April 30, 1957 J. F. ARMSTRONG 2,790,630

FUEL FEED FOR MULTI-STAGE CARBURETORS

Filed March 23, 1954 5 Sheets-Sheet 1

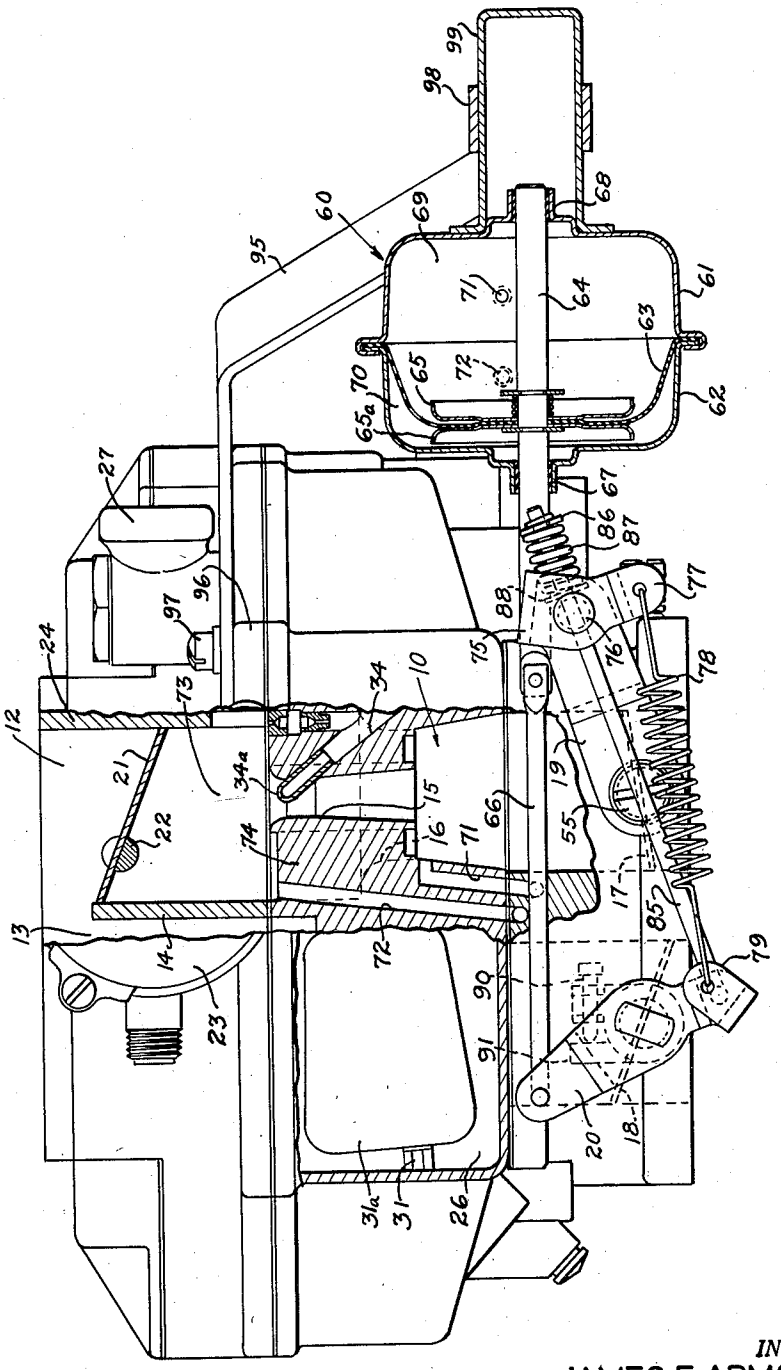


FIG. 1

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FUEL FEED FOR MULTI-STAGE CARBURETORS

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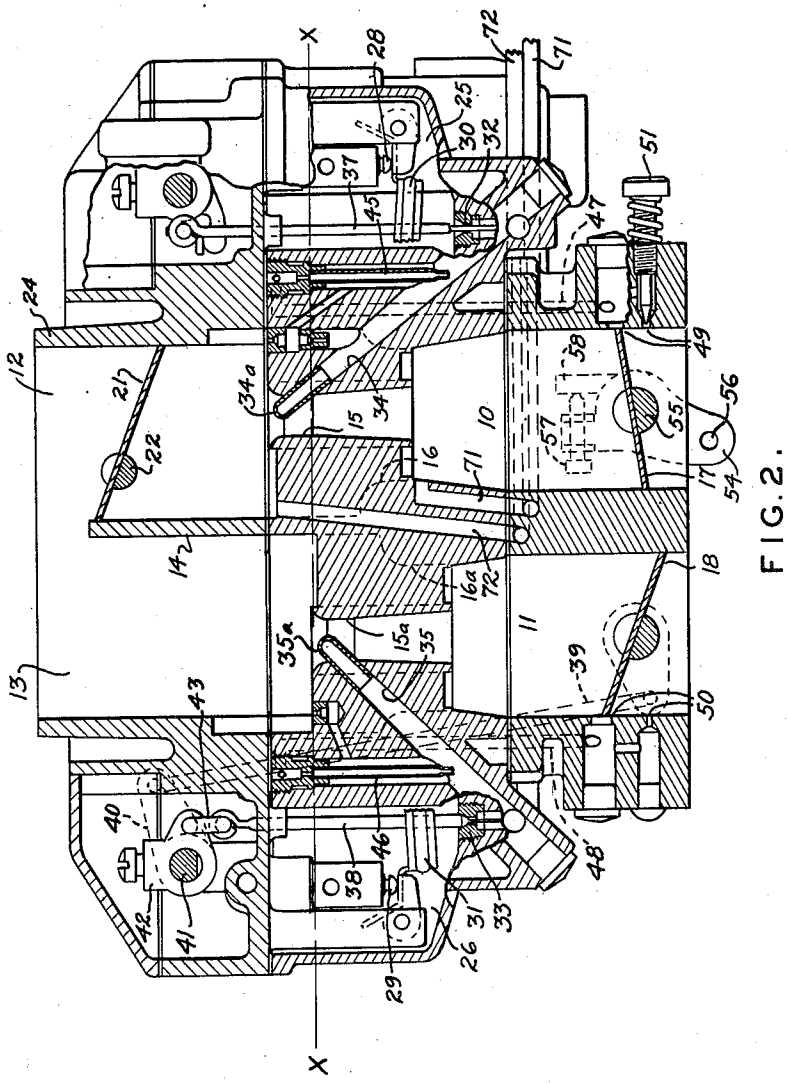


