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G. G. GAST

3,249,345

WARM-UP ENRICHMENT SYSTEM

Original Filed May 7, 1962

3 Sheets-Sheet 1

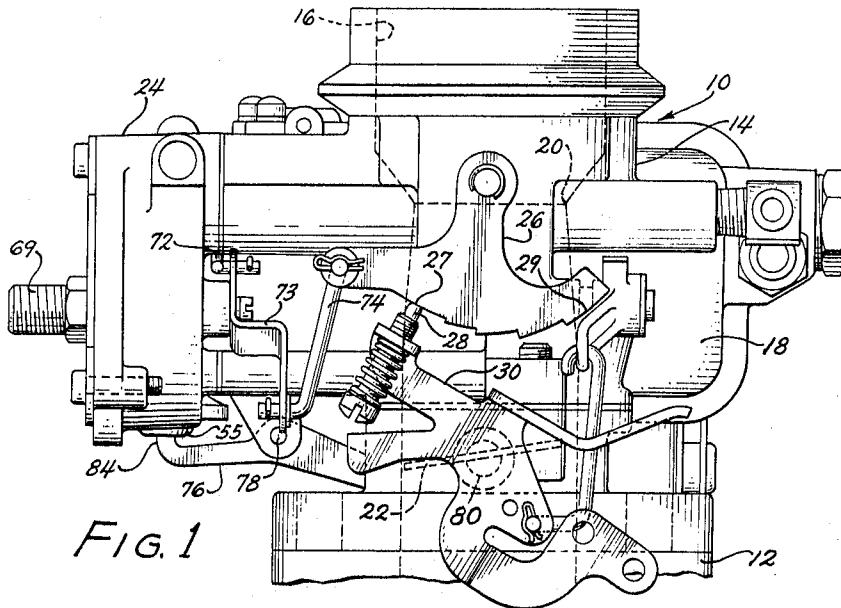


FIG. 1

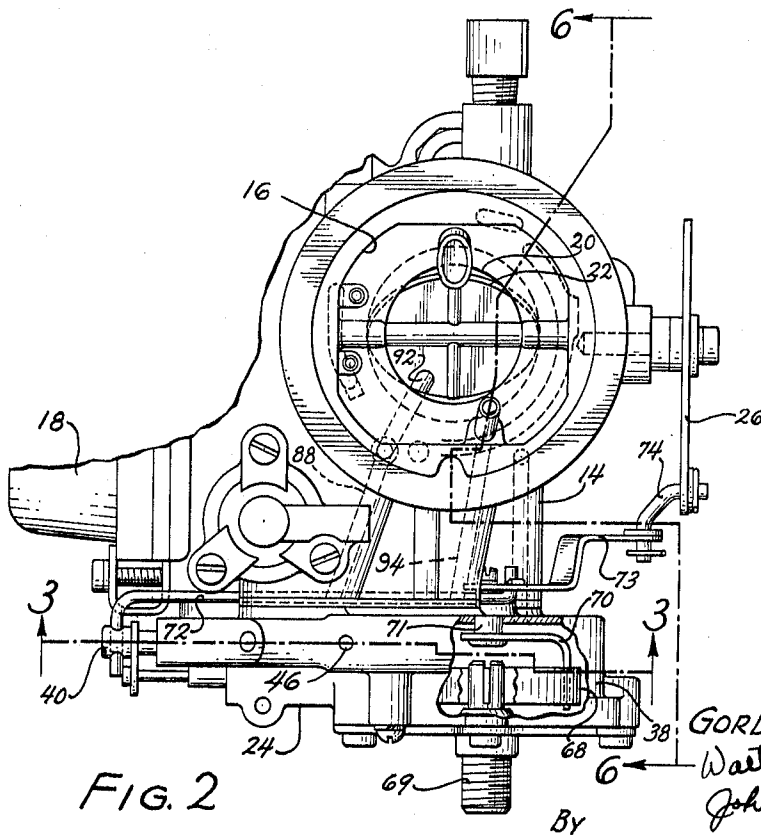


FIG. 2

