Dec. 22, 1959 F. W. HAMILTON 2,918,266

MULTIPLE STAGE CHOKE CONTROL

Filed Feb. 5, 1958 2 Sheets-Sheet 1

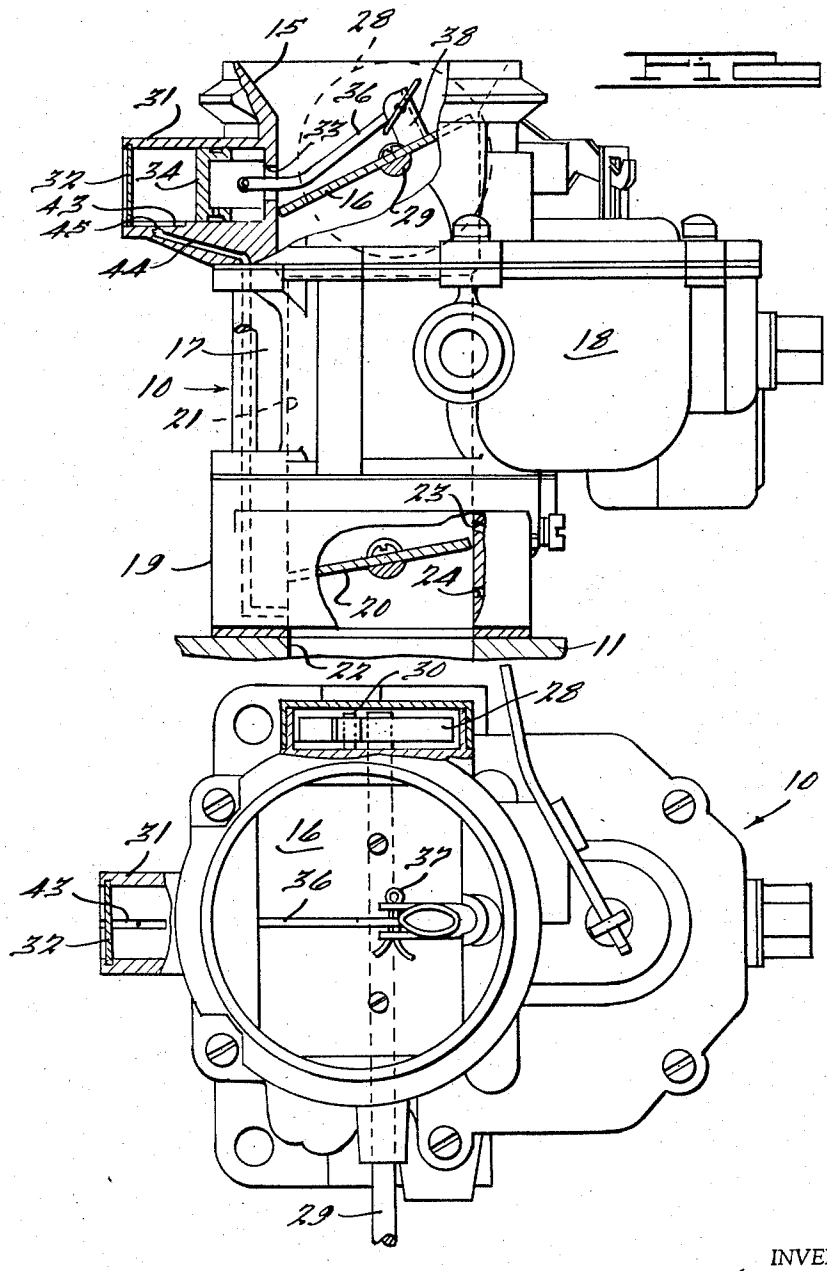


FIG. 1.

FIG. 2.

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FIG. 3.