FIG. 2.

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FUEL FEED FOR MULTI-STAGE CARBURETORS

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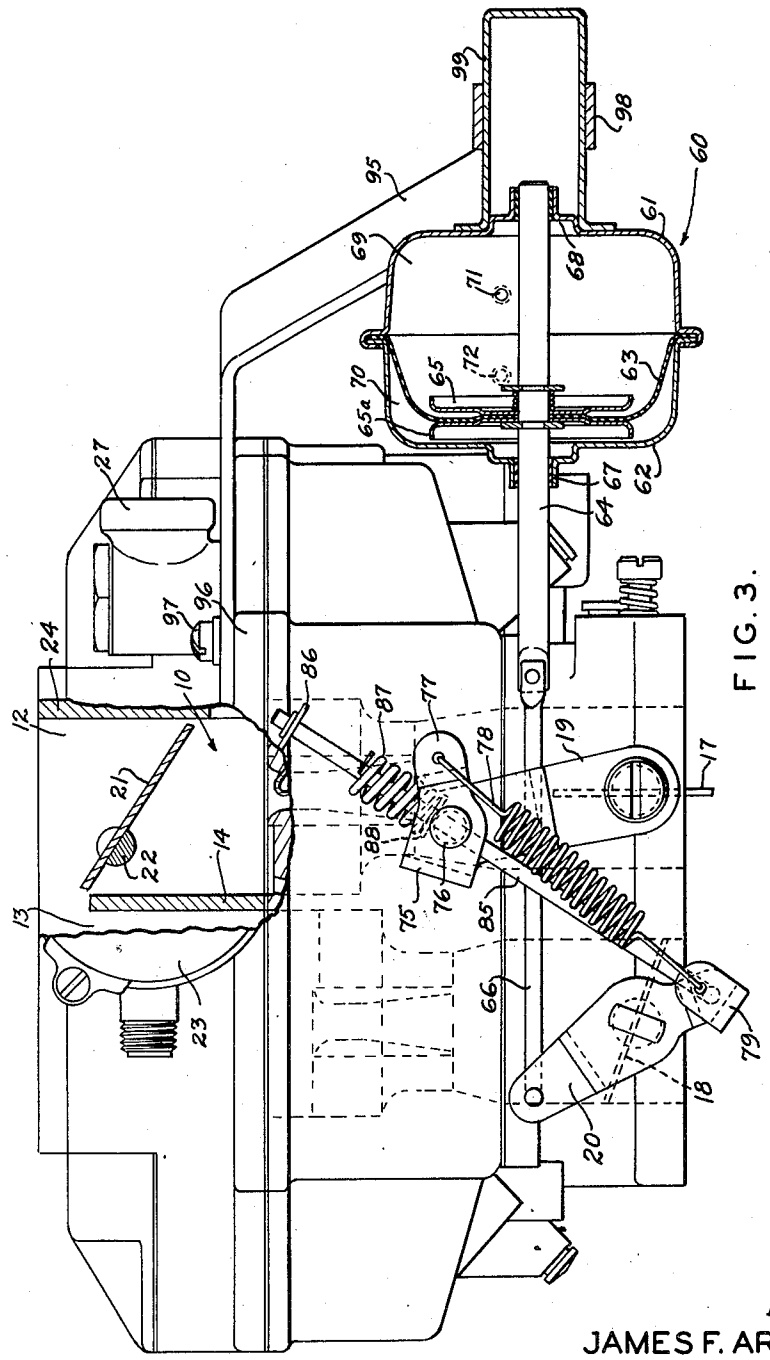


FIG. 3.

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FUEL FEED FOR MULTI-STAGE CARBURETORS

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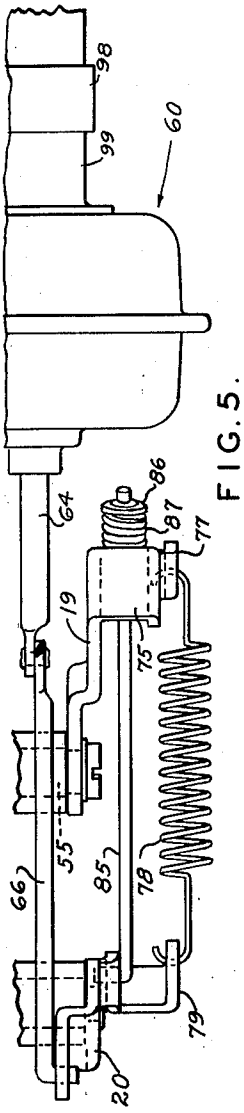


FIG. 5.

