

May 24, 1960

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2,937,635

AUTOMATIC CHOKE CONTROL

Filed Feb. 24, 1958

4 Sheets-Sheet 1

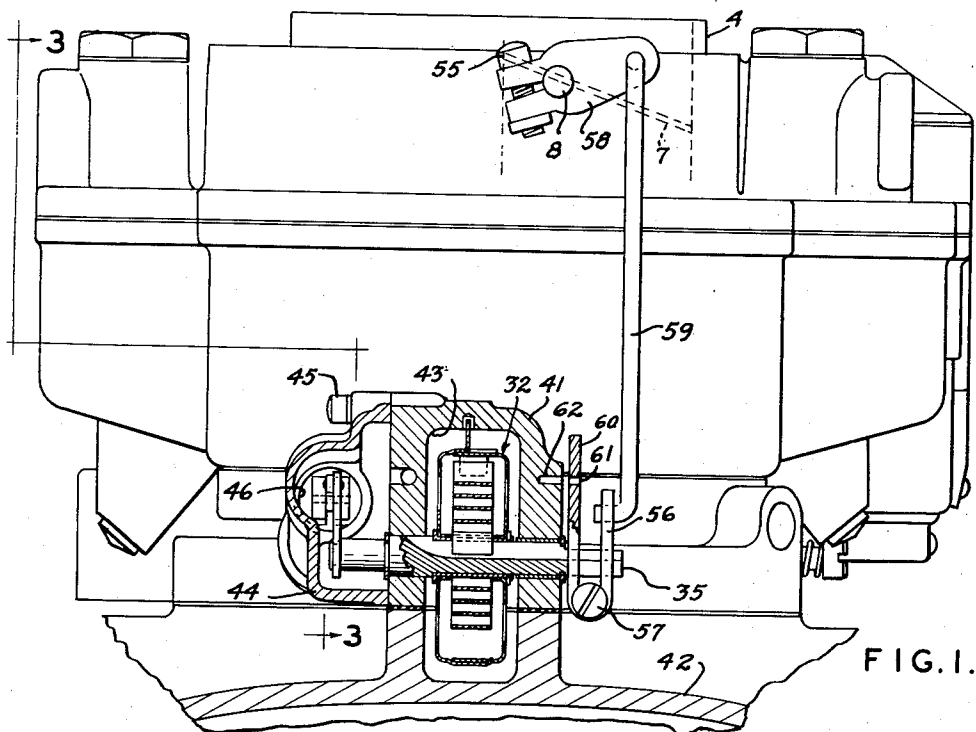
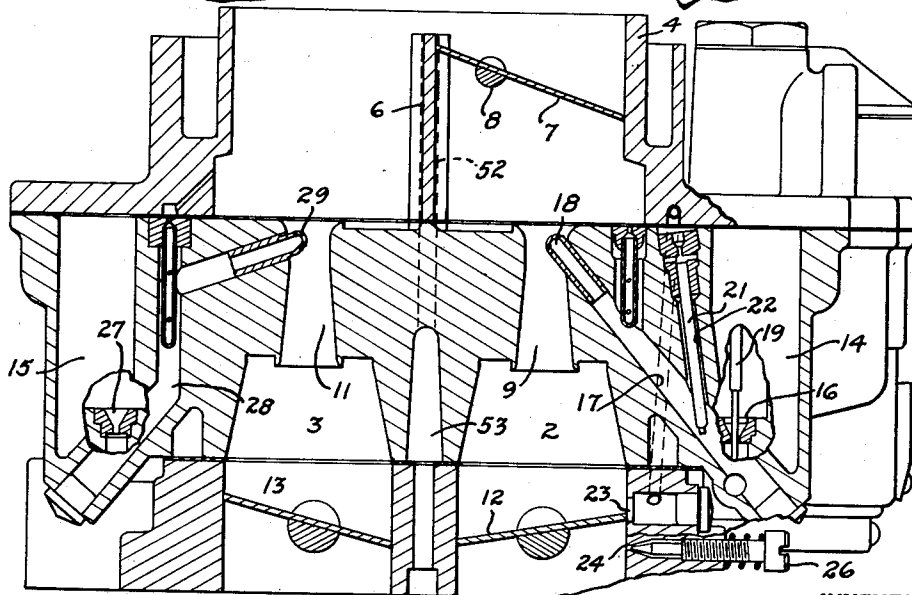


FIG. 2.

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4 Sheets-Sheet 2

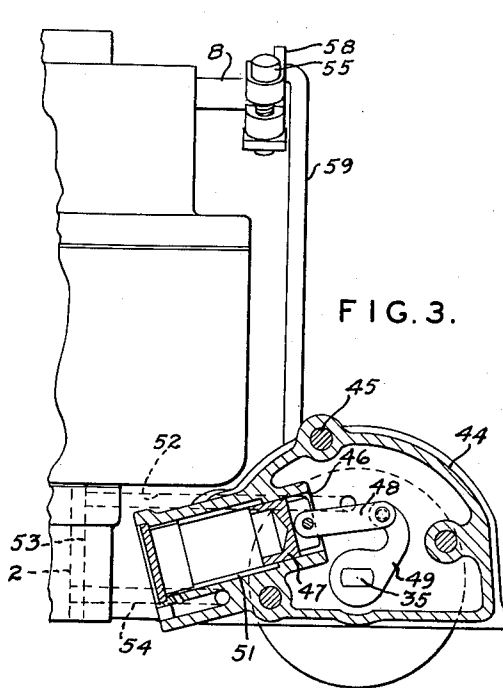


FIG. 3.