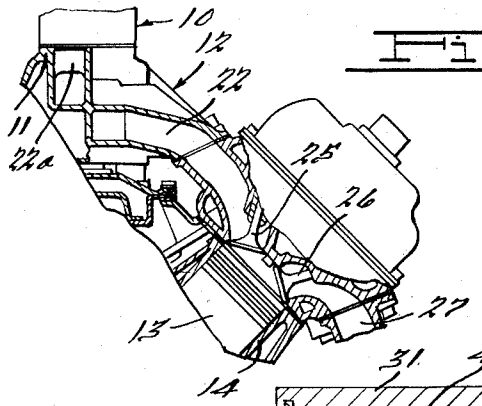
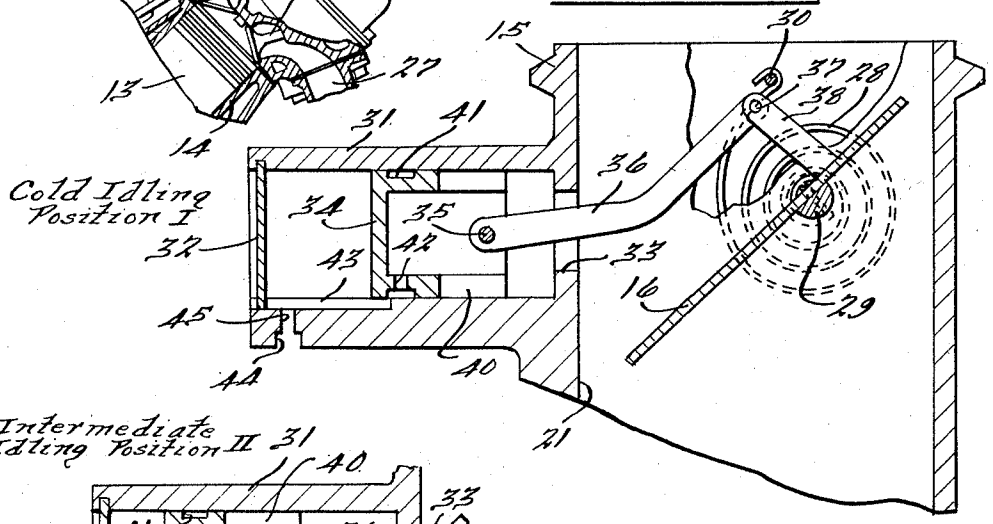


FIG. 4.



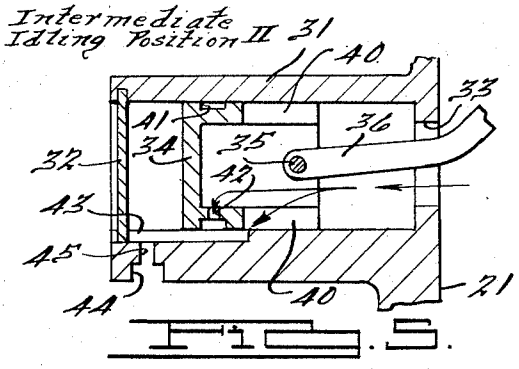


FIG. 5.

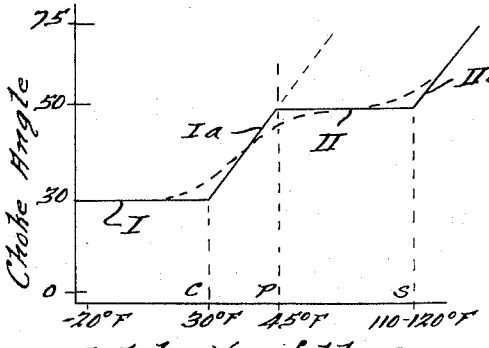


FIG. 7.

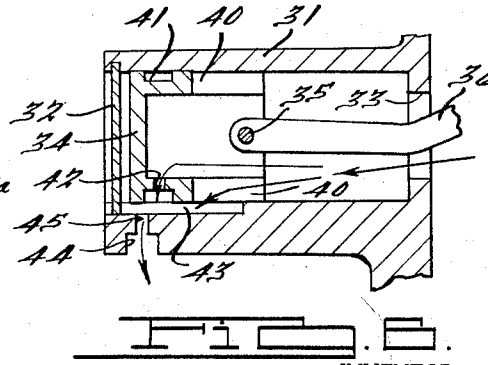


FIG. 6.

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2,918,266

MULTIPLE STAGE CHOKE CONTROL

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Application February 5, 1958, Serial No. 713,353

10 Claims. (Cl. 261—39)

This invention relates to improvements in automatic means for adjusting the positions of the choke valve for the carburetor of an internal combustion engine at low engine loads and temperatures.