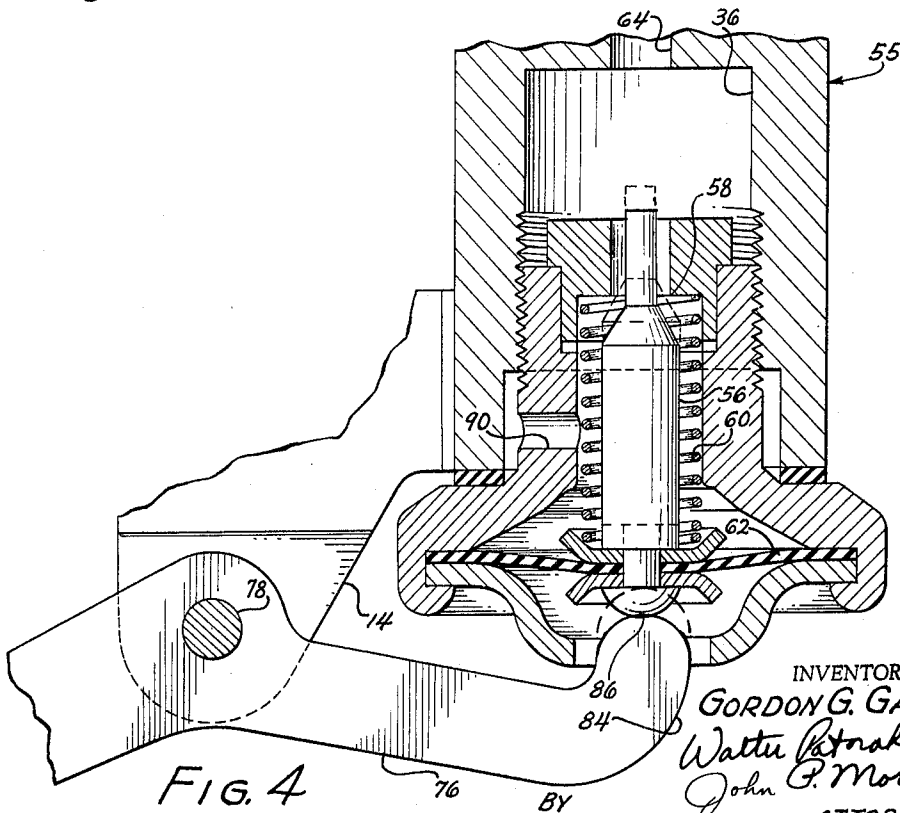
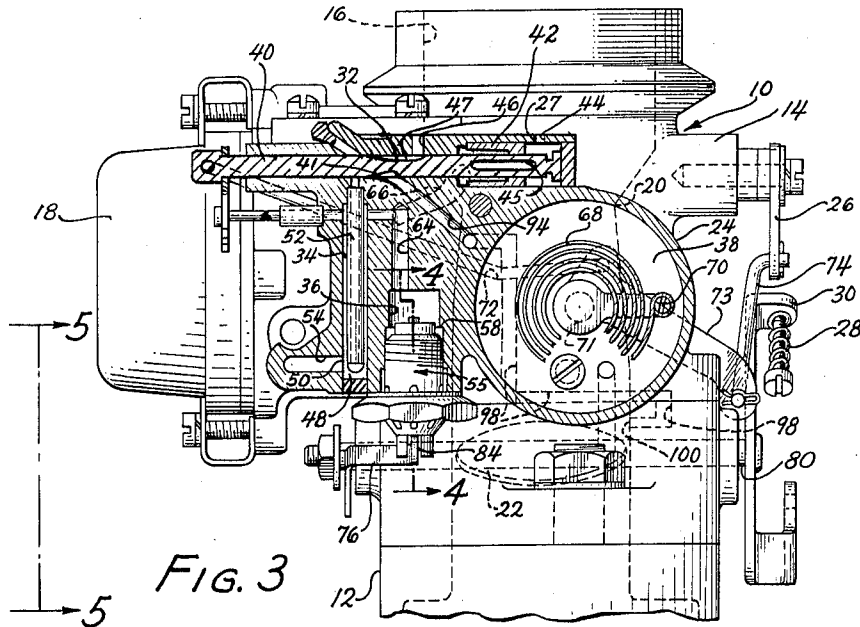
INVENTOR
GORDON G. GAST
Walter Patzsch, Jr.
John P. Moran
ATTORNEYS

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INVENTOR.
GORDON G. GAST
Walter Patnaik, Jr.
John P. Moran
ATTORNEYS