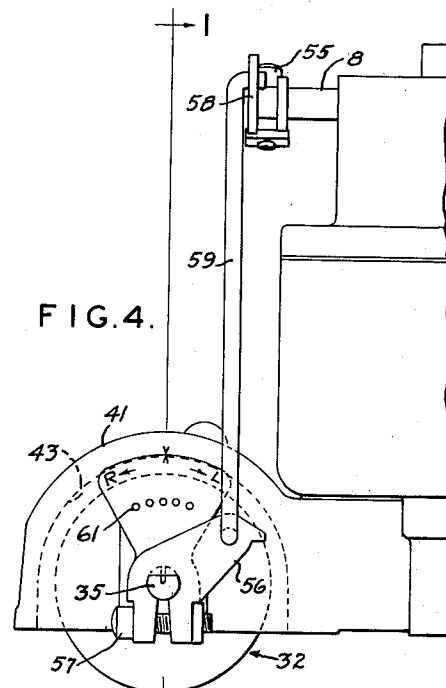


FIG. 4.

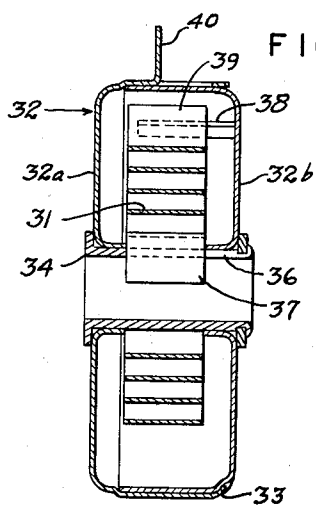


FIG. 6.

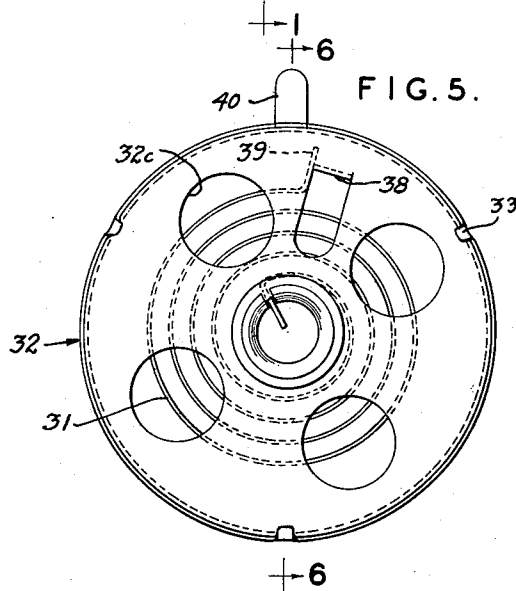


FIG. 5.

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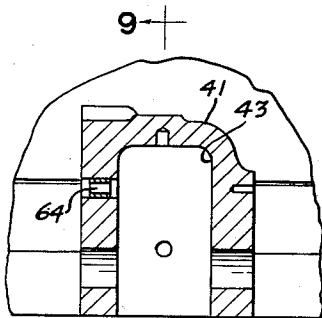


FIG. 8.

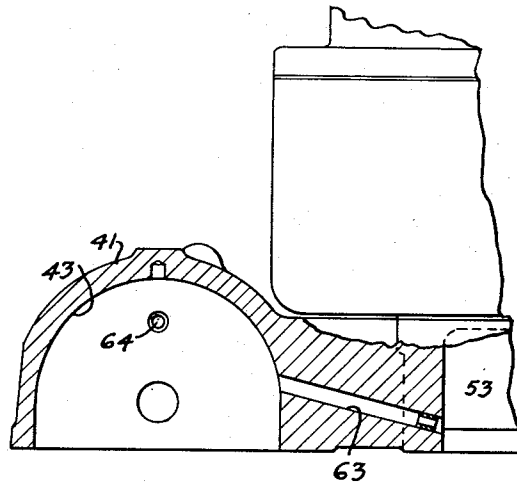


FIG. 9.

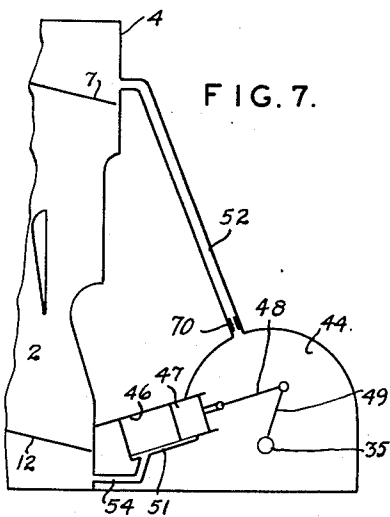


FIG. 7.

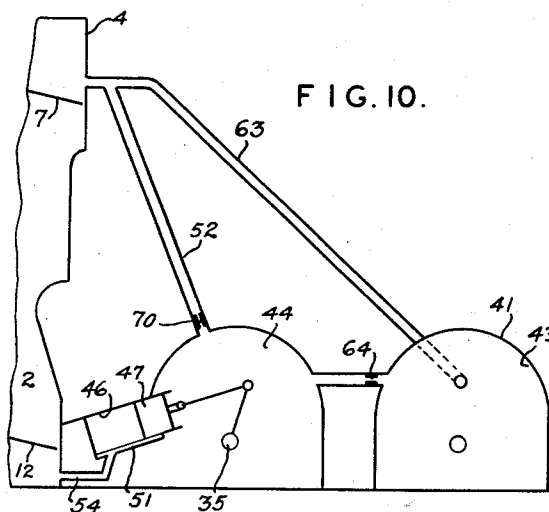


FIG. 10.

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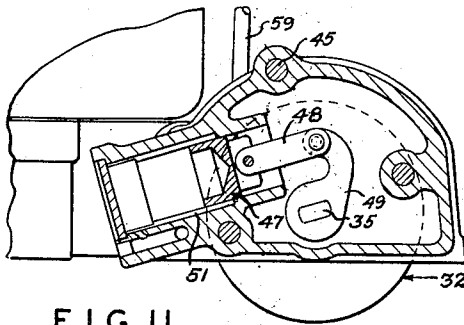


FIG. 11.

