Dec. 16, 1958 L. C. DERMOND 2,864,596

CARBURETOR

Filed Aug. 3, 1954 3 Sheets-Sheet 1

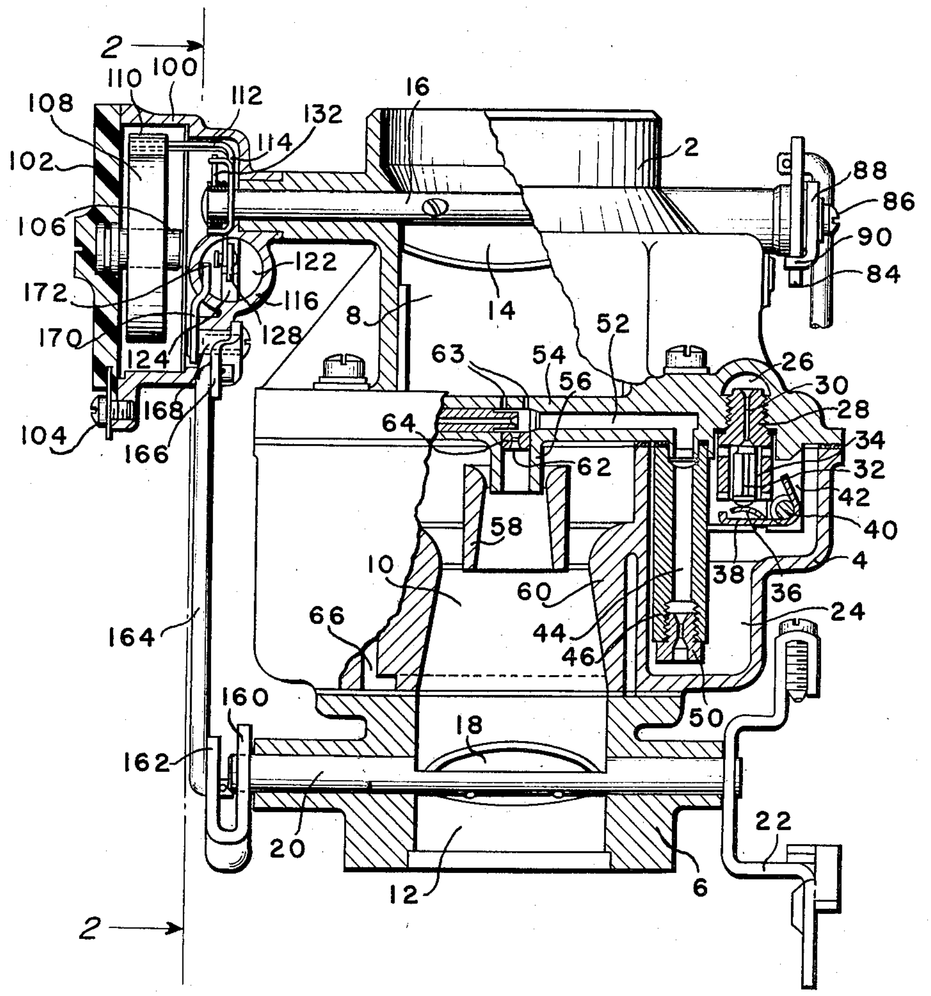

Fig. 1

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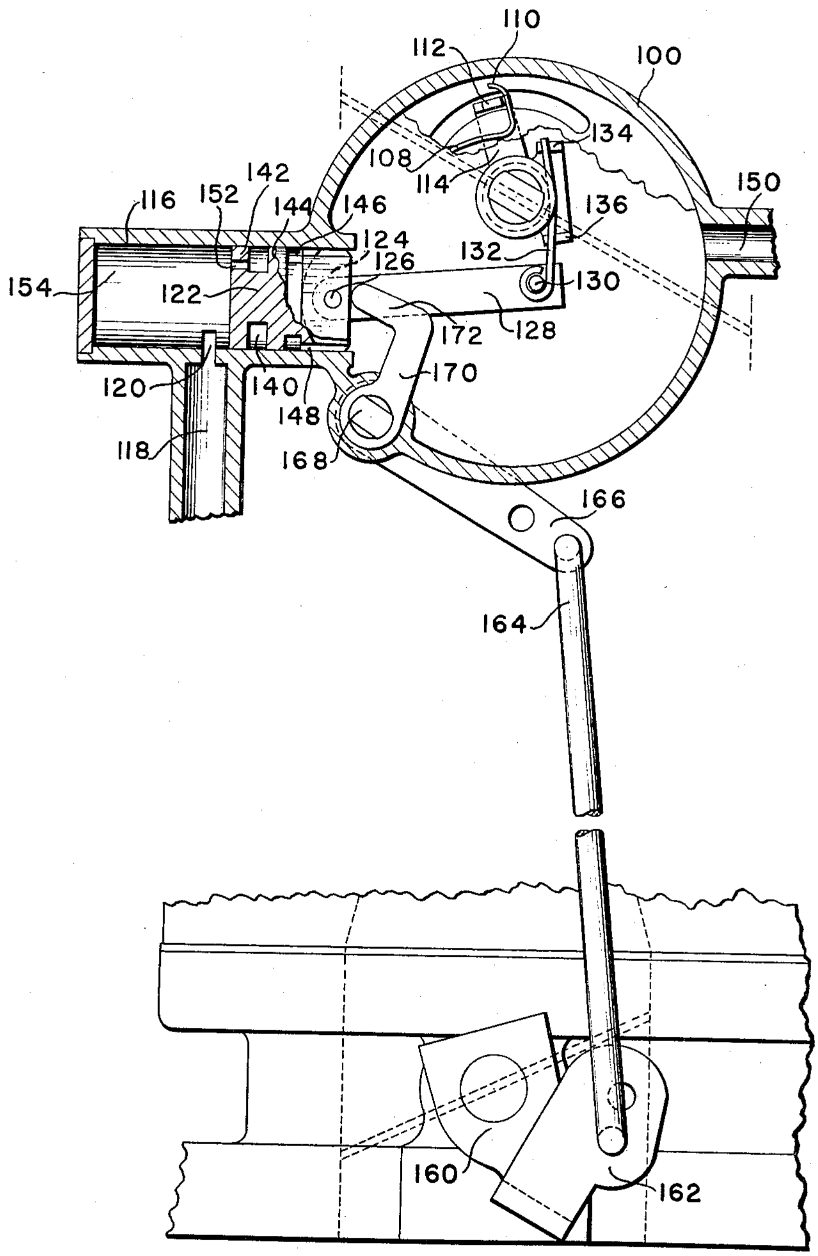

Fig. 2

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3 Sheets-Sheet 3

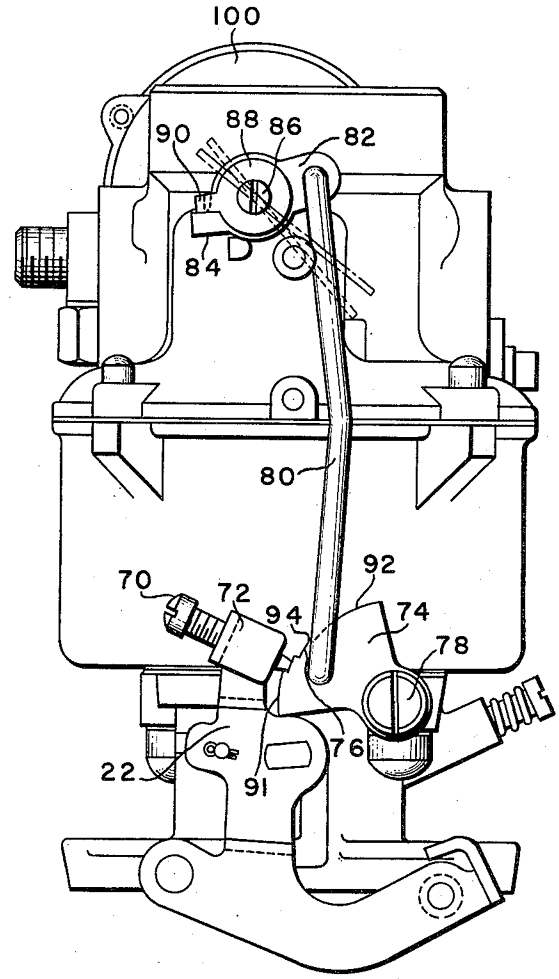

Fig. 3

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CARBURETOR

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Application August 3, 1954, Serial No. 447,495

3 Claims. (Cl. 261—39)

This invention relates to carburetors for internal combustion engines, primarily for automotive use, and more particularly to carburetors provided with an automatic choke mechanism, operable in response to variations in temperature and engine suction, to variably control the proportions of fuel and air in the combustible mixture in order to provide a mixture of proper proportions for all conditions of operation, most particularly for starting and operation during the warm-up period, before the engine reaches its normal operating temperature.