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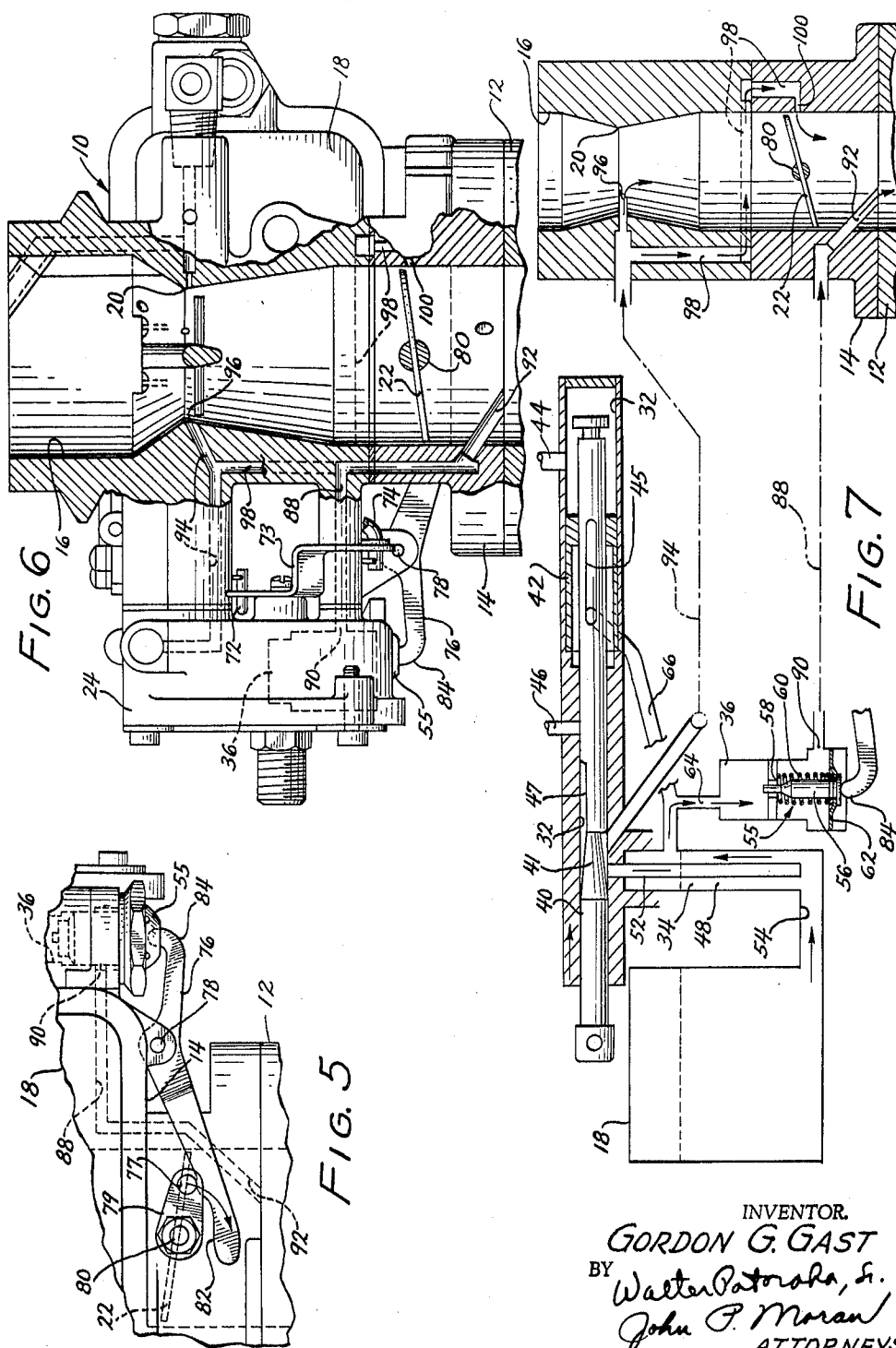
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3 Sheets-Sheet 3



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3,249,345

WARM-UP ENRICHMENT SYSTEM

Gordon G. Gast, Madison Heights, Mich., assignor to Holley Carburetor Company, Warren, Mich., a corporation of Michigan

Continuation of application Ser. No. 192,688, May 7, 1962. This application Apr. 23, 1965, Ser. No. 450,495
13 Claims. (Cl. 261—39)

This is a continuation of application Serial No. 192,688, now abandoned filed May 7, 1962 in the name of Gordon G. Gast.

This invention relates generally to fuel systems for internal combustion engines, and more particularly to an enrichment system which is automatically operative during engine warm-up.

Heretofore, the well-known choke system has been the most common and convenient method of enriching the fuel discharge. These choke systems have consisted of either the manual or automatic types. Both have employed choke plates as an integral part of the carburetor usually located in the air inlet sections. The choke plate has been used to "false sense" the metering systems in order to provide enrichment to operate a cold engine. Specifically, closing the choke plate in the air inlet produces a pressure lower than atmospheric pressure within the carburetor. The normal pressure of the air in the float chamber then forces fuel through the usual idle and main metering systems, resulting in the discharge to the engine having a somewhat higher fuel-air ratio.