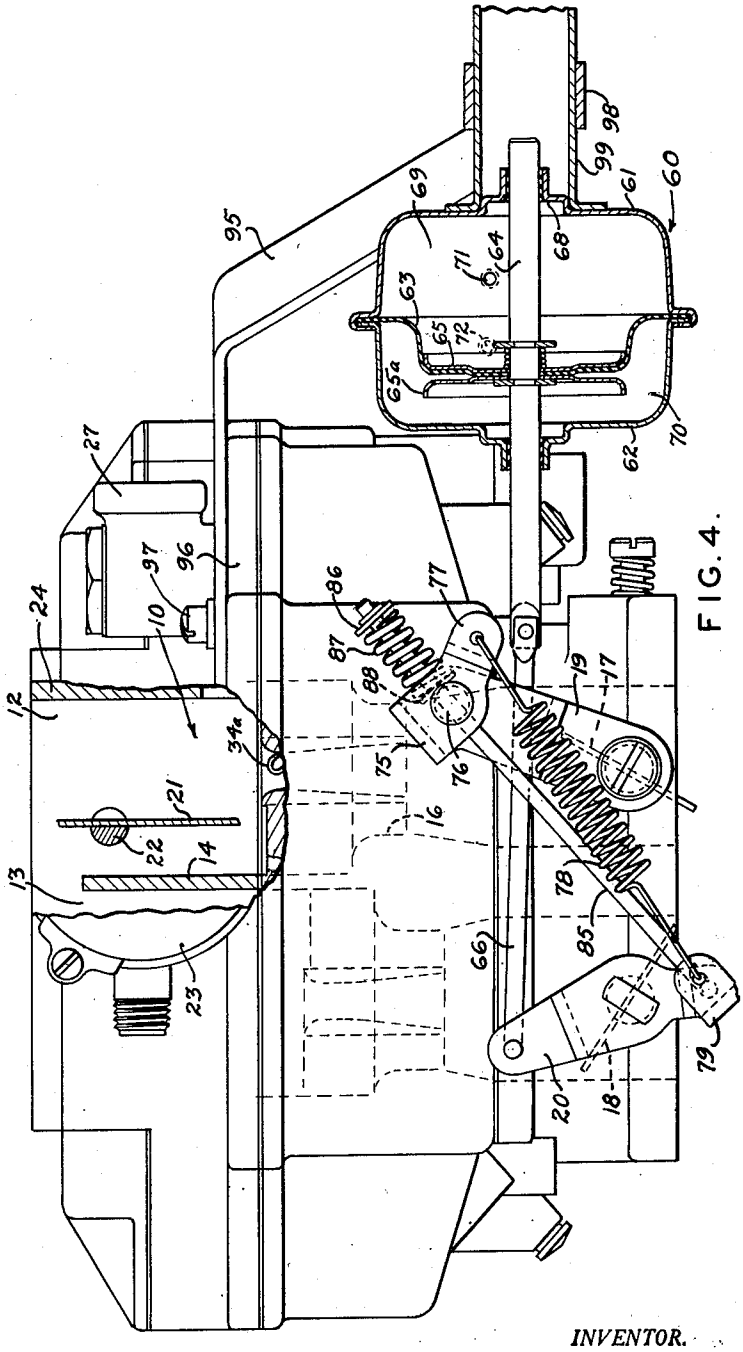


FIG. 4.

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FUEL FEED FOR MULTI-STAGE CARBURETORS

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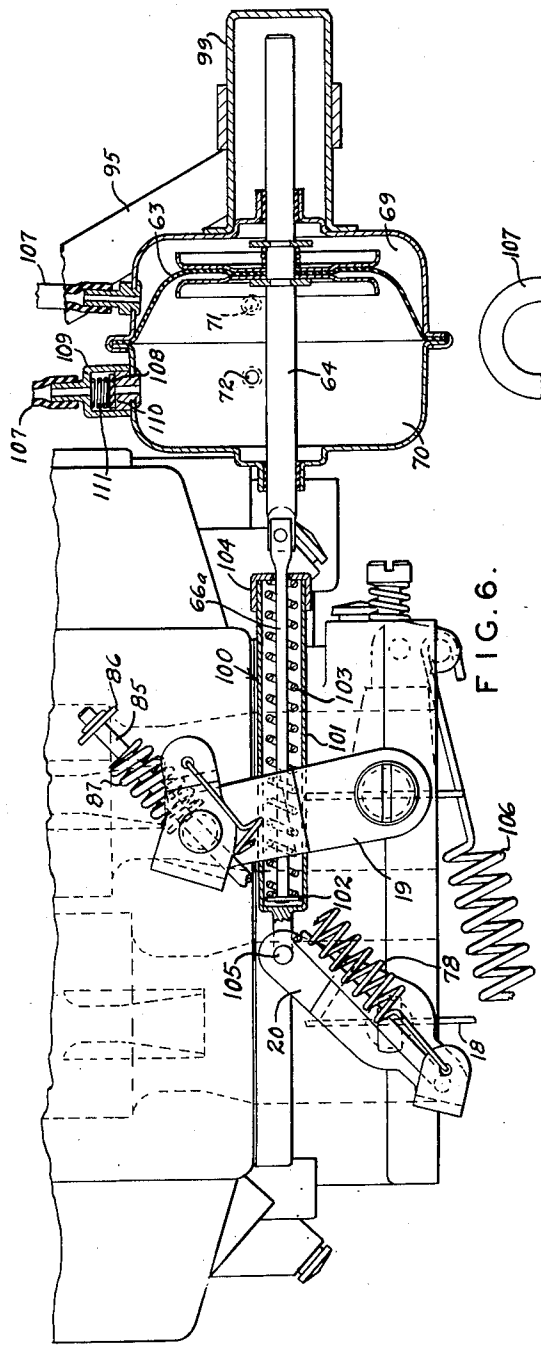


FIG. 6.