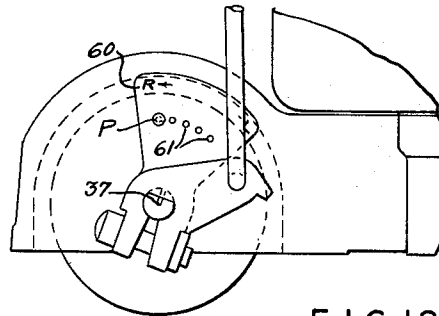


FIG. 12.

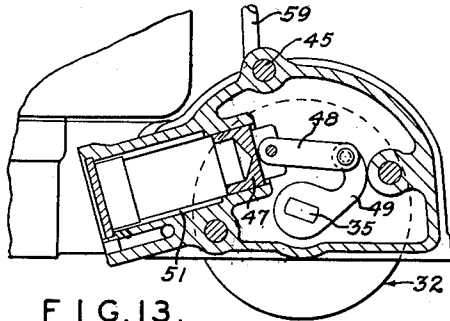


FIG. 13.

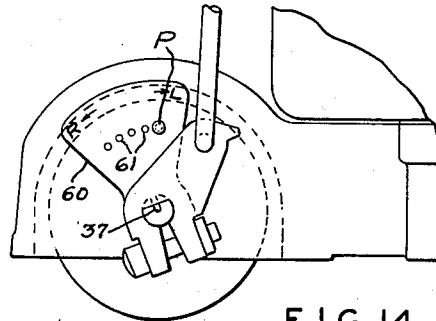


FIG. 14.

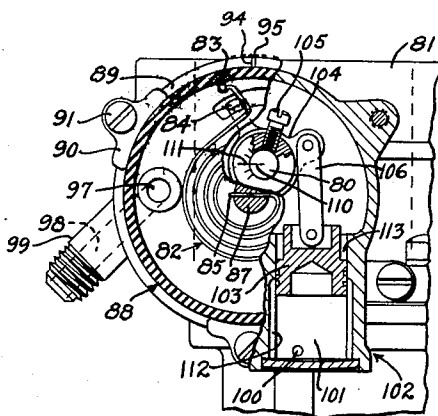


FIG. 15.

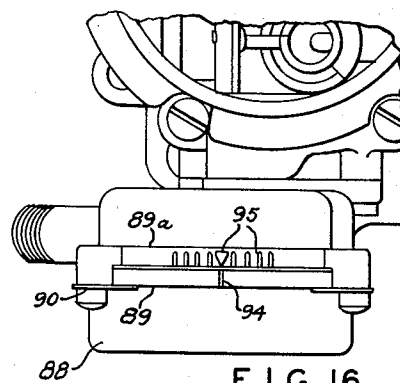


FIG. 16.

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2,937,635

AUTOMATIC CHOKE CONTROL

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Filed Feb. 24, 1958, Ser. No. 717,163

30 Claims. (Cl. 123—119)

This invention relates to automatic choke controls for internal combustion engine carburetors, and is a continuation-in-part of our prior pending application, Serial Number 632,830, filed January 7, 1957, and now abandoned.

In the use of conventional automatic choke mechanisms on carburetors to facilitate starting of cold engines, the automatic choke control is designed to enrich the fuel mixture in proportion to engine temperature. It is, however, well known to those skilled in the art that such automatic choke controls must be accurately adjusted and properly located on the engine to obtain the desired results in controlling the enrichment of the fuel mixture to the engine. It is also well known that different engines require different choke control settings due to the differences in time required to reach their normal operating temperatures.

Upon stopping of an engine which has been operating at its normal temperature, the choke control thermostat usually cools off more rapidly than the engine and acts to close the choke valve. When the engine is again started after a short stop, there is often an undesirable delay in the opening of the choke valve, thereby causing an unnecessary and undesirable enrichment of the fuel mixture to the engine.

When an engine is started while cold, engine suction during warm-up functions through a suction motor to maintain a choke valve in the carburetor slightly open. Because of engine age, changes in operating conditions, such as altitude or other conditions, the original setting of the initial opening of the choke valve may not provide optimum service. In addition, most carburetors are provided with a temperature responsive device for progressively opening the choke valve as the engine continues to warm up. Improper installation of this device results in an incorrect fuel-air mixture during warm-up, producing a poor idle.

It has been the practice to permanently preset the suction motor, and to have a temperature responsive device which is easily adjustable in the field. Should the fuel-air mixture be improper immediately upon starting the engine, for example, either too rich or too lean, only the temperature responsive device may be adjusted to correct such an undesirable condition. To facilitate starting a cold engine, it is necessary that the fuel-air mixture be proper during the initial operation of the engine. To compensate for the starting fuel-air mixture by adjusting the temperature responsive device, subsequent warm-up operation of the engine may result in a fuel-air mixture which is either too lean or too rich. Such difficulties are normally encountered in the field, but a man in the field can only adjust the temperature responsive device, and this may result in improper engine operation, either during the starting, or during the warm-up, period.

It is, therefore, an object of the invention to provide an improved, automatic choke control embodying ad-

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justable means for varying the amount of initial choking operation to suit the requirements of different engines.

Another object of the invention resides in the provision of an automatic choke control which more accurately controls the position of the choke valve responsive to engine temperature.

A further object of the invention is to provide an improved automatic choke control which is relatively simple and inexpensive in construction and reliable in operation.

Still another object of the invention is to provide an improved automatic choke thermostatic control unit.

A further object of this invention is to provide improved, cooperating, temperature responsive, and engine suction responsive, automatic control for a choke valve, and a single adjustment for both controls.

Another object of this invention is to provide an improved control for slightly opening the choke valve immediately upon starting of the engine.

Another object of this invention is to provide a choke valve suction responsive control which is adjustable independently of a temperature responsive control.

Still another object of this invention is to provide a choke valve suction responsive control which can be satisfactorily adjusted by a man in the field.

The invention embodies other novel features, details of construction, and arrangement of parts, which are hereinafter set forth in the specification and claims and illustrated in the accompanying drawings, wherein:

Fig. 1 is a vertical sectional view taken along the line 1—1 of Fig. 4 illustrating an automatic choke control embodying features of the invention as applied to a conventional multi-stage carburetor.

