April 5, 1927. 1,623,750

S. J. PINGREE

APPARATUS FOR SUPPLYING FUEL TO INTERNAL COMBUSTION ENGINES

Filed Feb. 19, 1921 4 Sheets-Sheet 1

Fig. 1

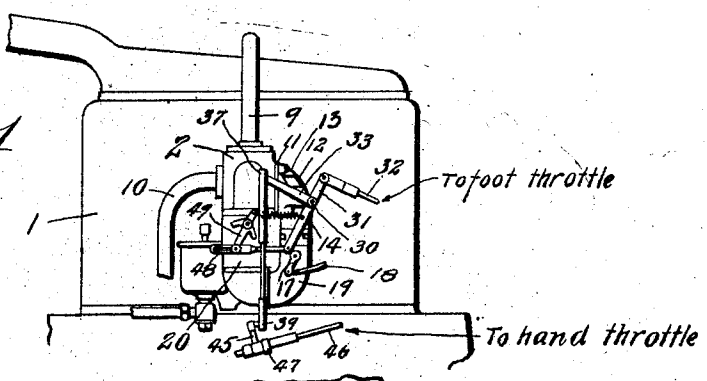
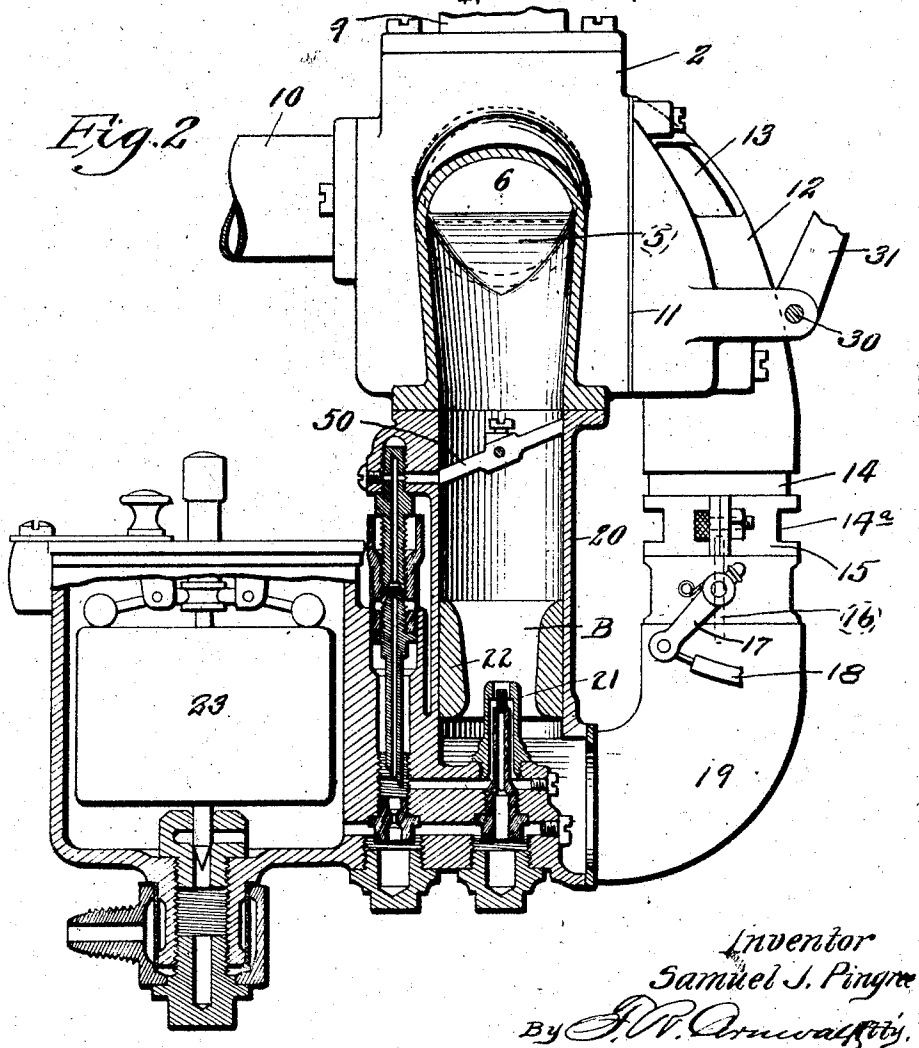


Fig. 2



Inventor
Samuel J. Pingree
By [illegible]