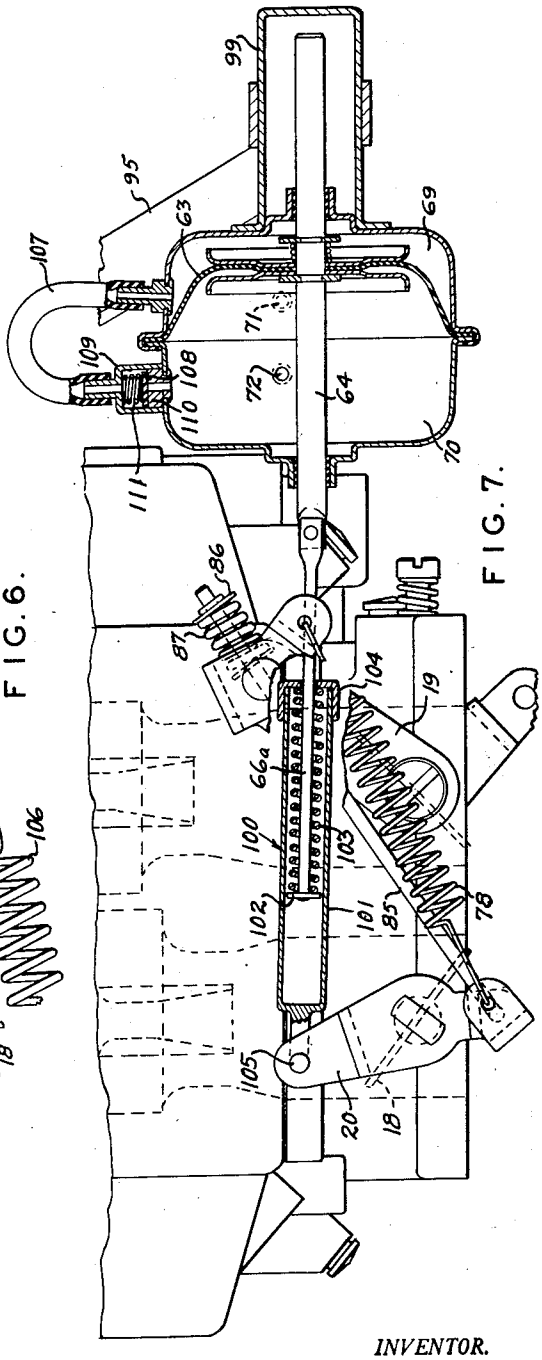


FIG. 7.

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United States Patent Office 2,790,630 Patented Apr. 30, 1957

2,790,630

FUEL FEED FOR MULTI-STAGE CARBURETORS

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Application March 23, 1954, Serial No. 418,049
18 Claims. (Cl. 261—23)

This invention relates to two-stage carburetion and fuel supply devices for internal combustion engines.

The invention incorporates the following advantageous, novel and interrelated features:

1. More accurate automatic control of the secondary throttle valve without increasing the height or length of the carburetor, as is necessary where an extra, automatic valve is provided.

2. Provision for insuring firm closing of the secondary throttle valve without increasing the strength of the secondary throttle closing spring and, thereby, the force needed to open this throttle.

3. Means insuring prompt issue of fuel from the secondary main fuel nozzle, upon initiation of opening of the secondary throttle, so as to avoid a flat spot frequently noted at this point.

4. Means preventing opening of the secondary throttle valve as long as the choke valve in the air entrance of the primary mixture conduit is in a substantially restricting position, without the provision of the usual stops and locking devices heretofore used for this purpose.

5. Means limiting the opening force applied to the secondary throttle to insure prompt closing of the throttle when the operator releases the accelerator pedal.

The invention is illustrated as embodied in a four-barrel type of carburetor, but applies to any two-stage mixture supply system in which the second fuel supply means becomes operative after a predetermined, initial opening movement of the primary throttle valve.

In the accompanying drawings:

Fig. 1 is a side view of a carburetor embodying the invention, portions being broken away and sectioned to illustrate the underlying structure and both throttle valves being shown in their idling positions.

Fig. 2 is a vertical, transverse section through the carburetor illustrating the fuel feeding parts.

Fig. 3 is a side view of the carburetor with certain parts broken away and illustrating the effect of the partially closed choke valve upon secondary throttle operating mechanism.

Fig. 4 is a view similar to Fig. 3 but with the secondary throttle partially opened.

Fig. 5 is a top view of the linkage mechanism interconnecting the primary and secondary throttle valves.

Figs. 6 and 7 show a modified form of the carburetor in the previous figures, with the throttles in different positions.