Fig. 2 is a vertical sectional view illustrating the carburetor.

Fig. 3 is a fragmentary sectional view taken along the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary side elevational view of the carburetor and choke control structure shown in Fig. 1.

Fig. 5 is a detail side elevational view illustrating a spirally wound bimetallic thermostat as mounted within a casing.

Fig. 6 is a sectional view taken along the line 6—6 of Fig. 5.

Fig. 7 is a schematic view illustrating the invention shown in Figs. 1 to 6.

Fig. 8 is a fragmentary vertical sectional view, corresponding to Fig. 1, illustrating a modified form of the invention.

Fig. 9 is a fragmentary sectional view taken along the line 9—9 of Fig. 8.

Fig. 10 is a schematic view illustrating the embodiment of the invention shown in Figs. 8 and 9.

Figs. 11 and 12 are views similar to Figs. 3 and 4 illustrating the choke control mechanism adjusted for rich operation. Fig. 11 is a fragmentary, sectional view corresponding to Fig. 3, and Fig. 12 is a fragmentary, side elevational view corresponding to Fig. 4.

Figs. 13 and 14 are views similar to Figs. 11 and 12, but illustrating the choke control mechanism adjusted for lean operation, Fig. 13 being a fragmentary, sectional view corresponding to Fig. 3, and Fig. 14 being a fragmentary, side elevational view corresponding to Fig. 4.

Fig. 15 is a fragmentary, sectional, elevational view of another embodiment of the invention.

Fig. 16 is a fragmentary, top view of a portion of the embodiment illustrated in Fig. 15.

Referring now to the drawings for a better understanding of the invention and more particularly to Figs. 1 to 7 therein, an automatic choke control structure embodying features of the invention is shown as applied to

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a conventional multi-stage carburetor of the type shown and described in Patent No. 2,715,522, granted August 16, 1955, to Carlson et al., but it will be apparent that the choke control may readily be embodied in other types of conventional carburetors without departing from the invention.

The carburetor is shown as comprising primary and secondary mixing conduits 2 and 3 arranged side by side and provided with an air inlet horn 4 having a transverse partition 6. An unbalanced choke valve 7 is fixed on a shaft 8 journaled on the primary side of the air horn to control the flow of air downwardly through the primary conduit 2.

The primary and secondary conduits are provided with venturis 9 and 11, respectively, and throttle valves 12 and 13, respectively. The primary throttle 12 is adapted to be connected to an accelerator pedal for manual operation and also connected to the secondary throttle 13 for serial opening, as shown and described in said patent. It will also be understood that the mechanical choke unloader shown in said patent would be embodied in the carburetor structure for unloading any excess fuel from the manifold.

Provided on opposite sides of the carburetor are constant level fuel chambers 14 and 15 having fuel inlets controlled by the usual float actuated needle valves. The fuel chamber 14 is provided with metering orifice 16 leading into a main fuel passage 17 for the discharge of fuel through a nozzle 18 into the venturi 9. A metering pin 19 is provided in the orifice 16 and actuated responsive to manifold vacuum and primary throttle movement, as shown and described in said Patent No. 2,715,522.

An idling system is associated with the main fuel passage 17 and is shown as comprising a restriction tube 21 in an idling passage 22 leading from the main fuel passage to the usual idle ports 23 and 24 located adjacent the edge of the primary throttle valve 12 when the latter is in its closed position, the idle port 24 being provided with an idle adjustment screw 26.

The fuel chamber 15 is provided with a metering orifice 27 leading into a secondary fuel passage 28 having a nozzle 29 for the discharge of fuel into the venturi 11 of the secondary mixing conduit 3. If desired, an idle system may be provided for the secondary conduit 3, as shown and described in Patent No. 2,728,536.

The means for controlling the position of the choke valve 7 responsive to engine temperature is shown as comprising a resilient, spirally wound, bimetallic, thermostat spring 31 mounted within a casing 32, comprising cup-shaped sections 32a and 32b, each provided with air vents 32c. A sleeve 34 is journaled in the casing 32 and is slotted at 36 to receive the inner end 37 of the thermostat 31. A fixed stop, boss, or abutment shoulder 38 is provided on the casing section 32b to engage the outer end 39 of the thermostat.

As shown in Fig. 1, the sleeve 34 is mounted on a control shaft 35 journaled at its ends in bearing apertures provided in opposite walls of a housing 41 mounted on or formed, in part, integral with an engine manifold 42 heated by exhaust gases or hot water from the engine. The casing section 32a is provided with a lug 40 engaged in a recess in the housing 41 to prevent movement of the casing relative to the housing. During assembly of the thermostat 31 and sleeve 34 in the casing 32, the casing sections 32a and 32b are telescopically engaged and rotated relative to each other to dispose the stop 38 in a predetermined, circumferentially spaced relationship to the lug 40; after which, the casing sections are secured against relative movement by pressing stake fingers 33 on the section 32a against section 32b to provide stake receiving recesses in the latter, as illustrated in Figs. 5 and 6.

In one form of the invention, the housing 41 provides a hot chamber 43, closed to atmosphere, to house the thermostat 31 in a dead air space to prevent too rapid

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cooling off of the thermostat when the engine is stopped, to thereby prevent closing of the choke valve 7 when the engine is in a heated condition.

A suction motor housing 44 is secured by screws 45 to one side of the thermostat housing 41 and formed with a cylinder 46 to receive a piston 47. The housing portion 44 may be formed integrally by casing with the carburetor body. Whether the housing 44 is formed integrally with the body or is secured thereto by screws 45, it forms part of the carburetor unit assembly, and it is merely necessary to secure the unit assembly to the manifolds. The piston is connected by means of a link 48 to an arm 49 secured to one end of the control shaft 35. By-pass ports or grooves 51 extend longitudinally along the inner surface of the cylinder 46 for a portion of its length for the passage of air past the piston after the latter has been moved in a direction to open the choke valve 7.