April 5, 1927. 1,623,750

S. J. PINGREE

APPARATUS FOR SUPPLYING FUEL TO INTERNAL COMBUSTION ENGINES

Filed Feb. 19, 1921 4 Sheets-Sheet 2

Fig. 3

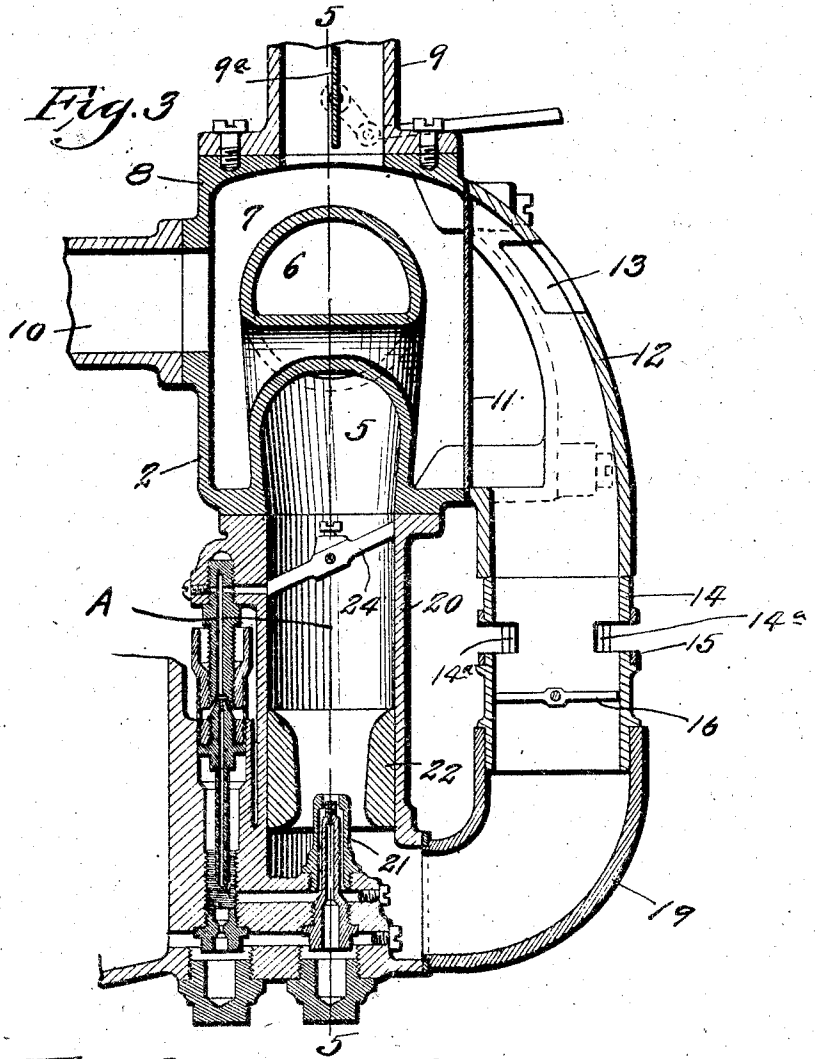
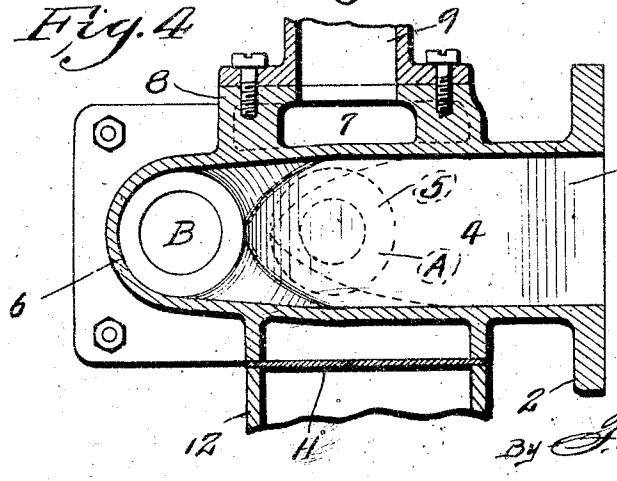


Fig. 4



Inventor
Samuel J. Pingree
By J. R. Conrad Atty.