While this has been satisfactory to a certain extent, the choke plate is subject to inconsistent operation due to exposure to dirt, fuel residues, and other contaminants. Also the deliberate restriction of airflow has lessened the availability of maximum power from the engine during the warm-up period. This latter factor could prove to be hazardous where a vehicle is moving prior to becoming fully warmed up.

Accordingly, a general object of this invention is to eliminate the need for a choke plate.

A more specific object is to permit maximum power from the engine to be available during warm-up.

A further object of this invention is to provide a means of supplying an engine with the proper fuel/air ratios during the warm-up period.

An additional object of this invention is to provide such a means which is automatic in operation and responsive to exhaust manifold temperature.

A still further object of this invention is to regulate the enrichment fuel to provide only the minimum required from the standpoint of fuel economy.

Another object of this invention is to provide such a device which may be either an integral or an attached part of a carburetor.

Still another object of this invention is to provide a carburetor structure which has a lower configuration by virtue of not requiring a choke plate section.

Other objects and advantages of the invention will become more apparent when reference is made to the following description and the accompanying drawings, wherein:

FIGURE 1 is a side elevational view of a carburetor embodying the invention;

FIGURE 2 is a top view of the carburetor shown in FIGURE 1;

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FIGURE 3 is a cross-sectional view taken on the plane of line 3—3 of FIGURE 2 and looking in the direction of the arrows;

FIGURE 4 is a fragmentary cross-sectional view taken on the plane of line 4—4 of FIGURE 3 and looking in the direction of the arrows;

FIGURE 5 is a fragmentary end view of FIGURE 3 taken on the plane of line 5—5 and looking in the direction of the arrows;

FIGURE 6 is a cross-sectional view taken on the plane of line 6—6 of FIGURE 2 and looking in the direction of the arrows;

FIGURE 7 is a schematic illustration of the invention as used in conjunction with the air passage of a carburetor.

Referring to the drawings in greater detail, FIGURE 1 illustrates a carburetor assembly 10 mounted on the engine manifold 12. The carburetor assembly 10 includes the usual carburetor body 14, an air inlet passage 16 and a fuel reservoir 18. FIGURE 1 further illustrates the fast idle cam 26 which is also normally incorporated in a conventional choke system. The fast idle cam 26 is at times in contact at some step, such as steps 27 or 29, with the usual throttle stop screw 28, the latter being connected to the throttle lever 30 and responsive in the well known manner to manual movement of the foot pedal (not shown).

Looking now at FIGURE 2, the carburetor body 14 includes the venturi 20 and the throttle plate 22 (shown partly open). In this view, it can be noted that the carburetor body 14 does not include a choke plate, as was commonly included heretofore. A housing 24 embodying the invention is shown attached to carburetor body 14, but it could be included as an integral part of the carburetor body 14.

In FIGURE 3, the housing 24 embodying the invention can be seen to contain four chambers 32, 34, 36 and 38. Chamber 32 contains the metering rod 40 and metering rod sleeve 42 as well as fresh air bleeds 44 and 46. The metering rod 40 includes a tapered section 41, a flat section 47, and a passageway 45. Chamber 34 serves as a metering well 43 and contains inlet 50 and tube 52 extending from chamber 32. The inlet 50 connects with conduit 54 which leads from fuel reservoir 18. Chamber 36 houses start valve assembly 55, which, in FIGURE 4, can be seen to contain start valve 56, heat 58, spring 60 and diaphragm 62. Conduit 64 communicates between chamber 36 and metering well 43. Referring again to FIGURE 3, conduit 66 can be seen to communicate between conduit 64 and chamber 32. Chamber 38 contains a bimetallic thermostat spring 68 and a lever 70 which connects with the metering rod 40 by means of pin 71 and link 72; it also connects with the fast idle cam 26 by means of arm 73 and link 74, as also illustrated in FIGURE 2.

As illustrated in FIGURE 5, a lever 76 is pivotally fastened to the carburetor body 14 at pivot point 78. The lever 76 is influenced by the movement of the throttle plate 22 through a pin 77 fastened to the extension 79 which is rigidly fastened to the end of throttle plate shaft 80. As the throttle plate 22 is opened by throttle lever 30, the pin 77 rides along the end 82 of the lever 76 causing it to pivot about point 78. The other end 84 of the lever 76 is thus directed against the start valve assembly 55. Specifically, as shown in FIGURE 4, the

lever end 84 contacts the start valve 56 at point 86, causing it to move toward the seat 58.

Referring now to FIGURE 6, the conduit 88 leads from the outlet 90 of the chamber 36 (FIGURE 5) to the orifice 92 located in the air passage 16 below the throttle plate 22. The conduit 94 leads from the chamber 32 to the orifice 96 located at the venturi 20 of the air passage 16. The branch conduit 98 leads from the conduit 94 to another orifice 100, also located in the air passage 16 below the throttle plate 22.