An air inlet passage 52 leads downwardly through the partition 6 into a chamber 53 and thence laterally from the chamber into the suction motor housing 44. An air outlet passage 54 leads from the closed end of the cylinder 46 to the primary mixing conduit 2 posterior to the primary throttle valve 12. The passage 52 has a metering orifice 70.

A lever 56 is secured by a bolt 57 in a predetermined, fixed setting on the end of the control shaft 35 opposite the arm 49, and is connected to a lever 58 on the choke valve shaft 8 by means of a link 59. The lever 58 is adapted to be rotatably adjusted on the shaft 8 by means of a bolt 55. An index plate 60 is shown in Figs. 1 and 4 as formed integral with the lever 56 and provided with a plurality of apertures 61 selectively movable into registry with a recess 62 in the housing 41 to permit a stop pin P to be received in one of the apertures 61 and the recess 62 during adjustment of the choke control to provide a leaner or richer fuel mixture for the engine, as hereinafter described.

In the operation of the automatic choke control thus shown and described, the thermostat 31 is adapted to hold the choke valve 7 in its closed position when the engine is cold. Upon starting of a cold engine, suction in the intake manifold causes the piston 47 to move into the cylinder a short distance, overcoming the resistance of the thermostat 31 and partially opening the choke valve 7. As the engine approaches its operating temperature, the thermostat gradually permits the choke valve to be moved to its full open position.

To vary the richness of the fuel mixture during warm-up of a cold engine, it is only necessary to loosen the bolt 55 on the lever 58, then manually pivot the index plate 60 to align a selected aperture 61 therein in registry with the recess 62 and insert a lock pin P in said selected aperture and recess, move the choke valve 7 to closed position, and then tighten the bolt 55 and remove the lock pin.

As illustrated in Figs. 11 and 12, when the index plate 60 is adjusted to the rich side, the piston 47 is moved into the cylinder closer to the by-pass grooves 51 to reduce the amount of pull-off or choke valve opening on start and run of the engine, thereby providing a richer mixture. Such adjustment, at the same time, increases the tension of the thermostatic spring 31 through movement of the inner end 37 of the spring in a clockwise direction, as viewed in Fig. 12. The suction piston 47 and the thermostatic spring 31, therefore, are adjustable together and act in unison to increase the richness of the fuel-air mixture and provide for a better operating balance during warm-up of the engine. The converse will occur when the index plate is adjusted to the lean side, as shown in Figs. 13 and 14. Here the piston 44 is drawn outwardly in the cylinder, increasing the amount of pull-off or choke valve opening, and the tension in the thermostatic spring 31 has been decreased by counter-clockwise movement of its end 37, as seen in Fig. 14.

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Figs. 8 through 10 illustrate a modified form of the invention in which the automatic choke control heretofore shown and described is provided with a branch passage 63 leading from the air inlet passage 52 into the hot chamber 43 in the thermostat housing 41, and a metering orifice 64 leading from the hot air chamber 43 into the suction motor housing 44.

In this form of the invention, cooling air is circulated through the hot chamber 43 in controlled quantities responsive to suction in the intake manifold and movement of the piston 47 into the cylinder, as illustrated schematically in Fig. 10. The circulation of controlled quantities of cool air through the hot chamber 43 serves to control the choke valve opening movement of the thermostat. By varying the volume of circulating air, the time required to fully open the choke valve may be varied. This form of the invention is otherwise similar to the form heretofore shown and described.

Figs. 15 and 16 illustrate the embodiment of the invention in which the choke valve is controlled by an independently adjustable thermostatic spring and suction motor. A choke shaft 80 is rotatably mounted in the wall of an air horn 81. A thermostatic spring 82 has an outer end 83 formed with a hook engaging a lever 84 fixed to the choke shaft 80. The inner end 85 of the spring 82 is held in a slot in boss 87, the boss being secured to or formed integrally with a cover 88. The cover 88 has a circular rim 89 engaging a similar circular rim 89a on the carburetor body. The cover 88 is clamped to the carburetor body by plates 90 secured to the carburetor body by bolts 91.

The cover 90 may be rotated with respect to the carburetor body, rotation in a clockwise direction, as viewed in Fig. 15, decreasing the effective tension in spring 82, and counterclockwise motion increasing the tension in the spring. An index mark 94 is provided in the peripheral edge of the rim 89, as seen in Fig. 16, and a plurality of index marks 95 on the face of rim 89a indicate the position of the inner end 85 of the spring 82 and, therefore, the richness of the fuel-air mixture during warm-up of the engine. A substantially air tight chamber is formed within the cover 88, and a port 97 connects with a passageway 98 in a protrusion 99. The end of the protrusion is threaded to receive a connector for a tube leading to an appropriately heated portion of the engine, such as the exhaust manifold. Hot gases pass through the passage 98 into the thermostatic spring chamber and may be withdrawn through a passage 100 opening into a cylinder 101 of a suction motor 102. The opening 100 joins a passageway system leading to the induction system of the carburetor and engine, as described in conjunction with the other embodiments. As the thermostatic spring 82 becomes heated, it expands, releasing the tension against lever 84, permitting the choke valve to open progressively.

The suction motor 102 includes the previously mentioned cylinder 101 and the passageway system from the induction system opening into the cylinder through port 100. A piston 103 is slidably mounted in the cylinder 100 and is adjustably secured to the choke shaft 80 by a lever 104 adjustably secured to the choke shaft by a set screw 105, and by a link 106 inter-connecting the lever 104 and the piston 103. An index mark 110 is provided on the end of the choke shaft 80, and cooperating index marks 111 are provided on the end of the boss of lever 104 to indicate the position of the piston 103 in the cylinder 100. Grooves 112 are provided in the cylinder wall so that as the piston is drawn into the cylinder and reduced portion 113 of the piston passes the grooves, the hot gases in the thermostatic spring chamber will be permitted to escape through the port 100. The grooves limit the penetration of the piston 103 into the cylinder 100 immediately upon starting.