April 5, 1927. S. J. PINGREE 1,623,750

APPARATUS FOR SUPPLYING FUEL TO INTERNAL COMBUSTION ENGINES

Filed Feb. 19, 1921 4 Sheets-Sheet 3

Fig. 5

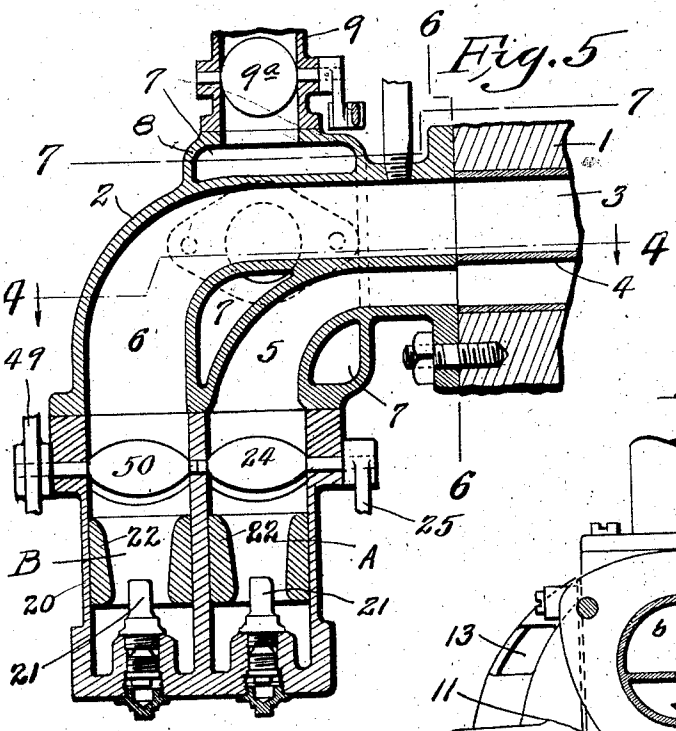


Fig. 6

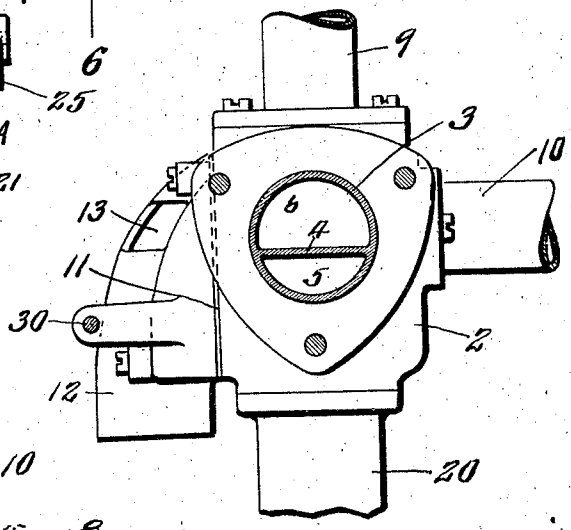
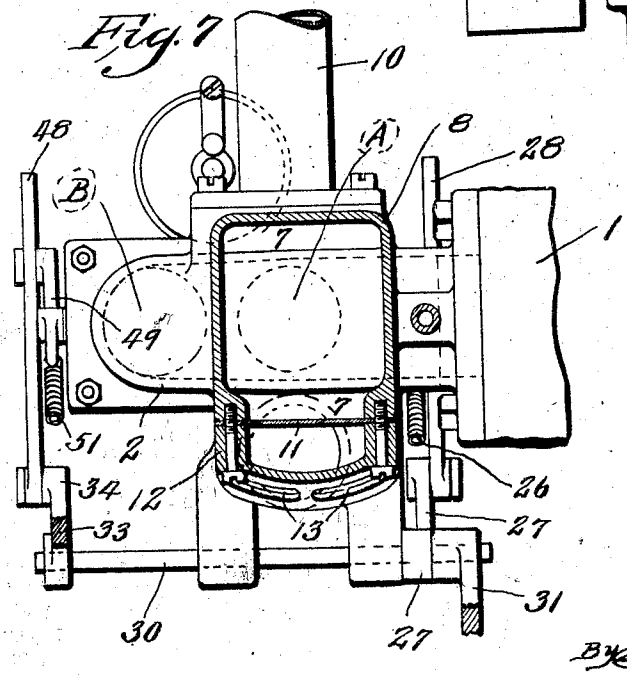