It has been customary heretofore to modulate engine carburetion by means of a bimetallic thermostat coupled with the carburetor choke valve so as to control the latter's position at light loads in response to engine temperature. The thermostat is usually arranged to maintain the choke valve partially closed when the engine is at a predetermined comparatively cold temperature. Without some mechanism to the contrary, the thermostat control alone results in too rich a mixture during the usual stages of engine warmup at idling or low load conditions and too lean a mixture as the engine approaches its operating temperature. It has accordingly been customary to employ a vacuum actuated piston coupled with the choke blade to partially open the latter against the tension of the thermostat so as to achieve a more flexbile choke control. In such structures the side wall of the cylinder within which the vacuum actuated piston reciprocates is provided with a port connected with the low pressure portion of the gas intake passage or manifold. The sidewall of the piston is provided with a bypass or vent port adapted to register with the cylinder port when the piston and coupled choke valve move to a predetermined intermediate warmup position. The registering side wall ports are effective to vent or at least partially vent the low pressure end of the piston to atmosphere and thereby to reduce the vacuum induced force exerted on the piston. In consequence, the piston remains at the intermediate position until the engine temperature rises sufficiently to relax the tension in the thermostatic control, whereupon the remaining vacuum induced force continues to urge opening movement of the choke valve until the engine attains its desired operating temperature.

Although the choke control devices known to the art heretofore are marked improvements over the thermostatic control alone, such structures are still subject to objection. In order to obtain a suitable lean fuel-air mixture as the engine approaches intermediate stages of warmup, the fuel-air ratio at cold idling conditions is far too lean, with consequent poor engine operation. On the other hand, when the conventional control devices of the type described above are adjusted to obtain the fuel-air mixture enrichment required at cold idling temperatures, the fuel-air mixture at intermediate warmup temperatures will be far too rich, with consequent loss of economy.

It has been found that at cold engine temperatures of approximately 30° F. or lower, a comparative constant high fuel-air ratio is required for optimum engine efficiency. At approximately 30° F., the engine operating characteristics change sharply, so that a progressive decrease in the fuel-air ratio is desired for optimum fuel economy as the engine temperature rises above 30° F. to the desired operating temperature.

It is accordingly an important object of the present invention to provide an improved device for controlling a carburetor choke valve, thereby to modulate the fuel-air ratio at idling or low engine loads so as to obtain an idle fuel enrichment at comparatively cold temperatures which closely approximate optimum engine requirements and yet obtains optimum fuel economy at intermediate conditions of engine warmup.

Another object is to provide such a device which is comparatively simple and inexpensive in construction, highly efficient in operation, and capable of rendering comparatively standardized carburetor idling characteristics when produced by mass production methods.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Figure 1 is substantially a fragmentary side elevational view showing portions of a choke control device embodying the present invention.

Figure 2 is substantially a fragmentary plan view of the structure of Figure 1.

Figure 3 is a fragmentary transverse sectional view of an internal combustion engine employing the present invention.

Figure 4 is a fragmentary enlarged sectional view showing the vacuum actuated choke control piston at the cold starting position.

Figure 5 is a view similar to Figure 4, showing the vacuum actuated piston at an intermediate stage of engine warmup.

Figure 6 is a view similar to Figure 5, showing the position of the vacuum actuated piston when the engine temperature is proximate its desired operatng temperature.

Figure 7 is a diagrammatic representation of the choke blade angle with respect to intake manifold temperature.

It is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring to the drawings, a carburetor **10** is illustrated in Figure 1 mounted on the customary inlet riser **11** of a piston-type internal combustion engine **12** having a number of driving pistons **13** reciprocable in corresponding engne cylinders **14**. The carburetor **10** comprises an air horn casting **15** which contains the customary unbalanced pivotal choke blade or valve **16**, an intermediate body casting **17** which includes the fuel bowl **18**, and a lower throttle body casting **19** containing the customary throttle valve **20**. An intake air passage **21** extends vertically within the carburetor from an upper air filter, not shown, through the air horn **15**, the intermediate casting **17**, and throttle body **19** and communicates at its lower end with the intake passage **22** in the riser **11** to which the carburetor **10** is suitably secured. Upper and lower idle fuel supply ports **23** and **24** respectively open into the throttle body portion of passage **21** to supply fuel for engine idle or low load operation.

Intake passage **22** extends to the engine cylinder **14** to supply the latter with a combustible air-fuel mixture as determined by engine requirements in accordance with operation of the inlet and exhaust valves **25** and **26** respectively. The passage **22** is one of several branch passages including passage **22***a* of the engine intake manifold, which lead to the various engine cylinders **14**. Accordingly the intake manifold temperature, which in turn is responsive to engine temperature, is a measure of the temperature of the combustible fuel-air mixture conducted

to the engine. The combustion products are exhausted via exhaust manifold 27. The structure thus far may be conventional and is accordingly not described in further detail.