The carburetor is of the currently popular four-barrel type, but only two of the barrels are shown in the views and the description will proceed on the basis of these two barrels only, it being understood that the primary and secondary instrumentalities may be duplicated, if desired. A pair of adjacent, downdraft mixture conduits are shown, namely, the primary conduit **10** and secondary conduit **11**. The conduits have air entrance portions **12** and **13** divided by partition **14** and each has a pair of venturi tubes **15**, **16** and **15***a*, **16***a* forming the mixing chamber portion of the conduit. At the lower or discharge ends of the mixture conduits are primary throttle valve **17** and secondary throttle valve **18** having operating levers **19** and **20** secured, respectively, thereto and movable therewith. An unbalanced choke valve **21** is pivotally mounted on a shaft **22** in air inlet portion **12** of the primary mixture conduit and is controlled by any suitable mechanism, such

as the well known automatic choke control mounted in housing **23** on the outside of airhorn structure **24** which forms the air entrances.

As best shown in Fig. 2, constant level chambers, as at **25** and **26**, are provided adjacent each mixture conduit and supplied with fuel through a common inlet fitting **27** and past needle valves **28** and **29** and operated by yokes **30** and **31** carrying the usual floats, as at **31***a* (Fig. 1). Preferably, constant level chambers **25** and **26** will be entirely separated so as to minimize the effect of surging in the fuel. At the bottoms of the constant level chambers are the metering orifice elements **32**, **33** for metering fuel to primary main fuel passage **34** and secondary main fuel passage **35** discharging into venturi tubes **15** and **15***a* in the primary and secondary conduits, respectively, through nozzles **34***a* and **35***a*. Secondary main nozzle **35***a* discharges slightly below normal fuel level X—X in bowl **26**, while primary main nozzle **34***a* discharges slightly above the normal fuel level, as customary. Metering orifice elements **32** and **33** are controlled by metering pins **37** and **38** operated from the throttle valves by suitable linkage. Metering pin **38** seats upon and closes secondary metering orifice element **33** when secondary throttle valve **18** is closed. This metering pin is operated from throttle valve **18** by means of a link **39**, crank **40**, countershaft **41** rigid thereof, and a small crank **42** rigid with the countershaft and carrying the metering pin through a link **43**. Primary metering pin **37** variably restricts metering orifice element **32**, according to the position of primary throttle **17**, as customary, by means of similar mechanism (not shown). Fuel for idling is supplied through idle restricting tubes **45** and **46**, connecting main fuel passages **34** and **35** with idling passages **47** and **48** leading to ports **49** and **50** adjacent and posterior to the primary and secondary throttle valves, respectively, when closed. A mixture adjusting screw **51** is provided in connection with one of the idling ports **49** on the primary side.

A lever **54** is secured to the end of primary throttle shaft **55** opposite previously mentioned lever **19** (Fig. 2) and is provided with a hole **56** for connection of linkage extending to the accelerator pedal in the driver's compartment for manual control of the primary throttle against the usual throttle return spring (not shown). The normal idling position of the primary throttle is determined by an adjusting screw **57** disposed to engage a stop **58**. A suitable fast idling stop of any known construction, preferably, will be provided to increase the engine idling speed at low temperatures when the choke valve is in a restricting position.

Secondary throttle valve **18** is controlled by a suction motor, generally indicated at **60** (Figs. 1, 3, and 4). This motor is formed of a pair of housings **61** and **62** which clamp a flexible diaphragm **63** between the flanged, abutting edges thereof. An actuating stem **64** is secured centrally to the diaphragm by means of large washers **65** and **65***a* and passes outwardly through a guide packing **67** in casing wall **62**. The inner, free end of stem **64** slides in a guide **68** located centrally in the end of casing member **61**. Stem **64** is pinned at its outer end to a link **66** which is pivotally connected to one end of previously mentioned, secondary throttle actuating lever **20**.

Motor housings **61** and **62** form pressure chambers **69** and **70** to which are connected passages **71** and **72** leading, respectively to the throat portion of main venturi tube **16** in the primary mixture conduit and chamber **73** in the air entrance portion of conduit **10** between venturi tubes **15** and **16** and choke valve **21**. Passage **72** extends through rib **74** which supports venturi tube **15** and opens upwardly against the direction of air flow into the mixture conduit in the manner of a pitot tube. Passage **71** opens flush through the wall of venturi tube **16** so as to trans-

mit the static pressure condition caused by the velocity of air flow through the venturi tube. Thus, suction motor chambers **70** and **69** and diaphragm **63** are exposed to the differential pressures which exist between the air entrance portion of the primary mixture conduit, posterior to choke valve **21**, and the mixing chamber portion of the primary conduit. Diaphragm **63** will be urged rightwardly, as the rate of air flow through venturi tube **16** increases. However, opening of the secondary throttle is prevented by means to be described hereafter, until a predetermined rate of primary air flow is reached and, consequently, the associated engine is operating at a predetermined speed. The location of passage **72** posterior to choke valve **21** provides for substantially reducing the pressure difference applied to motor chambers **69** and **70** as long as the choke valve is in a substantially restricting position, so that no movement of diaphragm **63** and the secondary throttle valve can then occur.

Lever **19** secured to primary throttle shaft **55** extends away from the secondary throttle shaft and, at its outer extremity, has a folded over portion **75**, which journals a cross pin **76**, and has a tail **77** to which is secured one end of a coiled tension spring **78**. The other end of spring **78** is secured to a lug **79** on the end of secondary throttle actuating lever **20** opposite link **65**. Thus, the force of tension spring **78** is applied to lever **20** in the direction tending to close secondary throttle valve **18**. Actuating lever **19** on the primary throttle is positioned, when the primary throttle valve is closed, substantially on center relative to primary throttle shaft **55** and lug portion **79** of secondary lever **20**. Thus, as primary throttle valve **17** is opened, bracket **75**, **77** moves, harmonically, away from the dead center position so as to progressively relax spring **78** and, thereby, reduce the resistance applied by spring **78** to opening of secondary throttle **18**.