Operation

The operation of the invention can best be described by reference to the schematic drawing illustrated by FIGURE 7, which shows the warm-up enrichment system in its starting or "cold" position. This assumes that the vehicle operator has begun his starting operation by having initially depressed the foot pedal (not shown), as is customary in the usual internal combustion engine starting process. This would have pivoted the usual throttle stop screw 28 away from whichever step of the fast idle cam 26 it was contacting from the previous operation of the vehicle (FIGURE 1). The cold bimetallic thermostat spring 68 in chamber 38, thus freed, would have immediately tightened around its center mounting (FIGURE 3) so as to rotate the lever 70 which, in turn, would have pushed the metering rod 40 to its outermost or extreme left position via pin 71 and linkage 72 (FIGURE 2). The fast idle cam 26 would also have been rotated by the linkage 73 and 74 leading from the pin 71 and lever 70, which, as mentioned above, was turned by the cold bimetallic thermostat spring 68. Release of the initial foot pedal depression would then have allowed the throttle stop screw 28 to return against the now rotated high step 29 of the fast idle cam 26. FIGURE 1 illustrates, for example, the throttle stop screw 28 in contact with the lowest step 27, where it would normally remain from a prior engine use and before the above described starting operation.

The initial cranking of the engine would occur with the throttle plate 22 substantially closed, as controlled by the stop screw 28. The start valve spring 60 is calibrated so that the start valve 56 will remain open until the manifold vacuum reaches a predetermined amount, say 3" Hg. Thus it can be seen that, below 3" Hg, fuel will be forced out of the fuel well 48 into chamber 36, past the start valve 56 through the outlet 90 and the conduit 88 and out through the orifice 92 below the throttle plate 22. The importance of this phase of the operation can be seen from the fact that at .5 to 1.5" Hg the fuel/air ratio required is generally greater than 0.80, whereas, in a carburetor not employing any enrichment provisions, the fuel/air ratio during this starting phase would be on the order of say 0.08.

It is obvious also that since the orifice 100 is located below the throttle plate 22, the manifold vacuum would permit fuel to be forced out of the fuel well 48 through the tube 52, past the tapered portion of the metering rod 40 and via the conduits 94 and 98 through the orifice 100, with the orifice 96 at the venturi 20 acting as a bleed at this time. Because of this bleed through the venturi 20, orifice 96 and the preferred maximum size of the orifice 100, a suitable flow of fuel through the orifice 100 alone would not be available during this beginning phase while the throttle plate 22 is closed. It is for this reason that the invention includes the additional orifice 92 and start valve assembly 55 which is operative only while the manifold vacuum is 3" Hg or less. Above 3" Hg, the pressure on diaphragm 62 will cause start valve 56 to overcome spring 60 and close against seat 58.

It can be seen that fuel will be forced from the fuel well 48 through the tube 52 and through conduits 94 and 98 to either or both the orifices 96 and 100 during all values of manifold vacuum. Depending upon the position of the throttle plate 22, which, of course, would

correspond to particular values of manifold vacuum, fuel would flow through either orifice 96 or 100 while the other acted as a bleed. It is essential to keep in mind that the engine is still cold at this point and the metering rod 40 is still positioned at the extreme left permitting flow past the tapered section.

It is possible that the throttle plate 22 may be rotated to a wide open throttle position while the engine is still cold. This could occur after a vehicle operator has pulled away from the curb soon after having started his engine. Conceivably, an emergency situation could arise requiring him to depress the foot pedal to the floor. If this were to happen, the manifold vacuum would drop to below 3" Hg by virtue of the throttle lever 30 having opened the throttle plate 22 to a wide open position. This resultant low vacuum would cause the start valve 56 to leave the seat 58. At wide open throttle position, the maximum upward movement of lever end 84 is such that the maximum opening of the start valve 56 is limited. The maximum opening at this point is as shown in FIGURE 4 and will permit the proper amount of fuel once again to flow from the fuel well 48, through the conduit 64 into chamber 36 and out through the orifice 92 via conduit 88, at a time when additional fuel is required. Obviously, since the maximum opening of the valve 56 is limited at this time by the lever 76, excess fuel cannot be supplied to the engine; hence, the fuel/air ratio will be ideal from the standpoint of both efficiency and economy.

By this time the engine has begun to warm up. This causes air heated by the exhaust manifold (not shown) to flow through a heat tube 69 (FIGURE 2) and into chamber 38 wherein the bimetallic thermostat spring 68 is located. This process of supplying heat to the spring 68 is identical to that employed in the well known conventional automatic choke system.