Referring to Figure 1, when the engine is cold and is not operating, choke valve 16 is normally maintained in a closed position by a coiled bimetallic thermostatic spring 28, Figure 4, secured at opposite ends to shaft 29 of choke valve 16 and to a fixed portion 30 of the air horn 15. The thermostatic spring 28 is responsive to changes in the temperature of the intake passage or manifold 21—22 and progressively relaxes its tension urging valve 16 to the closed position as the intake manifold temperature rises. Spring 28 is illustrated somewhat schematically in the drawings, inasmuch as other preferred couplings between the spring 28 and valve 15 and other preferred locations of the spring 28 to render the same most responsive to intake manifold temperature are well known to the art.

In order to supplement operation of the thermostatic spring 28 in modulating the position of the choke valve when the engine is idling or operating at light loads, a cylinder 31 is provided as an integral casting with the air horn 15. The left hand or outer end of cylinder 31 is closed by a plate 32, whereas the inner or right end opens through a vent opening 33 into the air horn portion of inlet passage 21 at a location above or upstream of the choke valve 16 when the latter is closed, Figure 1. A hollow piston 34 closed at its left end and opening at its right end into the vent portion of cylinder 31 is pivotally secured by a transverse pin 35 to the outer and lower end of a dog leg lever 36. The upper end of lever 36 is pivotally connected by a pin 37 to the upper end of a shorter arm 38 which extends perpendicularly to the choke blade 16 and is secured to the smaller or upper extension thereof adjacent the shaft 29. The length of the arm 38 is approximately one-half the distance between the pivots 35 and 37 so as to afford adequate leverage for rocking valve 16 as described below. Also as is apparent from Figure 2, the axes of cylinder 31, lever 36, and arm 38 are on the transverse vertical mid-plane through valve 16 so as to achieve a symmetrical arrangement of the linkage connecting piston 34 and valve 16 and to minimize the possibility of jamming or cocking of the linkage or piston 34. This latter feature is important in order to minimize friction in a structure of the type shown because the forces operating on the valve 16 are small.

Extending longitudinally within the inner or vent end of piston 34 for slightly more than half of its axial length are diametrically opposed vent slots 40. An annular port 41 extends circumferentially in the outer side wall of the piston 34 adjacent the latter's outer closed end and is connected with the interior of the piston 34 and thence via cylinder 31 with the vent opening 33 by means of a restricted radial bleed duct 42. By virtue of the annular port 41, the restricted bleed duct 42 may be formed at any circumferential location within the piston 34. Likewise by reason of the diametrically opposed slots 40, the piston can be installed upside down from the position shown, facilitating both manufacture and installation of the assembly.

Extending longitudinally within the inner side wall of the outer end of cylinder 31 is a recess 43 in communication with a conduit 44 which extends through the body of the carburetor and opens into the inlet passage 21 at a location in the throttle body 19 below or downstream of the throttle valve 20 when the latter is closed, Figure 1. Within the side wall of the cylinder 31, the upper end of conduit 44 is restricted at 45, whereby a controlled low pressure is induced within the leftward or outer end of cylinder 31 when the engine 12 is operating at an idling or low load condition. The piston 34 is dimensioned to substantially fill the cross sectional area of cylinder 31, except in the region of the recess 43, so as to partition cylinder 31 into an inner high pressure vent portion, which is substantially at atmospheric pressure, and an outer low pressure portion.

Operation of the structure shown is described in reference to Figure 7. At low temperatures when the engine is not operating, thermostatic spring 28 is tensioned to maintain choke valve 16 in the closed position of Figure 1. During operation of the engine at idling or low load conditions, a comparatively low pressure is developed in the portions of the intake passage 21—22 downstream of the throttle valve 20, which low pressure is transmitted via conduit 44 and restriction 45 to the low pressure end of cylinder 31. Restrictions 42 and 45 are dimensioned with respect to the cross sectional area of cylinder 31 and the tension of spring 28 so as to pull piston 34 immediately to the position shown in Figure 4 when the intake manifold temperature is between approximately 30° F. and minus 20° F., thereby to open choke valve 16 to a cold idling position which assures a high constant idle fuel enrichment.