Most carburetors which are in use on automotive vehicles now produced are provided with an automatic choke mechanism of the character referred to and such devices are very much alike both in principle of operation and construction. The conventional automatic choke mechanism includes an unbalanced choke valve positioned in the carburetor air intake which is subject to the pressure differential across the valve. This pressure differential is created by the flow of air into the carburetor and exerts a force tending to open the valve when the engine is in operation. A thermostat is provided which exerts a force urging the choke valve toward closed position at low temperatures, the force varying inversely with the temperature. In addition, the conventional choke mechanism includes a piston connected to the choke valve and subject to the suction of the engine intake posterior to the throttle valve and this suction exerts a force tending to open the choke valve, and this force increases as the suction increases.

The forces exerted by suction are opposed to that exerted by the thermostat and the position which the choke valve assumes during operation at less than normal operating temperature is that where the opposed forces acting on the valve will be in balance. After normal operating temperature is reached, the thermostat exerts no closing force on the valve which will be moved to wide open position by the force of suction and will stay in such position as long as the engine continues to operate at its normal temperature.

Also, in most conventional carburetors of the present day, mechanism is provided to automatically control the idling speed of the engine in such a way that the idling speed varies inversely as the temperature, this being done primarily for the purpose of preventing stalling at low temperatures. This mechanism generally includes a stepped cam which is moved by the choke valve as the latter closes. This cam controls the idling position of the throttle and is so arranged that a low temperatures the throttle is held open to a greater degree for idling than it is for idling at high temperatures, and the degree of opening of the throttle for idling is progressively decreased by movement of the stepped cam until the minimum idle opening is reached when normal engine temperature is reached.

When the engine first starts to run under its own power at low temperatures, the closed position of the throttle and the idling speed is controlled by the high step of the control cam, but if the throttle is opened for acceleration and is then allowed to move toward its closed position, the choke valve does not move all the way back to the position it occupied before its opening movement, which was effected by opening of the throttle, due to hysteresis of the system. Similarly, if the temperature increases, the choke is moved somewhat toward open position and the fast idle cam may move to a position where the high step of the cam no longer controls the throttle and the latter can occupy a more nearly closed position than when the engine first started.

It has been found that in some installations, where a conventional automatic choke device of the type described is employed, it has not been wholly successful in providing a mixture of exactly the correct ratio under all conditions. For example, if the mixture is right when the engine first starts to run under its own power, the mixture might become too rich under the conditions above referred to and this would result in somewhat unsatisfactory engine operation, under these conditions. This specific difficulty might be corrected by enlarging the piston so that the force exerted thereby would be increased for any position of the throttle, but if this were done, the mixture provided under the first-named condition, i. e. operation when the engine first becomes self-operative and the throttle position is controlled by the first step of the fast idle cam, would be too lean because the choke would be too far open.

It is, therefore, the primary object of the present invention to provide novel means for variably controlling the application of engine suction to the suction operated piston of the automatic choke mechanism in such a way that the force exerted by said piston can be variably regulated as the piston and the valve operated thereby move to different positions and in this way obtain the proper positioning of the choke valve to produce a mixture of the proportions required to effect most satisfactory engine operation under all operating conditions and with the throttle in any position in its operating range.

A further object of the invention is the provision of a yielding operating connection between the suction operated piston and the choke valve.

A further object of the invention is the provision of mechanism through the medium of which movements of the throttle can effect movements of the piston and thus modify the position of the choke valve in accordance with throttle position.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Figure 1 is a view mainly in vertical section of a carburetor embodying the present invention;

Figure 2 is a broken view including a section on line 2—2 of Figure 1 on a somewhat enlarged scale and showing certain parts in elevation; and

Figure 3 is a side elevation of the carburetor seen from the right in Figure 1.

Since the invention to which this application relates is concerned primarily with an automatic choke mechanism which controls automatically the admission of air to the carburetor, the structural details of other features of the carburetor are not material and form no part of the invention.