The operation of the embodiment illustrated in Figs. 15 and 16 is as follows: With the engine cold, a maxi-

mum pull is exerted by spring 82 against lever 84 holding the choke in its normally closed position. Immediately upon starting the engine, suction in the induction system is applied through port 100 in cylinder 101 drawing the piston 103 into the cylinder until the reduced portion 113 is adjacent the upper ends of grooves 112. Drawing the suction piston into the cylinder opens the choke valve a small amount, permitting adequate air to be drawn into the induction system for the initial warm-up operation of the engine. As the engine warms up, warm air is drawn through passage 98 into the thermostatic spring chamber and out through port 100 in the cylinder 101. As the warm gases heat the spring 82, tension in the spring is reduced through expansion of the spring, and the lever 84 is permitted to move in a clockwise direction, permitting the choke valve to open additionally. The choke valve is preferably of the unbalanced type, and the rush of air past the valve causes it to open.

In adjusting the operation of this embodiment, the cover 88 is removed by removing screws 91 and plates 90, whereupon set screw 105 is loosened, and the lever 104 is rotated on the choke shaft 80 to the index mark providing the proper spacing between the reduced portion 113 on the piston 103 and the upper ends of grooves 112, thereby controlling the initial pull-off of the choke valve upon starting of the engine. The set screw 105 is then tightened, and the cover 88 is properly positioned on the rim 89a of the carburetor body, making certain that spring 82 is properly positioned. With the plates 90 and bolts 91 lightly in place, the cover is rotated until the desired index mark 95 coincides with the index mark 94 on the cover body. Screws 91 are then securely tightened, and the adjustment has been completed.

It is, therefore, possible to adjust the suction responsive device or suction motor independently of the temperature responsive device or thermostatic spring 82, to permit a man in the field to properly adjust the choke valve for optimum performance, both during initial starting operation and during subsequent warm-up operation of the engine. It is no longer necessary to rely on the initial calibration of a carburetor and to attempt to compensate for variations in individual engines or operating conditions by establishing in the field an in-between setting for the thermostatic spring.

The embodiment of Figs. 15 and 16, which illustrate the adjustable suction motor may be applied to the other embodiments, as in Figs. 7 and 10, by providing a lever which is adjustable on shaft 35, in lieu of fixed lever 49. Similarly, the features illustrated in the embodiments of Figs. 7 and 10 may be incorporated into the embodiment of Figs. 15 and 16.

Although this invention has been described with particular reference to certain embodiments, features, and particular structural arrangements, various changes will be apparent to one skilled in the art, and the invention is therefore not to be limited to such features, embodiments, or structural arrangements except as set forth in the appended claims.

We claim:

1. In an automatic fuel mixing control, a carburetor choke valve, a housing to be heated during warm-up of an engine and defining a chamber, temperature responsive means in said chamber for urging said valve towards closed position for cold starting, and means to circulate cool air through said chamber responsive to operation of the engine.

2. In an automatic fuel mixing control, an unbalanced carburetor choke valve, a housing to be heated during warm-up of an engine and defining a chamber, temperature responsive means in said chamber, a control shaft operatively connected to said choke valve and to said temperature responsive means, said control shaft being journaled in said housing for rotation by said means to yieldingly urge said choke valve towards closed position for cold starting, suction responsive means to rotate said

valve toward its open position against the resistive force exerted by said first means, and means controlled by said suction responsive means to circulate cool air through said chamber.

3. In an automatic fuel mixing control for an internal combustion engine, an unbalanced carburetor choke valve, a housing to be heated during warm-up of the engine and defining a chamber, temperature responsive means in said chamber, a control shaft operatively connected to said choke valve and to said temperature responsive means, said control shaft being journaled in said housing for rotation by said means to yieldingly urge said choke valve towards closed position for cold starting, and means providing a controlled circulation of cool air through said chamber during operation of the engine.

4. In an automatic fuel mixing control for an internal combustion engine, a carburetor choke valve, a housing to be heated during warm-up of the engine and defining a chamber, temperature responsive means in said chamber, a control shaft journaled in said housing for rotation by said means to close said choke valve, and means including a passage having a restricted orifice to provide a controlled circulation of cool air through said chamber during operation of the engine.

5. In an automatic control for a carburetor choke valve, a housing defining a chamber, temperature responsive means in said chamber, and a control shaft journaled in said housing for rotation by said means to close said choke valve, said temperature responsive means being enclosed in a casing journaled on said shaft and anchored to said housing.

6. In an automatic control for an engine having a fuel system including an unbalanced carburetor choke valve, the combination comprising a housing to be heated during warm-up of said engine and defining an air chamber, temperature responsive means in said chamber, a control shaft operatively connected with said choke valve, said control shaft being journaled in said housing for rotation by said means to urge said choke valve towards closed position for cold starting, and means responsive to engine suction when said engine is operating to provide a controlled circulation of cool air through said chamber, and to stop said circulation of air to provide a substantially dead air mass in said chamber when said engine is stopped, to retard cooling of said temperature responsive means and closing of said choke valve.

7. In an automatic control for an unbalanced carburetor choke valve, a housing to be heated during warm-up of an engine and defining a dead air chamber, temperature responsive means in said chamber, a control shaft journaled in said housing and operatively connected to said choke valve for rotation by said means to close said choke valve for cold starting, and suction responsive means to rotate said valve toward its open position against the resistive force exerted by said first means, said housing forming part of an engine manifold.

8. In conjunction with an engine manifold, an automatic control for a carburetor choke valve, a housing to be heated during warm-up of an engine and defining an air chamber, temperature responsive means in said chamber, a control shaft operatively connected to said choke valve, said control shaft being journaled in said housing for rotation by said means to urge said choke valve toward closed position for cold starting, suction responsive means to rotate said valve toward its open position against the resistive force exerted by said first means, said housing forming part of an engine manifold, and means providing a controlled circulation of cool air through said housing and casing.