The desired position of angular adjustment of choke valve 16 at the cold idling position is substantially independent of temperature changes below 30° F., but depends upon the operating characteristics of the carburetor and engine. Thus the cold idling position of the choke valve blade may range from approximately 15° to 30° of arc, depending upon the engine and carburetor design. For any given carburetor and engine design, the preferred cold idling position remains substantially constant at normally encountered temperatures below approximately 30° F. It is therefore important to dimension restrictions 42 and 45 so that when piston 34 shifts to the cold idling position of Figure 4, sufficient air will be vented via openings 33, 42, 41, and 43 into the outer low pressure end of cylinder 31 to prevent further leftward movement of piston 34 until the engine temperature warms to approximately 30° F. This first stage of operation of piston 34 is indicated at I, Figure 4, whereat port 41 is in communication with recess 43. Thus during idling of the engine at all normally encountered temperatures below approximately 30° F. down to approximately minus 20° F., choke valve 16 will be shifted to the cold idling position I, which in the present instance is indicated at 30° of arc.

It is well known that at intake manifold temperatures above approximately 30° F. a sharp change takes place in the engine idling characteristics and the required minimum fuel-air ratio for idling or low load operation progressively decreases with increasing temperature. Accordingly the temperature-tension response of spring 28 is determined with respect to restrictions 42 and 45 and the cross sectional area of piston 34, so that when the intake manifold temperature progressively rises above 30° F. to a primary intermediate temperature P, the tension of thermostatic spring 28 will gradually relax and enable progressive leftward movement of the vacuum actuated piston 34 to the intermediate idling position II of Figure 5. At position II, the leading edge of slot 40 registers with recess 43 to increase the vent action and substantially decrease the vacuum force urging piston 34 to the left, whereupon further leftward movement of piston 34 stops until the intake manifold temperature rises to a secondary intermediate temperature S.

During the stage of the operation between positions I and II, the choke angle gradually increases along line Ia as the intake manifold temperature rises from the cold idling temperature C of approximately 30° F. to the primary intermediate idling temperature P of approximately 45° F., whereat slot 40 and recess 43 are in communication. Above the secondary intermediate idling temperature S of approximately 110 to 120° F., piston 34 gradually moves leftward and the angle of the choke opening rises along line IIa as tension in thermostatic spring 28 relaxes upon increasing inlet manifold temperature.

As piston 34 shifts leftward from the position II of Figure 5 to adjacent the fully open position Figure 6, the maximum vent action through slot 40 and recess 43 is

obtained and the vacuum force urging piston **34** leftward rapidly diminishes, as does also the tension in thermostatic spring **28**. The choke valve **16** then progressively moves to its fully open position primarily in accordance with the forces resulting from downwardly flowing air striking the unbalanced choke blade and the uncoiling of thermostatic spring **28** until the engine attains its operating temperature.

In order to achieve standardized operation of the vacuum actuated choke control mechanism when the latter is produced by mass production methods, the juxtaposed leading edges of recess **43** and port **41** are formed parallel to each other, and in the present instance extend in parallel planes transverse to the axis of cylinder **31**. This construction assures positive registration between port **41** and recess **43** when piston **34** moves to a predetermined cold idling position and enables comparatively consistent standardized operation of the choke with a minimum of expense for manufacture, installation, and adjustment. The same situation prevails in regard to the leading edge of slot **40**.

It is also to be noted that the straight line elements I, I*a*, II, and II*a* of Figure 7 are shown to facilitate description and understanding of the basic principle of operation. Actually a limited amount of leakage and progressive porting takes place as the leading edge of either port **41** or slot **40** approaches and moves into recess **43**. Accordingly, instead of sharp angular intersections between the several line elements I, I*a*, II, and II*a*, the actual relationship between the choke angle and the intake manifold temperature follows the dotted wavy path shown. The latter smooths out excesses and deficiencies indicated at the intersections of the straight lines I, I*a*, II, and II*a* and results in a curve that corresponds more closely to the relationship actually desired.

I claim:

1. In a device for regulating the choke valve position for the carburetor of an internal combustion engine at conditions of low engine load and temperature, the combination of a gas intake passage connecting said carburetor with said engine, a cylinder, a piston reciprocable in said cylinder, means connecting said piston and choke valve for progressively opening the latter upon movement of said piston in one direction, vent means, an air bleed duct in communication with said vent means and having a port in the side wall of said piston, conduit means connecting said cylinder with a low pressure region of said passage, said conduit means opening at the side wall of said cylinder at locations in communication with said port when said piston is in a range of positions extending from a cold idling position to an intermediate idling position located beyond said cold idling position in said one direction, and second conduit means provided at least in part by said piston, said second conduit means connecting the first-named conduit means and said vent means when said piston is in another range of positions extending from said intermediate idling position in said one direction, said piston substantially blocking communication between said first-named conduit means and said vent means when said piston is anterior to said cold idling position, said first-named conduit means also opening into said cylinder in advance of said piston in said one direction at all positions of said piston anterior to said intermediate idling position, thereby to urge said piston in said one direction to said cold idling and intermediate idling positions with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means, and said piston substantially blocking communication between said first-named and second conduit means when said piston is anterior to said intermediate idling position.