As the bimetallic thermostat spring 68 warms up, it unwinds about its center mounting, causing the metering rod 40 to be moved toward the right. Partial movement of the metering rod 40 will still permit the flow of fuel past the tapered section, but the movement will have uncovered the fresh air bleed 44. Air will thus flow through the opening 45, around the sleeve 42 in the chamber 32 and out through the conduit 66 to the conduit 64 and thence to the chamber 36, thus rendering the start valve system inoperative, the amount of air being sufficient to prevent fuel from being drawn out of the metering well 48 into the chamber 36.

Once the engine has become fully warmed the bimetallic spring 66 will have moved the metering rod 40 all the way to the right, as shown in FIGURE 3. This will close off the opening at the top of the tube 52, to the extent that the tolerances of the sliding fit will permit. At the same time, the flat portion 47 of the metering rod 40 will now permit fresh air to enter the chamber 32 through the bleed 46 and flow through the conduit 94, thus effectively rendering the remainder of the system inoperative. In other words, no leakage past the tapered portion will now be possible.

It can readily be understood that the pressure in various cavities and conduits within the system can be regulated by the use of various sized restrictions and bleeds in order to provide optimum enrichment for the engine.

It should be apparent from the above description that the invention provides a means for providing a proper amount of additional fuel to the engine during all conditions of warm-up, as well as providing a means for preventing an excessive amount of fuel from being supplied during these conditions. In other words, ideal fuel-air ratios are supplied during warm-up from the standpoint of both maximum efficiency and maximum economy.

Although but one embodiment of the invention has been shown and described, it is conceivable that various modifications are possible, and no limitations not recited in the appended claims are intended.

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What I claim as my invention is:

1. In a carburetor for an internal combustion engine, said carburetor comprising a main body having an air passage with a venturi therein, a throttle plate positioned downstream of said venturi, and fuel reservoir means adjacent to said body, a warm-up enrichment system comprising a housing having a plurality of chambers formed therein; valve means located in the first of said chambers; a first passageway communicating between said first chamber and a point downstream of said throttle plate; means to cause said valve means to be responsive to a low engine manifold vacuum while the engine is being started to allow fuel to flow into said first passageway; a lever operably connected between said throttle plate and said valve means for controlling the opening of said valve means during warm-up when said throttle plate is in a wide open position; metering rod means slidably positioned in a second of said chambers; a fuel well formed in a third of said chambers; a second passageway communicating between said fuel well and said second chamber; a third passageway communicating between said second chamber and said venturi; a fourth passageway communicating between said third passageway and a point downstream of said throttle plate; a fifth passageway communicating between said third chamber and said first chamber; a sixth passageway communicating between said second chamber and said fifth passageway; a bimetallic thermostatic spring rotatably located in a fourth of said chambers, said spring being responsive to engine manifold temperature; linkage means connected between said spring and said metering rod means, such that said metering rod means is slidably moved in said second chamber in response to movement of said bimetallic thermostatic spring; and first and second fresh air bleeds formed in said second chamber; said metering rod means being formed such that, once said metering rod means has been moved by said linkage means to a position wherein it blocks off said second passageway, said first fresh air bleed will be in communication with said third passageway, thereby preventing any leakage of fuel from said second passageway into said second chamber, and said second fresh air bleed will be in communication with said first chamber via said sixth and fifth passageways, thereby preventing any further fuel flow from said fuel well into said first chamber.

2. In a carburetor for an internal combustion engine, said carburetor comprising a main body having an air passage with a venturi therein, a throttle plate positioned downstream of said venturi, and fuel reservoir means adjacent to said body, a warm-up enrichment system comprising valve means; a first passageway communicating between said valve means and a point downstream of said throttle plate, means to cause said valve means to be responsive to a low engine manifold vacuum while the engine is being started to allow fuel to flow into said first passageway; a lever operably connected between said throttle plate and said valve means for controlling the opening of said valve means during warm-up when said throttle plate is in a wide open position; a slidably operated metering rod means; a fuel well, a second passageway communicating between said fuel well and said metering rod means; a third passageway communicating between said metering rod means and said venturi; a fourth passageway communicating between said third passageway and a point downstream of said throttle plate; a fifth passageway communicating between said fuel well and said valve means; a sixth passageway communicating between said metering rod means and said fifth passageway; a bimetallic thermostatic spring, said spring being responsive to engine manifold temperature; linkage means connected between said spring and said metering rod means, such that said metering rod means is slidably moved in response to movement of said bimetallic thermostatic spring; first and second fresh air bleeds con-

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trolled by the movement of said metering rod means, said metering rod means being formed such that, once said metering rod means has been moved by said linkage means to a position wherein it blocks off said second passageway, said first fresh air bleed will be in communication with said third passageway, thereby preventing any leakage of fuel from said second passageway into said third passageway past said metering rod means, and said second fresh air bleed will be in communication with said valve means via said sixth and fifth passageways, thereby preventing any further fuel flow from said fuel well past said valve means.