9. In conjunction with an engine exhaust manifold, an automatic control for an unbalanced carburetor choke valve, a housing to be heated during warm-up of an engine and defining an air chamber, temperature responsive means in said chamber, a control shaft operatively connected to said choke valve and to said temperature

responsive means, said control shaft being journaled in said housing for rotation by said means to urge said choke valve towards closed position for cold starting, suction responsive means to rotate said valve toward its open position against the resistive force exerted by said first means, said housing forming part of an engine exhaust manifold, and means including said suction means providing a controlled circulation of cool air through said housing and casing.

10. In an automatic control for a carburetor choke valve, a housing to be heated during warm-up of an engine and defining an air chamber, temperature responsive means in said chamber, a control shaft journaled in said housing and connected to said means for rotation therewith to close said choke valve, suction responsive means to rotate said valve toward a partially open position against the resistive force exerted by said first means and to permit cool air to pass through said chamber, and means to adjust said suction responsive means to vary the amount of partial opening of said valve.

11. In an automatic control for a carburetor choke valve, a housing defining a chamber, temperature responsive means in said chamber, a control shaft journaled in said housing for rotation by said means to close said choke valve, suction responsive means to rotate said valve during starting toward a partially open position against the resistive force exerted by said first means, and means to adjust said suction responsive means to vary the amount of partial opening of said choke valve.

12. In an automatic control for a carburetor choke valve, a housing defining a chamber, temperature responsive means in said chamber, a control shaft journaled in said housing for rotation by said means to close said choke valve, suction responsive means to rotate said valve during starting of said engine toward a partially open position against the resistive force exerted by said first means, and means associated with the temperature and suction means to vary the amount of partial opening of said choke valve.

13. In an automatic control for an engine having a fuel system including a carburetor choke valve, the combination comprising a housing to be heated during warm-up of said engine and defining an air chamber, temperature responsive means in said chamber, a control shaft journaled in said housing for rotation by said means to close said choke valve, suction responsive means to maintain said valve in an open position against the resistive force exerted by said first means, and means responsive to said suction responsive means to permit cooling air to circulate through said chamber.

14. In an automatic control for a carburetor choke valve, a housing to be heated during warm-up of an engine and defining an air chamber, temperature responsive means in said chamber, a control shaft journaled in said housing for rotation by said means to close said choke valve, suction responsive means to rotate said valve toward its open position against the resistive force exerted by said first means, said temperature responsive means being enclosed in a casing journaled on said shaft and anchored to said housing, and said temperature responsive means comprising a spiral bimetallic spring.

15. In an automatic control for a carburetor choke valve, a housing to be heated during warm-up of an engine and defining an air chamber, temperature responsive means in said chamber, a control shaft journaled in said housing for rotation by said means to close said choke valve, said temperature responsive means being enclosed in a casing journaled on said shaft and anchored to said housing, said temperature responsive means comprising a spiral bimetallic spring, and said casing having a lug engaging said housing and a boss engaging the outer end of said spring.

16. In an automatic control, a carburetor choke valve for an engine having a manifold, a housing on said mani-

fold to be heated during warm-up of the engine and defining a chamber, temperature responsive means in said chamber, said temperature responsive means being enclosed in a casing and operatively connected to said valve and anchored to said housing, said casing comprising two telescopically engaged cup-shaped sections, said temperature responsive means comprising a spiral bimetallic spring, one casing section having a lug engaging said housing, the other section having a boss engaging the outer end of said spring, and means to secure said sections to each other.

17. In an automatic control, a carburetor choke valve for an internal combustion engine having an exhaust manifold, a housing provided on the manifold and defining a hot chamber, temperature responsive means in said chamber and connected with said choke valve to urge the same towards closed position for cold starting, and means to circulate cool air through said chamber during operation of the engine.

18. In an automatic control, a carburetor choke valve for an internal combustion engine having an exhaust manifold, a housing provided on the manifold and defining a hot chamber, temperature responsive means in said chamber and connected with said choke valve to urge the same towards closed position for cold starting, and means to circulate cool air through said chamber during operation of the engine to retard circulation of air through said chamber when said engine is stopped.

19. In a carburetor for an internal combustion engine, a mixing conduit, choke and throttle valves in said conduit, a housing heated by the engine and defining a hot chamber, temperature responsive means in said chamber operatively connected to said choke valve to urge the same towards closed position for cold starting, and means to cool said chamber, the last said means comprising an air inlet passage leading from said conduit anterior to said choke valve to said chamber, and an air outlet passage leading from said chamber to said conduit posterior to said throttle valve.

20. In an internal combustion engine, an induction conduit, a choke valve therein, an automatic choke control including means to close said choke valve for cold starting of the engine, a suction motor having a chamber communicating with said conduit, said chamber including a wall and a movable portion, an atmospheric bleed means in said wall, said movable portion including means to open and close said bleed means, connection means between said movable portion and said choke valve for opening said choke valve responsive to suction in said induction conduit when the engine starts to run under its own power, said connection means including adjustable means to permit varying the relationship of said bleed means and said movable portion and the resultant position of said choke valve during the warm-up period and to permit said movable portion to substantially restrict said bleed means when said choke valve is opened for exposing said chamber to atmosphere, whereby the effect of induction conduit suction on said choke valve is reduced.

21. In an internal combustion engine, an induction conduit, a choke valve therein, an automatic choke control including means to close said choke valve for cold starting of the engine, a suction motor having a chamber communicating with said conduit and a wall with a movable portion, an atmospheric bleed means in said wall and controlled by said movable portion, and an operative connection between said movable portion and said choke valve for opening said choke valve responsive to suction in said induction conduit when the engine starts to run under its own power, said movable portion substantially restricting said bleed means when said choke valve is closed and clearing said bleed means as said choke valve is opened for exposing said chamber to atmosphere and, thereby, reducing the effect of induction conduit suction on said choke valve, said operative connection being adjustable for varying the relationship of

said bleed means and said movable portion and, therefore, the positioning of said choke valve during the warm-up period.