The carburetor comprises three castings, an air inlet casting **2**, a casting **4** immediately below the casting **2**, in which the fuel chamber is formed and which is supported on the mixture outlet or throttle body casting **6**. The casting **6** is adapted to be secured to intake manifold of the engine in the usual way and suitable gaskets are provided between the several castings to prevent leakage and to minimize the transfer of heat by conduction.

An air inlet passage **8** is formed in casting **2** and communicates with a mixing chamber **10** formed in casting **4**, such chamber discharging into a mixture outlet passage **12** formed in the casting **6**. Admission of air through the passage **8** is controlled by a choke valve **14** secured to a shaft **16**, suitably journalled in the walls of the casting **2** and the valve is positioned off-center with respect to said shaft so that it is unbalanced and responsive to engine suction which creates a pressure differential across the valve. The operation of this valve is automatically controlled in response to variations in temperature and suction by mechanism which will be later described. The combustible mixture which is formed in the chamber **10** flows through the mixture outlet **12** into the intake manifold and the quantity of mixture supplied to the manifold is controlled by a throttle valve **18** secured to a shaft **20** suitably journalled for rotation in the wall of casting **6** and operable manually by an arm **22** secured to one end of the shaft and operated by the usual operating connection extending to the foot-operated accelerator pedal.

Fuel is supplied to a constant level fuel chamber **24** formed in the casting **4** by a conduit, which is not shown, and which delivers fuel to a chamber **26** formed in the casting **2**. A nipple **28** is screwed into the casting and has a passage **30** formed therein through which fuel flows into the chamber **24**, and this passage is controlled by a valve **32**, received in a chamber **34** formed in the nipple and in which the valve is vertically movable. The lower end of the valve is engaged by a tongue **36** punched out of a plate **38** pivoted on a pin **40** supported in downwardly extending lugs **42** integral with the casting **2** and a float (not shown) is connected to the plate **38**, so that the valve **32** is operable by the float to cut off the flow of fuel through passage **30** when the fuel reaches a predetermined level, in the conventional manner.

Fuel is conveyed from the chamber **24** to the fuel inlets which supply fuel to the mixture passage through a passage **44** formed in a tubular member **46** which is secured to the casting **2** in any suitable way and extends downwardly into the chamber **24** so that it is surrounded by fuel on all sides and is not in metallic contact with the casting **4** at all. This construction is provided to substantially prevent the formation of fuel vapor in the passage **44** and minimize or substantially eliminate the difficulties occasioned by "percolation," this construction being substantially the same as that fully shown and described in the copending application of Elmer Olson, S. N. 109,347, filed August 9, 1949, now Pat. No. 2,694,560, issued November 16, 1954.

Flow of fuel from the chamber **24** into passage **44** is controlled by a metering plug **50** which is screwed into the lower end of the tubular member **46** and at its upper end the passage **44** connects with a horizontal fuel passage **52** formed in a substantially tubular bridge member **54** which is a part of casting **2** and extends across the mixture passage, as indicated in Fig. 1. The passage **52** supplies fuel to the main nozzle **56** which terminates at the throat of a small venturi tube **58**, and this in turn discharges into a large venturi tube **60** formed by the wall of the mixing chamber **10**. Flow of fuel into the nozzle is controlled by a restricted passage **62**, somewhat like a venturi tube in shape and formed in a member **64** fitted within the nozzle **56**. Air is admitted to the passage **52** immediately above the main nozzle through orifices **63**, forming an emulsion of fuel air and aiding in atomization of the fuel. As already stated, the passage **52** extends entirely across the mixture passage and at its left end connects with a vertical passage **66** which leads to the idling fuel inlet, not shown. The arrangement of fuel supply passages forms no part of this invention and is substantially the same as the arrangement disclosed in the above-mentioned application of Olson.

As shown best in Fig. 3, the throttle operating arm **22** supports a stop screw **70** which has threaded engagement with an offset portion **72** of the arm **22** and is adjustable to determine the closed or idling position of the throttle. The stop screw cooperates with a stepped cam **74** having a series of steps **76** at different distances from the axis of the cam to variably determine the idling position of the throttle in accordance with the position of the cam. The cam is pivotally mounted on a pin **78** screwed into the carburetor housing and the cam is rotated on such pin by closing movement of the choke valve to different positions.