3. In a carburetor for an internal combustion engine, said carburetor comprising a main body having an air passage with a venturi therein, a throttle plate positioned downstream of said venturi, and fuel reservoir means adjacent to said body, a warm-up enrichment system comprising a housing having a plurality of chambers formed therein; valve means located in the first of said chambers; a first passageway communicating between said first chamber and a point downstream of said throttle plate; means to cause said valve means to be responsive to a low engine manifold vacuum while the engine is being started to allow fuel to flow into said first passageway; a lever operably connected between said throttle plate and said valve means for controlling the opening of said valve means during warm-up when said throttle plate is in a wide open position; metering rod means slidably positioned in a second of said chambers; a fuel well formed in a third of said chambers; a second passageway communicating between said fuel well and said first chamber; a third passageway communicating between said second chamber and said second passageway; a fresh air bleed formed in said second chamber; a bimetallic thermostatic spring located in a fourth of said chambers, said spring being responsive to engine manifold temperature; linkage means connected between said spring and said metering rod means, such that said metering rod means is slidably moved in said second chamber in response to movement of said bimetallic thermostatic spring; said metering rod means being formed such that, once said metering rod means has been moved a predetermined distance by said linkage means, said fresh air bleed will be in communication with said third passageway, thereby preventing any further fuel flow from said fuel well into said first chamber.

4. In a carburetor for an internal combustion engine, said carburetor comprising a main body having an air passage with a venturi therein, a throttle plate positioned downstream of said venturi, and fuel reservoir means adjacent to said body, a warm-up enrichment system comprising valve means; a first passageway communicating between said valve means and a point downstream of said throttle plate, means to cause said valve means to be responsive to a low engine manifold vacuum while the engine is being started to allow fuel to flow into said first passageway; a lever operably connected between said throttle plate and said valve means for controlling the opening of said valve means during warm-up when said throttle plate is in a wide open position; metering rod means; a fuel well; a second passageway communicating between said fuel well and said valve means; a third passageway communicating between said metering rod means and said second passageway; a fresh air bleed controlled by the movement of said metering rod means; a bimetallic thermostatic spring, said spring being responsive to engine manifold temperature; linkage means connected between said spring and said metering rod means, such that said metering rod means is slidably moved in response to movement of said bimetallic thermostatic spring; said metering rod means being formed such that, once said metering rod means has been moved a predetermined distance by said linkage means, said fresh air bleed will be in communication with said third passageway, there-

by preventing any further fuel flow from said fuel well past said valve means.

5. In a carburetor for an internal combustion engine, said carburetor comprising a main carburetor body having an air passage with a venturi therein, a throttle plate positioned downstream of said venturi and fuel reservoir means adjacent to said carburetor body, a warm-up enrichment system comprising:

- (a) a housing adapted to be fastened to said main carburetor, said housing having a plurality of chambers formed therein,
- (b) a thermostat spring in a first of said chambers,
- (c) metering rod means slidably located in a second of said chambers,
- (d) linkage means connected between said thermostat spring and said metering rod means,
- (e) a metering well in a third of said chambers,
- (f) a tube extending from said second chamber into said metering well the opening therebetween being controlled by the movement of said metering rod means,
- (g) a first passageway communicating between said fuel reservoir means and said metering well,
- (h) start valve means in a fourth of said chambers,
- (i) a lever pivotally connected at its one end to said throttle plate and at times abutted at its other end against said start valve means,
- (j) a second passageway communicating between said second chamber and said venturi,
- (k) a third passageway communicating between said fourth chamber and said air passage downstream of said throttle plate,
- (l) a fourth passageway communicating between said metering well and said fourth chamber,
- (m) a fifth passageway communicating between said second chamber and said fourth passageway,
- (n) a sixth passageway communicating between said second passageway and said air passage downstream of said throttle plate, and
- (o) first and second fresh air bleeds means in said second chamber at times in communication with said second passageway and said fifth passageway, respectively, depending upon the position of said metering rod means.