A rod **85** is also pivotally connected to lug portion **79** of secondary throttle lever **20** and extends slidably through previously mentioned cross pin **76**. A collar **86** is keyed to the free end of rod **85** and a coiled, compression spring **87** is compressed between this collar and a washer **88** slidable on the rod for seating against cross pin **76**. Spring **87** is substantially stiffer than tension spring **78**, but is shorter so that its effect upon initial opening of the secondary throttle **18** is eliminated after a partial opening movement of primary throttle valve **17**. Secondary throttle **18** cannot be opened as long as spring **87** is stressed. The purpose of spring **87** and overcenter rod **85** is to insure firm engagement of secondary throttle adjusting screw **90** with its stop **91**, which fixes the closed position of secondary throttle **18**, without the necessity of providing a strong return spring for this throttle. Thus, suction motor **60**, in opening the secondary throttle, need exert only sufficient force to counteract relatively light tension spring **78**, the force of which is progressively reduced as the primary throttle valve is opened. The resistance of compression spring **87** likewise, will be progressively reduced, as the primary throttle valve is opened, until, when the primary throttle is fully opened, as in Fig. 3, its resistance to opening in the secondary throttle will be entirely eliminated. Thus, since relatively light forces need be exerted by the suction motor, this motor may be made relatively small and compact. Moreover, springs **78** and **87** do not materially increase the resistance to opening of the primary throttle.

The suction motor is shown mounted upon the carburetor by means of a bracket **95**, secured to the cover **96** of the constant level chambers by means of bolts **97**, and having a loop **98** gripping a cylindrical axial extension **99** on outer motor casing member **61**.

It is believed that the operation will be readily apparent from the previous description. Fig. 1 shows both the primary and secondary throttle valves in their closed or normal idling positions, as when the associated engine is not in operation or is idling. Fig. 3 shows a condition during the warm-up period with primary throttle valve **17** substantially fully opened, but with the secondary throttle valve **18** remaining closed due to the fact that the restricting position of choke valve **21** prevents the application of sufficient pressure difference to suction diaphragm **63** to overcome the force of tension spring **78**, tending to hold the secondary throttle valve closed. This figure also shows stiff compression spring **87** completely separated from its supporting collar **86** on rod **85** so that its effect on the secondary throttle is completely eliminated.

In Figs. 1 and 2, with secondary throttle valve **18** fully closed, metering pin **38**, controlling secondary metering orifice **33**, will be lowered sufficiently to fully close this orifice and, therefore, prevent the flow of fuel through secondary main nozzle **35**. This is important since the outlet of secondary nozzle **35** is located slightly below normal fuel level X—X in constant level chamber **26** so that a sufficient head is constantly applied to the metering orifice to cause spillage through main nozzle **35** except for cut-off valve **33**. Operating linkage **39**, **40**, etc. of metering pin **38** is such that as secondary throttle **18** starts to open, metering pin **38**, also, will start to open to insure prompt supply of fuel to the secondary mixture conduit. The location of secondary passage **35** and nozzle **35***a* wholly below the fuel level in secondary bowl **26**, insures the prompt issuance of fuel from the secondary nozzle under a slight superatmospheric head, so that the flat spot which is frequently experienced in current two-stage carburetors, due to the delay of fuel supply on the secondary side, is eliminated.

Fig. 4 shows the choke valve fully opened so as to eliminate its effect upon the suction motor, and primary throttle valve **17** opened approximately to the degree at which the speed of the associated engine and the velocity of air flow through venturi tube **16** produces a difference of pressure on the opposite sides of suction motor diaphragm **63** sufficient to start opening movement of secondary throttle **18**. Tension spring **78** is considerably relaxed due to shortening in its movement from the position of Fig. 1, while compression spring **87** is fully expanded so that its resistance to initial opening of the secondary throttle valve is substantially eliminated.

Figs. 6 and 7 show a modification of the secondary throttle operating mechanism in which means are provided to limit the resistance to closing of the primary throttle which can be applied through the secondary throttle and its suction motor operating means. Such means comprises a spring capsule, generally indicated at **109** consisting of an elongated cylinder **101** which slidably receives link **66***a* connected to suction motor stem **64**. The link **66***a* has an enlarged head **102** at its free end between which and the opposite end of a cylinder **101** there is compressed a coiled spring **103**. Cylinder **101** has a detachable cap **104** at one end slidably receiving link **66***a* and, at its opposite end, is pinned to secondary throttle lever **20** at **105**. A throttle return spring for the primary throttle valve is indicated schematically at **106**.

Supplementary means for limiting the effective opening pressure which may be applied to the secondary throttle, tending to resist its closing, consists of a by-pass tube **107** extending around diaphragm **63** of the suction motor and connecting motor chambers **69** and **70**. A check valve **108** is received in valve casing **109** forming part of the by-pass and is normally urged against valve seat **110** by a coiled spring **111**. Under normal conditions, the by-pass is closed by means of spring-pressed check **108**. However, upon the existence of excessive depression in motor chamber **69** the valve can open to relieve this depression.