Fig. 7



Inventor
Samuel J. Pingree
By F. P. Cornwall Atty

April 5, 1927. 1,623,750

S. J. PINGREE

APPARATUS FOR SUPPLYING FUEL TO INTERNAL COMBUSTION ENGINES

Filed Feb. 19, 1921 4 Sheets-Sheet 4

Fig. 8

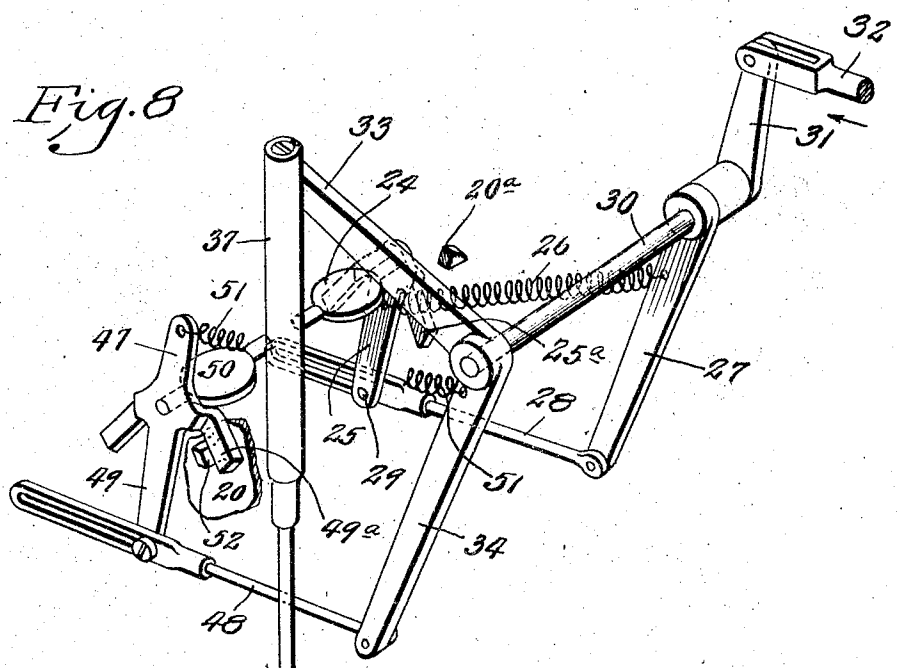


Fig. 9

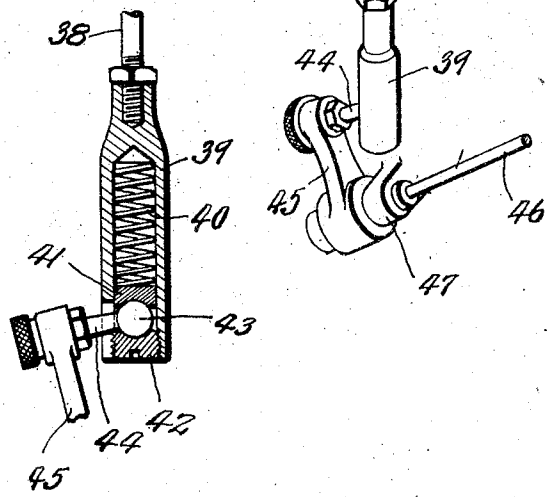
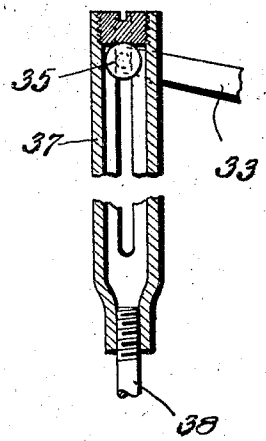


Fig. 10



Inventor
Samuel J. Pingree
By F. O. Conwell Atty.

Patented Apr. 5, 1927. 1,623,750

UNITED STATES PATENT OFFICE.

SAMUEL J. PINGREE, OF ST. LOUIS, MISSOURI, ASSIGNOR TO PINGREE PATENTS, INCORPORATED, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

APPARATUS FOR SUPPLYING FUEL TO INTERNAL-COMBUSTION ENGINES.

Application filed February 19, 1921. Serial No. 446,333.

Figure 1 is a side elevational view of my improved apparatus.

Figure 2 is an enlarged view of the same, partly in vertical section.

Figure 3 is a vertical sectional view through the central portion of the apparatus.

Figure 4 is a horizontal sectional view on line 4—4 of Figure 5.

Figure 5 is a vertical sectional view on line 5—5 of Figure 3 on a reduced scale.