2. In a device for regulating the choke valve position for the carburetor of an internal combustion engine at conditions of low engine load and temperature, the combination of a gas intake passage connecting said carburetor with said engine, temperature responsive means responsive to the temperature of said intake passage for yieldingly regulating the position of said choke valve, a cylinder, a piston reciprocable in said cylinder, means connecting said piston and choke valve for progressively opening the latter upon movement of said piston in one direction, vent means, an air bleed duct in communication with said vent means and having a port in the side wall of said piston, conduit means connecting said cylinder with a low pressure region of said passage, said conduit means opening at the side wall of said cylinder at locations in communication with said port when said piston is in a range of positions extending from a cold idling position to an intermediate idling position located beyond said cold idling position in said one direction, and second conduit means provided at least in part by said piston, said second conduit means connecting the first-named conduit means and said vent means when said piston is in another range of positions extending from said intermediate idling position in said one direction, said piston substantially blocking communication between said first-named conduit means and said vent means when said piston is anterior to said cold idling position, said first-named conduit means also opening into said cylinder in advance of said piston in said one direction at all positions of said piston anterior to said intermediate idling position, thereby to urge said piston in said one direction to said cold idling and intermediate idling positions with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means, and said piston substantially blocking communication between said first-named and second conduit means when said piston is anterior to said intermediate idling position.

3. In a device for regulating the choke valve position for the carburetor of an internal combustion engine at conditions of low engine load and temperature, the combination of a gas intake passage connecting said carburetor with said engine, temperature responsive means responsive to the temperature of said intake passage for yieldingly regulating the position of said choke valve, a cylinder, a piston reciprocable in said cylinder, means connecting said piston and choke valve for progressively opening the latter upon movement of said piston in one direction, vent means, an air bleed duct in communication with said vent means and having a port in the side wall of said piston, conduit means connecting said cylinder with a low pressure region of said passage, said conduit means opening at the side wall of said cylinder at locations in communication with said port when said piston is in a range of positions extending from a cold idling position to an intermediate idling position located beyond said cold idling position in said one direction, and second conduit means provided at least in part by said piston, said second conduit means connecting the first-named conduit means and said vent means when said piston is in another range of positions extending from said intermediate idling position in said one direction, said piston substantially blocking communication between said first-named conduit means and said vent means when said piston is anterior to said cold idling position, said first-named conduit means also opening into said cylinder in advance of said piston in said one direction at all positions of said piston anterior to said intermediate idling position, thereby to urge said piston in said one direction to said cold idling and intermediate idling positions with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means, and said piston substantially block-

ing communication between said first-named and second conduit means when said piston is anterior to said intermediate idling position, said first-named conduit means, bleed duct, and piston being dimensioned in accordance with said temperature responsive means to hold said piston at said cold idling position in opposition to the position regulating force of said temperature responsive means during idling of said engine when said intake passage is at temperatures below a predetermined cold idling temperature and to hold said piston at said intermediate idling position in opposition to the regulating force of said temperature responsive means when said engine is idling and said intake passage is at temperatures between a predetermined intermediate temperature and a predetermined higher intermediate temperature below the normal operating temperature of said engine.

4. In a device for regulating the choke valve position for the carburetor of an internal combustion engine at conditions of low engine load and temperature, the combination of a gas intake passage connecting said carburetor with said engine, a throttle valve in said passage, temperature responsive means responsive to the temperature of said intake passage for yieldingly regulating the position of said choke valve, a cylinder having one end in communication with said passage upstream of said throttle valve, a piston reciprocable in said cylinder, means connecting said piston and choke valve for progressively opening the latter upon movement of said piston in one direction away from said one end, an air bleed duct in communication with said one end and having a port in the side wall of said piston, conduit means connecting said cylinder with said passage downstream of said throttle valve, said conduit means opening at the side wall of said cylinder at locations in communication with said port when said piston is in a range of positions extending from a cold idling position to an intermediate idling position located beyond said cold idling position in said one direction, and second conduit means provided at least in part by said piston, said second conduit means connecting the first-named conduit means and said one end when said piston is in another range of positions extending from said intermediate idling position in said one direction, said piston substantially blocking communication between said first-named conduit means and said one end when said piston is anterior to said cold idling position, said first-named conduit means also opening into said cylinder in advance of said piston in said one direction at all positions of said piston anterior to said intermediate idling position, thereby to urge said piston in said one direction to said cold idling and intermediate idling positions with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means, and said piston substantially blocking communication between said first-named and second conduit means when said piston is anterior to said intermediate idling position.