22. In an internal combustion engine, an induction conduit, a choke valve therein, an automatic choke control including means to close said choke valve for cold starting of the engine, a suction motor having a chamber communicating with said conduit and a wall with a movable portion, an atmospheric bleed port in said wall and controlled by said movable portion, and an operative connection between said movable portion and said choke valve for opening said choke valve responsive to suction in said induction conduit when the engine starts to run under its own power, said movable portion substantially restricting said port when said choke valve is closed and clearing said port as said choke valve is opened for exposing said chamber to atmosphere and, thereby, reducing the effect of induction conduit suction on said choke valve, said operative connection being adjustable for varying the relationship of said port and said movable portion and, therefore, the positioning of said choke valve during the warm-up period.

23. In an internal combustion engine, an induction conduit, a choke valve therein, an automatic choke control including a thermostat for normally urging said choke valve closed for cold starting, means to heat said thermostat substantially in proportion to the engine temperature, a suction motor having a chamber communicating with said conduit and a piston working in said chamber, an atmospheric bleed means in a wall of said suction motor and controlled by said piston, and an operative connection between said piston and said choke valve for opening said choke valve against the force of said thermostat responsive to suction in said induction conduit when the engine starts to run under its own power, said piston substantially restricting said bleed means when said choke valve is closed and clearing said bleed means as said choke valve is opened for exposing said chamber to atmosphere and, thereby, reducing the opening effect on said choke valve of said suction piston, and means operatively interconnecting said thermostat, said suction piston, and said choke valve, and including an adjusting element for simultaneously varying the force of said thermostat and the relative positions of said piston and said bleed means and, thereby, the positioning of said choke valve during the warm-up period.

24. In an internal combustion engine, an induction conduit, a choke valve therein, an automatic choke control including a thermostat normally urging said choke valve toward closed position for cold starting, means to heat said thermostat substantially in proportion to the engine temperature, a suction motor having a chamber communicating with said conduit and a piston working in said chamber, an atmospheric bleed port in a wall of said suction motor and controlled by said piston, and an operative connection between said piston and said choke valve for opening said choke valve against the force of said thermostat responsive to suction in said induction conduit when the engine starts to run under its own power, said piston substantially restricting said port when said choke valve is closed and clearing said port as said choke valve is opened for exposing said chamber to atmosphere and, thereby, reducing the opening effect on said choke valve of said suction piston, and means operatively interconnecting said thermostat, said suction piston, and said choke valve and including an adjusting element for simultaneously varying the tension of said thermostat and the relative positions of said piston and said port and, thereby, the positioning of said choke valve during the warm-up period.

25. In an engine, a carburetor having an induction conduit forming part of an induction system for supplying a fuel-air mixture to said engine, an adjustable choke valve in said induction conduit, an automatic control for said choke valve, said control comprising a housing fixed with respect to said carburetor and forming a unit assembly

therewith, said housing adapted to be heated during warm-up of said engine, temperature responsive control means in said housing urging said choke valve closed during warm-up of said engine, a control shaft journaled in said housing for rotation by said means to open and close said choke valve, and suction responsive means to rotate said choke valve toward its open position against the resistive force exerted by said temperature responsive control means, said housing forming part of an engine manifold and defining therewith a chamber containing said temperature responsive control means.

26. In an engine, a carburetor body having an induction conduit, an adjustable choke valve in said induction conduit, a housing containing a temperature responsive spring connected with said choke valve for urging said choke valve closed during warm-up of said engine, said housing and said carburetor body forming a unit assembly, means to secure said unit assembly to a manifold system of said engine wherein said induction conduit discharges into an intake manifold and said housing forms part of an exhaust manifold.

27. In an engine, a carburetor body having an induction conduit, an adjustable choke valve in said induction conduit, a housing containing a temperature responsive spring, means connecting said spring and said choke valve whereby said spring normally urges said choke valve closed during warm-up of said engine, means responsive to engine suction to urge said choke valve open against the force of said temperature responsive means upon starting said engine, said housing and said carburetor body forming a unit assembly, means to secure said unit assembly to a manifold system of said engine wherein said induction conduit discharges into an intake manifold and said housing forms part of an exhaust manifold.

28. In a carburetor for use on an internal combustion engine, an induction conduit, a choke shaft rotatably mounted in said induction conduit and an unbalanced choke valve secured to said shaft, means normally tending to close said choke valve for cold starting, suction responsive means for rotating said choke valve toward its open position against the resistive force of said first means, said suction responsive means including a movable member having a limited movement and responsive

to suction in said induction conduit upon starting of the engine, means interconnecting said movable member and said choke shaft to partially open said choke valve upon starting, and means to adjust the amount of said limited motion of said movable member to control the amount of partial opening of said choke valve.

29. In an automatic control for a carburetor choke valve, a thermostatic spring normally urging said choke valve closed for cold starting, said thermostatic spring being responsive to engine temperature during warm-up to permit said choke valve to open progressively as the temperature of said engine increases, means to adjust the rate of said opening of said choke valve, a suction motor responsive to suction in an induction system of said carburetor, means interconnecting said suction motor and said choke valve to partially open said choke valve when said engine is started against the force of said thermostatic spring, said suction motor having a movable member actuating the last said means, means to limit the movement of said movable member upon starting of said engine, and means to adjust the amount of such limited movement of said movable member independently of the adjustment of said temperature responsive spring.

30. In an automatic fuel mixing control, an unbalanced carburetor choke valve, a housing to be heated during warm-up of an engine and defining a chamber, adjustable temperature responsive means in said chamber, a control shaft operatively connected to said choke valve and to said temperature responsive means, said control shaft being journaled in said housing for rotation by said temperature responsive means to yieldingly urge said choke valve towards closed position for cold starting, suction responsive means to rotate said valve toward its open position against the resistive force exerted by said first means, means for adjusting the suction responsive means independent of the adjustment of the temperature responsive means, and means controlled by said suction responsive means to circulate cool air through said chamber.

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