In order to effect this movement of the fast idle cam, an operating link **80** is pivotally connected at one end to the cam and at the other end is pivotally mounted on the choke valve shaft **16** and has an offset portion **84** which extends toward the end of the shaft, as indicated in Fig. 1. Secured to the shaft **16** adjacent its end by a screw **86** is an arm **88** having a projecting lug **90** which engages the upper side of the offset **84**, as shown in Fig. 3.

Obviously, as the choke valve moves toward closed position, the lug **90** pushes downwardly on the offset **84** and rotates the cam **74** in a clockwise direction, if the cam is free to move, so as to bring the highest portion, **91**, of such cam into engagement with the stop screw **70**. It will be understood that after a period of use, when the engine stops and is at normal operating temperature, the choke valve is wide open and the cam **74** has moved counter-clockwise, due to gravity, to a position where the lowest part of the cam surface, designated **92**, is in position to be engaged by the stop screw **70**. When the accelerator pedal is released by the operator, the throttle return spring will move the stop screw **70** into engagement with the surface **92**. The choke can then move toward its closed position only until the shoulder or step **94** at the end of surface **92** engages the screw **70**. Therefore, after the engine has been in operation and it is desired to start again, the throttle has to be moved partly toward open position to disengage the screw **70** from the shoulder **94**, in order to permit the choke valve to close and bring the high part of cam **74** into position to be engaged by the screw **70**.

The fast idle cam is moved by the choke valve only upon closing movements of the latter, which can open fully without any movement of the cam. The cam is moved toward normal idle position only by gravity and will not move, even if the choke is moved to fully open position by the thermostat, unless the throttle is moved enough to disengage the stop screw **70** from the cam. If this is done, the cam will be moved by gravity to whatever position is determined by the position of the choke valve.

As already indicated, the choke is positioned automatically in response to variations in temperature and engine suction and the mechanism for controlling the operation of the choke will now be described. A housing **100** is secured in any desirable way on an extension of the casting **2** in which the choke valve shaft **16** is journalled. This housing is of generally cylindrical shape and has a cover plate **102** which is usually of suitable plastic material held in position by an attaching screw **104** which is threaded in a lug extending from the housing **100**. A pin **106** is fixed at the center of the cover plate and extends into housing **100**, as shown in Fig. 1. One end of a bi-metallic coiled thermostat **108** is secured to this pin and a hook **110** which is formed at the other end of such thermostat engages a horizontally extending part **112** of an arm **114**, which is secured to the end of the choke valve shaft in any desirable way. Upon a reduction in temperature, the thermostat will move the arm to the left, as seen in Fig. 2, and will rotate the valve **14** in a counter-clockwise direction, as seen in Fig. 2, to its closed position. The thermostat is generally set to close the valve at about 70° F. and the thermostat contracts and builds up a force holding the valve closed, which progressively increases as the temperature falls. By adjustment of plate **102**, the position of one end of the thermostat can be changed to modify its effect and vary the proportions of the mixture during the warm-up period. The construction so far described is that of the conventional automatic choke control.

In the usual conventional automatic choke, a piston which is subject to manifold vacuum, is connected to the arm **114** by a positive linkage but according to the present invention, this mechanism has been modified by the provision of a resilient operating connection between the piston and such arm. As shown, a cylinder **116** is provided which is integral with the housing **100**, and to which the suction or partial vacuum which is maintained posterior to the throttle is communicated through a conduit **118** that connects with the cylinder through a rectangular slot **120** positioned in the side of such cylinder at some distance from the end thereof.

Slidable in the cylinder is a piston **122** which will be more particularly described later. The piston is slotted at one end, as indicated at **124** and pivoted on a pin **126** which extends across such slot is a link **128**, having a pin **130** at its opposite end to which is connected one end of a spring **132** which is coiled around the shaft **16** and the other end of which engages a laterally projecting ear **134** integral with the arm **114** which is secured to the choke shaft. If the piston is moved to the left in response to an increase in the suction effective thereon, the spring exerts a pressure on the ear **134** tending to move the arm **114** clockwise. If this force and the force exerted by the effect of suction directly on the unbalanced choke valve is greater than the force exerted by the thermostat in opposition thereto, the valve will be moved toward open position until the opposing forces effective on the valve are balanced, and the valve will stop in such position.

Upon reduction in temperature, the thermostat pulls the arm **114** toward the left and the piston to the right back toward its normal position, as shown in Fig. 2 through the medium of the spring **132**, and the piston will stop when a second ear **136** on the arm **114** engages the spring, as indicated in Fig. 2.