5. In a device for regulating the choke valve position for the carburetor of an internal combustion engine at conditions of low engine load and temperature, the combination of a gas intake passage connecting said carburetor with said engine, temperature responsive means responsive to the temperature of said intake passage for yieldingly regulating the position of said choke valve, a cylinder, a piston reciprocable in said cylinder, means connecting said piston and choke valve for progressively opening the latter upon movement of said piston in one direction, vent means, a restricted air bleed duct in communication with said vent means and having a port in the side wall of said piston, restricted conduit means connecting said cylinder with a low pressure region of said passage, said conduit means opening at the side wall of said cylinder at locations in communication with said port when said piston is in a range of positions extending from a cold idling position to an intermediate idling position located beyond said cold idling position in said one direction, and second conduit means provided at least in part by said piston, said second conduit means connecting the first-named conduit means and said vent means when said piston is in another range of positions extending from said intermediate idling position in said one direction, said piston substantially blocking communication between said first-named conduit means and said vent means when said piston is anterior to said cold idling position, said first-named conduit means also opening into said cylinder in advance of said piston in said one direction at all positions of said piston anterior to said intermediate idling position, thereby to urge said piston in said one direction to said cold idling and intermediate idling positions with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means, and said piston substantially blocking communication between said first-named and second conduit means when said piston is anterior to said intermediate idling position.

6. In a device for regulating the choke valve position for the carburetor of an internal combustion engine at conditions of low engine load and temperature, the combination of a gas intake passage connecting said carburetor with said engine, a throttle valve in said passage, temperature responsive means responsive to the temperature of said intake passage for yieldingly regulating the position of said choke valve, a cylinder having one end in communication with said passage upstream of said throttle valve, a piston reciprocable in said cylinder, means connecting said piston and choke valve for progressively opening the latter upon movement of said piston in one direction away from said one end, a restricted air bleed duct in communication with said one end and having a port in the side wall of said piston, restricted conduit means connecting said cylinder with said passage downstream of said throttle valve, said conduit means opening at the side wall of said cylinder at locations in communication with said port when said piston is in a range of positions extending from a cold idling position to an intermediate idling position located beyond said cold idling position in said one direction, and second conduit means provided at least in part by said piston, said second conduit means connecting the first-named conduit means and said one end when said piston is in another range of positions extending from said intermediate idling position in said one direction, said piston substantially blocking communication between said first-named conduit means and said one end when said piston is anterior to said cold idling position, said first-named conduit means also opening into said cylinder in advance of said piston in said one direction at all positions of said piston anterior to said intermediate idling position, thereby to urge said piston in said one direction to said cold idling and intermediate idling positions with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means, and said piston substantially blocking communication between said first-named and second conduit means when said piston is anterior to said intermediate idling position.

7. In a device for regulating the choke valve position for the carburetor of an internal combustion engine at conditions of low engine load and temperature, the combination of a gas intake passage connecting said carburetor with said engine, a cylinder, a piston reciprocable in said cylinder, means connecting said piston and choke valve for progressively opening the latter upon movement of said piston in one direction, vent means, an air bleed duct in communication with said vent means and having a transverse port extending circumferentially in

the side wall of said piston, conduit means connecting said cylinder with a low pressure region of said passage, said conduit means including a recess extending longitudinally of said cylinder in the side wall thereof and being in communication with said port when said piston is in a range of positions extending from a cold idling position to an intermediate idling position located beyond said cold idling position in said one direction, the proximate leading edges of said recess and port being parallel to each other to effect an abrupt communication between said recess and port upon movement of said piston in said one direction to said cold idling position, and second conduit means provided at least in part by said piston, said second conduit means connecting the first-named conduit means and said vent means when said piston is in another range of positions extending from said intermediate idling position in said one direction, said piston having portions blocking communication between said first-named conduit means and said vent means when said piston is anterior to said cold idling position and having portions blocking communication between said first-named conduit means and vent means via said second conduit means when said piston is anterior to said intermediate idling position, said first-named conduit means also opening into said cylinder in advance of said piston in said one direction at all positions of said piston anterior to said intermediate idling position, thereby to urge said piston in said one direction to said cold idling and intermediate idling positions with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means.