6. In a carburetor for an internal combustion engine, said carburetor including a main carburetor body having an air passage with a venturi therein, a throttle plate positioned downstream of said venturi and fuel reservoir means adjacent to said carburetor body, a warm-up enrichment system, said system comprising means for supplying fuel into the air passage downstream of said throttle plate at a low value of manifold vacuum while said engine is being started cold and at subsequent wide open throttle condition while said engine is still cold, means for introducing air through said second mentioned means in order to render said first mentioned means inoperative to supply fuel when said engine is partly warm, separate and distinct fuel passage means for supplying additional fuel into said air passage at both said venturi and downstream of said throttle plate at alternate times and at all values of manifold vacuum during the warm-up operation, and means for supplying air through said last mentioned means in order to render the same totally inoperative to supply fuel when said engine is fully warm.

7. The device described in claim 6, including, additionally, means for closing off flow of either air or fuel through said first mentioned means at a predetermined value of manifold vacuum.

8. In a carburetor for an internal combustion engine, said carburetor including a main carburetor body having an air passage with a venturi therein, a throttle plate positioned downstream of said venturi and fuel reservoir means adjacent to said carburetor body, a warm-up enrichment system, said system comprising means for supplying fuel into the air passage downstream of said

throttle plate at a low value of manifold vacuum while said engine is being started cold and at subsequent wide open throttle condition while said engine is still cold, means for introducing air through said first mentioned means in lieu of fuel when said engine is partly warm, separate and distinct fuel passage means for supplying additional fuel into said air passage at both said venturi and downstream of said throttle plate at alternate times and at all values of manifold vacuum during the warm-up operation, and means for supplying air through said last mentioned means in lieu of fuel when said engine is fully warm.

9. The device described in claim 8, including, additionally, separate means for limiting the amount of fuel being supplied by said first mentioned means at said wide open throttle condition.

10. In a carburetor for an internal combustion engine, said carburetor including a main carburetor body having a bimetallic thermostat, an air passage with a venturi therein, a throttle plate positioned downstream of said venturi, said air passage upstream of said throttle plate being continually fully open, and fuel reservoir means adjacent to said carburetor body, a warm-up enrichment system, said system comprising valve means for supplying fuel into the air passage downstream of said throttle plate at a low value of manifold vacuum while said engine is being started cold and at subsequent wide open throttle condition while said engine is still cold, separate and distinct conduit means for supplying additional fuel into said air passage at both said venturi and downstream of said throttle plate at alternate times and at all values of manifold vacuum during the warm-up operation, and means responsive to movement of said bimetallic thermostat for introducing air through said first mentioned means in lieu of fuel when said engine is partly warm and for supplying air through said last mentioned means in lieu of fuel in order to render said last mentioned means totally inoperative when said engine is fully warm.

11. The device described in claim 10, wherein said last mentioned means includes a dual acting valve means and two air bleeds adjacent said valve means, said valve means permitting air flow to enter said third mentioned means through said two air bleeds at different times.

12. In a carburetor for an internal combustion engine, said carburetor including a main carburetor body having an air passage with a venturi therein, a throttle plate positioned downstream of said venturi and fuel reservoir means adjacent to said carburetor body, a warm-up enrichment system, said system comprising means for supplying fuel into the air passage downstream of said throttle plate at a low value of manifold vacuum while said engine is being started cold and at subsequent wide open throttle condition while said engine is still cold, means for introducing air through said second mentioned means in lieu of fuel when said engine is partly warm, means for supplying additional fuel into said air passage at both said venturi and downstream of said throttle plate at alternate times during the warm-up operation, means for supplying air through said last mentioned means in lieu of fuel when said engine is fully warm, and separate means for limiting the amount of fuel being supplied by said first mentioned means at said wide open throttle condition, said separate means being a pivotable lever movable with said throttle plate and at times in contact with said first mentioned means.

13. In a carburetor for an internal combustion engine, said carburetor including a main carburetor body having a bimetallic thermostat, an air passage with a venturi therein, a throttle plate positioned downstream of said venturi, said air passage upstream of said throttle plate being continually fully open, and fuel reservoir means adjacent to said carburetor body, a warm-up enrichment system, said system comprising valve means for supplying fuel into the air passage downstream of said throttle plate at a low value of manifold vacuum while said en-

gine is being started cold and at subsequent wide open throttle condition while said engine is still cold, conduit means for supplying additional fuel into said air passage at both said venturi and downstream of said throttle plate at alternate times during the warm-up operation, means responsive to movement of said bimetallic thermostat for introducing air through said valve means in lieu of fuel when said engine is partly warm and for supplying air through said conduit means in lieu of fuel in order to render said conduit means totally inoperative when said engine is fully warm, and linkage means between said valve means and said throttle plate for limiting the

amount of fuel being supplied by said valve means at said wide open throttle condition.

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HARRY B. THORNTON, *Primary Examiner.*

T. R. MILES, *Assistant Examiner.*