In operation of this form of the invention, elements **66***a*, **101**, **102**, **103**, and **104** form, in effect, a resiliently extensible link connecting the suction motor to secondary throttle lever **20**. Thus, the resistance to closing of the

secondary throttle when the primary throttle is substantially opened and the engine traveling at a high rate of speed, is limited by the compressive strength of spring 103. Spring 103, of course, must be weaker than throttle return spring 106 which is the only instrumentality for applying closing force to the primary throttle valve and, through it, to the secondary throttle. Check valved by-pass 107 assists the extensible link mechanism in accomplishing this result. Accordingly, prompt closing of the throttle valves is insured, when the accelerator pedal is released by the operator, notwithstanding very high suction which may be applied to motor chamber 69 through suction passage 71 at high engine speeds.

The means shown in the modification for limiting the opening force applied to the secondary throttle by means of the suction motor may be utilized with other types of two-stage throttle controls of the general type utilizing a suction motor for opening the secondary throttle and the extensible linkage and by-pass may be used individually if desired.

Primary and secondary stages in either form may be provided in separately or independently mounted carburetors instead of the single carburetor, as shown. Moreover, each carburetion stage may be provided with a single, double, or any number of mixture conduits and corresponding charge forming and controlling elements.

The exclusive use of all modifications as come within the scope of the appended claims is contemplated.

I claim:

1. A two-stage carburetion system comprising primary and secondary mixture conduits having primary and secondary throttle valves therein, a choke valve in the air entrance portion of said primary conduit and a Venturi tube in said primary conduit posterior to said choke valve, a manual control for said primary throttle valve, and means responsive to the difference of pressure between said air entrance portion of said primary conduit, posterior to said choke valve, and said Venturi tube for opening said secondary throttle valve as the rate of air flow through said Venturi tube increases.

2. A two-stage carburetion system for internal combustion engines comprising primary and secondary mixture conduits having primary and secondary throttle valves and mixing chambers, respectively, therein, a choke valve in the air entrance portion of said primary conduit, a manual control for said primary throttle valve, means normally urging said secondary throttle valve closed, and suction motor means responsive to the difference of pressure between said air entrance portion of said primary mixture conduit, posterior to said choke valve, and said mixing chamber for opening said secondary throttle valve as said primary throttle valve is opened and the velocity of air flow through said primary mixing chamber increases.

3. A two-stage carburetion system for internal combustion engines comprising primary and secondary induction conduits having primary and secondary throttle valves therein, Venturi tubes therein forming fuel and air mixing chambers, a choke valve in the air entrance portion of said primary conduit, means normally closing said secondary throttle valve when said primary throttle valve is closed, and suction motor means responsive to the difference of pressure in said primary conduit between the mixing chamber portion thereof and the part between said portion and said choke valve for opening said secondary throttle valve as said primary throttle valve is opened and the velocity of air flow through said primary conduit mixing chamber increases.

4. A two-stage carburetion system for internal combustion engines comprising primary and secondary induction conduits, each having air entrance and mixing chamber portions and fuel nozzles discharging, respectively, into said latter portions, primary and secondary throttle valves, respectively, in said conduits, a choke valve in the air entrance portion of said primary conduit, means for manually controlling said primary throttle valve, means for normally holding said secondary throttle valve closed, and a suction motor responsive to the pressure difference between the air entrance and mixing chamber portions of said primary conduit for opening said secondary throttle valve as said primary throttle valve opens and the air velocity through the primary mixing chamber increases, the pressure connection between said suction motor and said air entrance portion being posterior to said choke valve whereby opening of said secondary throttle is prevented when said choke valve is in a substantially restricting position.

5. In a two-stage carburetion system for internal combustion engines, primary and secondary induction conduits having primary and secondary throttle valves, respectively, therein, manual means to control said primary throttle valve, said secondary throttle valve automatically tending to open as said primary throttle valve opens and the rate of air flow through said primary conduit increases, and means preventing opening of said secondary throttle valve until said primary throttle has opened a predetermined degree and the air flow through said primary conduit has attained a predetermined rate comprising first and second pivoted levers rotatable, respectively, with said primary and secondary valves, and a spring stressed between said levers, said spring being applied to a portion of said second lever so as to tend to close said secondary throttle valve, and engaging a portion of said first lever substantially on center, when said primary throttle valve is closed and which moves in the direction tending to relax said spring as said primary throttle valve is opened.

6. A two-stage carburetion system for internal combustion engines comprising primary and secondary mixture conduits having primary and secondary throttle valves, respectively, therein with first and second pivoted levers movable, respectively, therewith, means including a motor for yieldably opening said secondary throttle valve responsive to increasing velocity of air flow through said primary conduit as said primary throttle valve opens, and means causing closing of said secondary throttle valve when said primary throttle valve is closed, comprising a tension spring member interconnecting the ends of said levers and forming a one-way operative connection between said levers and acting thereon in a direction tending to hold both valves closed.

7. A two-stage carburetion system for internal combustion engines comprising primary and secondary induction conduits, primary and secondary fuel and air mixing chambers and throttle valves, respectively, in said conduits, a choke valve in the air inlet portion of said primary conduit, manual means for controlling said primary throttle valve, a suction motor operatively connected to said secondary throttle valve, said motor having operating pressure connections with said primary conduit, respectively, in the mixing chamber and air entrance portions thereof whereby said secondary throttle opens responsive to increase of air flow through said primary conduit, actuating levers movable with said throttle valves, and spring means stressed between said levers for resisting opening of said secondary throttle variably as said primary throttle opens.