8. In a device for regulating the choke valve position for the carburetor of an internal combustion engine at conditions of low engine load and temperature, the combination of a gas intake passage connecting said carburetor with said engine, a throttle valve in said passage, temperature responsive means responsive to the temperature of said intake passage for yieldingly regulating the position of said choke valve, a cylinder having one end in communication with said passage upstream of said throttle valve, a piston reciprocable in said cylinder, means connecting said piston and choke valve for progressively opening the latter upon movement of said piston in one direction away from said one end, a restricted air bleed duct in communication with said one end, said duct having a groove extending circumferentially in the side wall of said piston and a port extending into said piston from said groove and connecting said groove with a portion of said duct in communication with said one end, restricted conduit means connecting said cylinder with said passage downstream of said throttle valve, said conduit means including a recess extending longitudinally of said cylinder in the side wall thereof and being in communication with said port when said piston is in a range of positions extending from a cold idling position to an intermediate idling position located beyond said cold idling position in said one direction, the proximate leading edges of said recess and port being parallel to each other to effect an abrupt communication between said recess and port upon movement of said piston in said one direction to said cold idling position, and second conduit means provided at least in part by said piston, said second conduit means connecting the first-named conduit means and said vent means when said piston is in another range of positions extending from said intermediate idling position in said one direction, said piston having portions blocking communication between said first-named conduit means and said vent means when said piston is anterior to said cold idling position and having portions blocking communication between said first-named conduit means and vent means via said second conduit means when said piston is anterior to said intermediate idling position, said first-named conduit means also opening into said cylinder in advance of said piston in said one direction at all positions of said piston anterior to said intermediate idling position, thereby to urge said piston in said one direction to said cold idling and intermediate idling positions with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means.

9. In a device for regulating the choke valve position for the carburetor of an internal combustion engine at conditions of low engine load and temperature, the combination of a gas intake passage connecting said carburetor with said engine, temperature responsive means responsive to the temperature of said intake passage for yieldingly regulating the position of said choke valve, a cylinder, a piston reciprocable in said cylinder, means connecting said piston and choke valve for progressively opening the latter upon movement of said piston in one direction, vent means, an air bleed duct in communication with said vent means and having a portion between the side walls of said piston and cylinder, conduit means connecting said cylinder with a low pressure region of said passage, said conduit means opening at the side wall of said cylinder at locations in communication with said air bleed duct when said piston is in a range of positions extending from a cold idling position to an intermediate idling position located beyond said cold idling position in said one direction, and second conduit means provided at least in part by said piston, said second conduit means connecting the first-named conduit means and said vent means when said piston is in another range of positions extending from said intermediate idling position in said one direction, said first-named conduit means also opening into said cylinder in advance of said piston in said one direction at all positions of said piston anterior to said intermediate idling position, thereby to urge said piston in said one direction to said cold idling and intermediate idling positions with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means, and said piston substantially blocking communication between said first-named and second conduit means when said piston is anterior to said intermediate idling position.

10. In a device for regulating the choke valve position for the carburetor of an internal combustion engine at conditions of low engine load and temperature, the combination of a gas intake passage connecting said carburetor with said engine, temperature responsive means responsive to the temperature of said intake passage for yieldingly regulating the position of said choke valve, a cylinder, a piston reciprocable in said cylinder, means connecting said piston and choke valve for progressively opening the latter upon movement of said piston in one direction, vent means, a restricted air bleed duct in communication with said vent means and having a portion between the side walls of said piston and cylinder, restricted conduit means connecting said cylinder with a low pressure region of said passage, said conduit means opening at the side wall of said cylinder at locations in communication with said air bleed duct when said piston is in a range of positions extending from a cold idling position to an intermediate idling position located beyond said cold idling position in said one direction, and second conduit means provided at least in part by said piston, said second conduit means connecting the first-named conduit means and said vent means when said piston is in another range of positions extending from said intermediate idling position in said one direction, said first-named conduit means also opening into said cylinder in advance of said piston in said one direction at all positions of said piston anterior to said intermediate idling position, thereby to urge said piston in said one direction to said cold idling and intermediate idling positions with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means.

with forces determined by the extent of communication between said first-named conduit means and said vent means via said air bleed duct and said second conduit means, and said piston substantially blocking communication between said first-named and second conduit means when said piston is anterior to said intermediate idling position.

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