim **9**, the circuit including a temperature responsive switch connected in parallel to the vacuum switch and operable above a predetermined temperature to bypass the vacuum switch and energize the heater device to provide heat flow to the spring means at all times regardless of the heat flow from the first source.

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