8. A carburetion system as described in claim 7 in which one of the suction motor pressure connections communicates with the air entrance portion of primary conduit between said primary mixing chamber and said choke valve whereby the pressure difference applied to said suction motor and accordingly the response of said secondary throttle to air flow changes is effected by the positioning of said choke valve.

9. A carburetion system as described in claim 7 in which one of the suction motor pressure connections communicates with the air entrance portion of primary conduit between said primary mixing chamber and said

choke valve whereby the opening of said secondary throttle by said suction motor is prevented when said choke valve is in a substantially restricting position.

10. A carburetion system as described in claim 7 further including a one-way operative connection between said valves for closing said secondary throttle valve when said primary valve is closed.

11. A two-stage carburetion system for internal combustion engines comprising primary and secondary induction conduits having fuel and air mixing chambers and primary and secondary throttle valves respectively, therein, means responsive to suction in said primary conduit for opening said secondary throttle valve, said suction responsive means having operating passages exposing the same respectively to said primary mixing chamber and to a source of substantially atmospheric pressure under normal operating conditions, and choke valve means located in the air entrance portion of said primary conduit and operatively associated with one of said operating passages so as to prevent opening of said secondary throttle when said choke valve means is closed to start the associated engine.

12. A two-stage carburetion system for internal combustion engines comprising primary and secondary mixture conduits having primary and secondary throttle valves, respectively, therein with first and second pivoted levers movable, respectively, therewith, means for yieldably opening said secondary throttle valve responsive to increasing velocity of air flow through said primary conduit as said primary throttle valve openings, and means causing closing of said secondary throttle when said primary throttle is closed, comprising a spring member forming a one-way operative connection between said levers, said means for causing closing of said secondary throttle valve consisting of a spring member connected to a portion of said second lever so as to urge said secondary throttle valve closed when said element is stressed and connected to a portion of said first lever which approaches an on-center position as said primary throttle is closed so as to increasingly stress said spring element.

13. A two-stage carburetion system for internal combustion engines comprising primary and secondary mixture conduits having primary and secondary throttle valves, respectively, therein with first and second pivoted levers movable, respectively, therewith, means for yieldably opening said secondary throttle valve responsive to increasing velocity of air flow through said primary conduit as said primary throttle valve opens, and means causing closing of said secondary throttle when said primary throttle is closed, comprising a spring member forming a one-way operative connection between said levers, said one-way spring member being inoperative to effect said secondary throttle valve in the vicinity of its closed position when said primary throttle is opened beyond a predetermined degree.

14. A two-stage carburetion system for internal combustion engines comprising primary and secondary mixture conduits having primary and secondary throttle valves, respectively, therein with first and second pivoted levers movable, respectively, therewith, means for yieldably opening said secondary throttle valve responsive to increasing velocity of air flow through said primary conduit as said primary throttle valve opens, and means causing closing of said secondary throttle when said primary throttle is closed, comprising a spring member forming a one-way operative connection between said levers and additional spring means resisting opening of said secondary throttle valve, both said spring member and said additional spring means applying decreasing closing force to said secondary throttle valve as said primary throttle valve is opened.

15. A two-stage carburetion system for internal combustion engines comprising primary and secondary mixture conduits having primary and secondary throttle valves, respectively, therein with first and second pivoted levers movable, respectively, therewith, means for yieldably opening said secondary throttle valve responsive to increasing velocity of air flow through said primary conduit as said primary throttle valve opens, and means causing closing of said secondary throttle when said primary throttle is closed, comprising a spring member forming a one-way operative connection between said levers and additional spring means resisting opening of said secondary throttle valve, said spring member becoming operative to urge said secondary throttle closed as said primary throttle approaches closed position, and said additional spring means being connected to a position of said first lever which moves away from dead center position as said primary throttle is opened, so as to progressively decrease the resistance applied to said secondary throttle valve thereby.

16. A two-stage carburetion system for internal combustion engines, comprising primary and secondary mixture conduits having primary and secondary throttle valves, respectively, therein with first and second pivoted levers movable, respectively, therewith, means for yieldably opening said secondary throttle valve responsive to increasing velocity of airflow through said primary conduit as said primary throttle valve opens, and means causing closing of said secondary throttle when said primary throttle is closed, comprising a tension spring interconnecting said levers and whose axis varies so as to tend to decrease the force acting to open said primary throttle and increase the force acting to close said secondary throttle during closing of said primary throttle.

17. In a carburetor, a secondary mixture conduit having a throttle valve therein, stop means limiting the closing movement of said valve, means to open said valve, and manual means for closing said valve comprising a first pivoted lever movable with said valve and a manually actuated pivoted lever means including a second lever, a link connected with said first pivoted lever, a lost motion pivoted connection between said link and second lever operative to close said valve as said link and second lever approach a dead center position relative to said lost motion pivoted connection, and a tension spring interconnecting the ends of said first and second levers and effective in the dead center position of said levers to yieldably maintain said valve closed.

18. A two-stage carburetion system for an internal combustion engine comprising primary and secondary induction conduits with primary and secondary mixing chambers and throttle valves, respectively, therein, manual means to open said primary throttle valve, a throttle return spring for closing the primary throttle valve, a suction motor having pressure and suction chambers and responsive to suction in said primary mixing chamber for opening said secondary throttle when said primary throttle valve is opened, interconnection means between said throttle valves for causing closing of said secondary throttle valve as said primary throttle valve is closed, a by-pass between the pressure and suction chambers of said motor, and a resiliently seated check valve in said by-pass opening toward said suction chamber to limit the effective force applied by said motor.

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