The piston **122** is so constructed that its movements in response to variations in the suction which is effective thereon are different for a given change in suction when the piston is in different positions in the cylinder in which it slides and in certain positions of the piston, changes in suction will produce substantially no movement of the piston as long as it occupies such positions. To effect these results, the piston has a deep circumferential slot or groove **140** positioned between two lands, **142** and **144**. The land **142** is of sufficient width or thickness to completely block the opening **120** if the piston moves to a position where the land **142** is opposite opening **120**, while the land **144** is not quite of sufficient thickness to entirely block the opening in any position of the piston, this construction being provided for a purpose more fully set forth later.

To the right of the land **144** the piston has a shallower circumferential groove **146** which connects with two axial grooves **148** that, at the opposite ends thereof connect with the slot **124**, so that the groove **146** is always in communication with the slot **124**. With such construction, when the piston is in such a position that the groove **146** is in registry with the opening **120**, the full effect of engine suction is communicated to the interior of the housing **100**. This will cause heated air to be drawn through the housing in considerable quantity, this air being delivered to the housing through an opening **150**, with which a suitable conduit leading to an exhaust stove of conventional form is adapted to be connected. Therefore, when the piston is moved to a position where the groove **146** is in register with opening **120**, the thermostat will be heated much more rapidly than before the piston reaches such position and the choke will be moved much more rapidly toward open position, due to the action of the thermostat, after the valve is opened far enough for the piston to be in the position described than it will during the first part of its opening movement, when any suction communicated to the interior of housing **100** is brought about only as the result of leakage past the piston.

It should be noted that there is a small passage or bleed hole **152** extending through the land **142** and connecting the groove **140** with the space **154** in the cylinder **116** to the left of the piston, as seen in Fig. 2, for a purpose more fully set forth later.

The operation of and effect produced by the above described piston is substantially as follows. In Fig. 1 the parts are shown in the position they occupy when the engine is not operating and the temperature is low enough for the thermostat to hold the choke valve in fully closed position. In this position of the choke valve the piston is held in its extreme right position by the force exerted by the ear **134** on the end of spring **132** and the parts remain in this position during the cranking of the engine, the suction effective on the piston during cranking being insufficient to effect any opening of the choke valve. In such position of the parts the choke valve will hold the fast idle cam **74** in such position that the highest step of the cam is engaged by the stop screw **70**.

When the engine starts to run under its own power, the speed of operation will be considerable, due to the fast idle position of the throttle, probably comparable to the engine speed when the vehicle is operating at a speed of 20 M. P. H. on a level. Under such conditions, the suction communicated to the cylinder **116** tending to pull the piston **122** to the left, as seen in Fig. 2, is quite high while at the same time, the pressure differential across the choke valve tending to open such valve, is considerable. The result is that these forces overcome the force of the thermostat which holds the valve closed so that the piston **122** is moved to the left and the choke valve is partially opened. Under almost all conditions, the piston will be moved to the left far enough for the land **142** to completely block the opening **120** and will stop in such position because of the fact that when the opening **120** is blocked by land **142**, the passage which communicates suction to the left end of the piston is cut off and the pressure differential across the choke valve, with the throttle in its fast idle position, is insufficient to move the choke valve further open. Therefore, the position normally assumed by the piston **122**, as soon as the engine begins to run under its own power with the throttle in fast idle position, is that which has been described with opening **120** fully blocked by land **142**.

If the temperature at the time of starting the engine is very low, the force exerted by the thermostat to hold the valve closed might be so great that the piston might not move quite as far to the left and might not be in position to wholly block the opening **120** when movement of the piston stopped. However, the piston would soon move to such position if the engine continued to run at idle because the engine would begin to heat up and the force of the thermostat would be decreased sufficiently to permit the piston to move to the position referred to soon after the engine started to run. However, for all temperatures ordinarily encountered when the engine is started, the piston will move to a position to block opening **120** substantially immediately after the engine becomes self-operative. It should be understood that the opening of the choke valve and movement of the piston as described will not move the fast idle cam as the element **90** would simply move away from the offset **84**.

If the engine is running with the piston **122** in position to block the opening **120** and the throttle in its fast idle position, as described, and the throttle is opened for purposes of acceleration, the choke valve will be opened considerably further than the position it occupied before the opening of the throttle. The opening of the throttle will increase the pressure differential across the choke valve very materially, while there will be substantially no reduction in the suction effective on the piston due to the blocking of opening 120. If, after such acceleration the throttle is allowed to return to the idle position, the choke valve will not quite return to the position where the opening 120 is blocked, due to hysteresis of the system but will occupy a position where the piston 122 is slightly out of alignment with the opening 122 and suction will be communicated to the groove 140 and through the passage 152 to the end of the piston. The effect of this suction will move the piston to a position where the land 144 will be in registry with the opening 120 and will almost block such opening. The piston will stop in this position and will not be moved further by the effect of suction on the piston due to the fact that the suction effective through the opening 120 as it becomes nearly blocked is insufficient to effect further movement of the piston to the left. Any further movement of the piston to the left, after it reaches a position where the opening 120 is almost blocked by land 144 is due to a reduction in the force of the thermostat which holds the choke valve closed as the temperature progressively increases. As the temperature increases and the closing force is reduced, the choke valve is gradually opened and the piston 122 moved toward the left, primarily by the force exerted by the pressure differential across the choke valve.

After the acceleration which has been described, when the choke valve does not return to the position is occupied before the acceleration, the high step of the cam no longer controls the throttle position but the latter is controlled by the second cam step so that the throttle will be more nearly closed, and this would decrease the effect of the pressure differential across the choke valve which would normally tend to effect closing of the choke. This would be prevented by engagement of the screw 70 with the fast idle cam and the actual movement of the choke valve is toward open position. The increase in suction on the piston 122 which is brought about when the opening 120 communicates with the groove 140 is quite considerable and more than sufficient to offset the decrease in pressure differential across the choke valve, so that the latter is actually moved toward open position, as previously described.

As the closing force of the thermostat is progressively decreased upon increase of temperature, the choke valve is opened far enough to bring the groove 146 into communication with opening 120 and as soon as this takes place heated air is drawn through the thermostat housing much more rapidly than previously, which results in more rapid movement of the valve toward its full open position, as a result of temperature increase, after the valve reaches a predetermined open position, than in the first part of its opening movement, preventing over-richness of the mixture during the latter part of the engine warm-up period.

It should be apparent that the action of the device disclosed and claimed herein is quite different from the conventional automatic choke device in which the full effect of whatever manifold vacuum is maintained is always communicated to the end of the piston which is comparable to piston 122 regardless of what the position of the piston may be. In such a device, when the throttle is opened, the suction communicated to the end of the piston falls, while the pressure differential across the valve increases. Therefore, one offsets the other to some extent and any movement of the valve toward open position which would occur when the throttle is opened, would be less than if the suction on the piston did not decrease. Also, if the choke valve does not return to its original position after an acceleration, so that the throttle position is not determined by the high step of the fast idle cam and the throttle is more nearly closed than it was before the acceleration, the suction effective on the piston is slightly greater than it was prior to the acceleration. However, this is more than offset by the decrease in pressure differential directly effective on the choke valve, so that the choke valve is more nearly closed than it was prior to the acceleration. Because of this fact, the mixture produced is somewhat too rich for most satisfactory operation and some loading will take place.

With the device disclosed in this application, however, as has already been stated, at the time the throttle is moved to effect acceleration, the piston is in a position to cut off the suction passage and there is very little suction effective on the piston. After the acceleration, however, when the suction passage is no longer blocked by the land 142, but is in communication with groove 140, there is a very considerable increase in the suction effective on the piston. This will more than offset the decrease in pressure differential across the choke valve, due to the more nearly closed throttle, and as a result, the choke valve will be opened slightly further than it was before the acceleration took place, so that a mixture of proper proportions will be provided.

Mechanism is provided through the medium of which the throttle may mechanically control the choke valve. To this end, an arm 160 is secured to the throttle shaft 20, opposite to that on which the operating arm 22 is secured. In a laterally offset portion 162 of the arm 160 the end of an operating link 164 is pivotally connected. The other end of this link is pivotally connected to an arm 166 secured to one end of a short shaft 168 rotatably mounted in the choke valve housing. Secured to this shaft inside the housing is an arm 170 which is positioned in alignment with the piston 122 and has an end portion 172 substantially at 90° to the main portion of the arm which will engage the end of piston 122 when the throttle reaches a predetermined position and will move the piston in a direction to effect opening of the choke valve.

Sometimes if the throttle is opened relatively wide from a position where it is open to a relatively slight extent, it has been found that due to the fact that the forces exerted by suction tending to open the choke valve actually decrease or do not increase as rapidly as desirable, the choke valve temporarily occupies a more nearly closed position than it should, with the result that the mixture supplied to the engine is somewhat richer than it should be. In order to prevent this difficulty, the arm 172 will engage the piston 122 and move it to the left, thus mechanically opening the choke valve to some extent as the throttle is opened, the extent of opening being determined by the amount of movement of the arm and its position relative to the piston when the opening of the throttle takes place.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a charge forming device for an internal combustion engine having a constant level fuel supply chamber, an intake passage having fuel and air inlets and a mixture outlet for supplying a combustible mixture to said engine, a throttle valve for controlling the flow of said mixture and a choke valve for controlling the admission of air through said inlet; mechanism for automatically controlling the operation of said choke valve comprising thermally responsive means operable to hold the valve closed at low temperatures, means operable by engine suction and effective to move the valve toward open position when the engine starts to run under its own power, a resilient operating connection separate from and independent of the thermostat between said suction operating means of the choke valve, means for rendering said suction operated means substantially ineffective when the choke valve is opened to the position it normally occupies

when the engine first becomes self-operative, a second means for rendering the suction operated means ineffective when the choke valve is moved a predetermined distance beyond said first position, means for progressively heating the thermostat after the engine becomes self-operative in order to effect movement of said choke valve toward open position when said suction operated means is ineffective, and means for materially increasing the rate at which said thermostat is heated after the choke valve moves toward open position beyond the position it occupies when said second means becomes effective.

2. In a charge forming device for an internal combustion engine having a constant level fuel supply chamber, an intake passage having fuel and air inlets and a mixture outlet for supplying a combustible mixture to said engine, a throttle valve for controlling the flow of said mixture, an unbalanced choke valve operable in response to variations in the intake passage for controlling the admission of air through said inlet; mechanism for automatically controlling the operation of said choke valve comprising a thermostat operable to exert a force tending to hold said valve closed upon a reduction in temperature, a suction operated member connected to said valve and operable to move said valve toward open position upon an increase in suction, a conduit to communicate the engine suction to said member, means on said member for blocking the suction conduit to render the suction operated means ineffective when the choke valve moves to the position it normally occupies when the engine becomes self-operative, a second means on said member operable to substantially block said conduit when the choke valve is moved a predetermined distance beyond said first-mentioned position, a resilient operating connection separate from and independent of the thermostat between said suction operating means of the choke valve, means to progressively heat the thermostat after the engine becomes self-operative so that the valve closing force of the thermostat is progressively reduced whereby the valve can be moved further toward open position by suction effective on the valve when both means for blocking the suction conduit are effective, and means for materially increasing the rate at which the thermostat is heated after the choke valve has moved to a position to render the second conduit blocking means effective to increase the rate at which the valve is moved toward open position after the valve is opened to a predetermined extent.

3. In a charge forming device for an internal combustion engine having a constant level fuel supply chamber, an intake passage having fuel and air inlets and a mixture outlet for supplying a combustible mixture to said engine, a throttle valve for controlling the flow of said mixture, an unbalanced choke valve operable in response to variations in the intake passage for controlling the admission of air through said inlet; mechanism for automatically controlling the operation of said choke valve comprising a thermostat operable to exert a force tending to hold said valve closed upon a reduction in temperature, a suction operated piston connected to said valve and slidable in a cylinder to move the valve toward open position on an increase in the suction effective on said piston, a resilient operating connection separate from and independent of the thermostat between said suction operating means of the choke valve, a suction conduit connected with the side of said cylinder, a plurality of lands on said piston movable successively to a position to substantially block said suction conduit as the choke valve moves toward open position and prevent movement of the valve by said suction operated piston when the valve is opened to two different open positions, a groove between said lands for communicating with the suction conduit when the choke valve is in an intermediate position between the positions occupied when the lands are effective, a passage connecting said groove with the cylinder in which the piston slides, a housing surrounding said thermostat, a conduit for supplying heated air to said housing, a second groove in the piston movable into position to communicate with said suction conduit upon opening of the valve beyond a position where the suction conduit is blocked by either of said lands, and means establishing communication between said second groove and the thermostat housing so that when said second groove is in communication with the suction conduit heated air is drawn rapidly through said housing for heating the thermostat.

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