Figure 6 is a sectional view on line 6—6 of Figure 5.

Figure 7 is a sectional view on line 7—7 of Figure 5.

Figure 8 is a diagrammatic view of the throttle operating mechanism.

Figure 9 is a detail view showing the connection between the lower end of a manually operable adjusting means and said valve operating mechanism.

Figure 10 is a detail view of the upper end of said connection.

This invention relates to a new and useful improvement in apparatus for supplying fuel to the cylinders of variable speed internal combustion engines, such as are extensively used in automotive units.

The object of my invention is to provide an apparatus of the character described which will provide highly efficient fuel under all conditions and be capable of producing the maximum torque and horsepower at all engine speeds.

The basic principles of my apparatus provide many advantages over general practice of the present day, among which are:

Easy starting and quick attainment of perfect carburetion regardless of temperatures.

Increase of acceleration; flexibility; power and speed with greater fuel economy and instantaneous response.

A cleaner engine through providing more thoroughly combustible fuel.

The atomization and vaporization of fuel in most of the instruments known as carburetors depends upon the velocity of the intake air for energy. If one vaporizer is used the velocity of the intake air must vary tremendously with the different engine speeds, and, as there is a certain velocity which is most efficient, the vaporizer which must function at widely varying velocities can not be highly efficient throughout the speed range of the engine.

It may be said that if the vaporizer be proportioned to create an efficient velocity at low engine speeds it will prove incapable of supplying a sufficient volume for maximum power output at high engine speeds; and vice versa, if proportioned to supply a sufficient volume for maximum power output at high engine speed it will not create an efficient velocity at low engine speeds.

A single vaporizer used on an engine which operates at widely varying speeds can not, therefore, be better than a compromise.

Recognizing the inability of a single vaporizer to satisfactorily meet the requirements of widely variable speed internal combustion engines, I have provided for the use of more than one vaporizer to make possible the handling of varying volume without creating inefficient velocities.

The passage which conducts the fuel (or combustible mixture) from the carburetor to the valves or cylinders of an internal combustion engine is commonly termed an intake manifold.

An intake manifold should conduct and deliver a thoroughly combustible fuel to the valves or cylinders; and, since vaporized mixtures readily condense and return to a liquid state, conditions under which this condensation can take place must be avoided in an intake manifold. Temperature and velocity are the main controlling elements and the elimination of the possibility of this condensation taking place, can be accomplished by the control of these two factors.

Heat must be limited, as it can have a detrimental effect in expanding the mixture and thereby reducing the volumetric efficiency of the cylinders, therefore, velocity must be considered as the more important factor.

It may be said that a poorly designed or proportioned manifold can undo what a good carburetor has accomplished.

What has been said of vaporizers (car-

buretors) applies also to the intake manifolds; in that—there is a certain velocity in an intake manifold, which is most efficient. In a single manifold, the velocity must vary tremendously with the engine speeds, and the intake manifold cannot be highly efficient throughout the speed range of the engine.

It may be said that if the manifold be proportioned to provide an efficient velocity at low engine speeds it will prove incapable of supplying a sufficient volume for maximum power output at high engine speeds; and vice versa, if proportioned to supply a sufficient volume for maximum power output at high speeds it will not provide an efficient velocity at low engine speeds.

A single intake manifold used on an engine which operates at widely varying speeds cannot, therefore, be better than a compromise.

Recognizing the inability of a single intake manifold to satisfactorily meet the requirements of widely variable speed internal combustion engines, I have provided for the use of more than one passage (pipe or manifold, etc.) to make possible the handling of varying volumes without producing inefficient velocities.

Since present available fuel is not readily vaporized at ordinary atmospheric temperatures, the application (or supplying) of heat is necessary in order to produce a really vaporized fuel.

It has been found advantageous to heat the initial air supply so that heat will be available for vaporizing when the air comes into contact with the fuel.

It is difficult, however, to supply a sufficient amount of heat in this manner and the aplication (or supplying) of heat to the mixture after it has left the carburetor is desirable.

The heat, however, applied should be available when the engine is started; and the amount of heat should be in proportion to the quantity of air and fuel to where the engine begins to deliver its maximum; at which point the volumetric capacity of the cylinders becomes an important factor, and it is desirable that the combustible reach the cylinders in a dense form, so that the maximum expansion can be obtained in the cylinders.

I provide for heating the initial air supply of the primary carburetor and the application or supplying of heat to the primary mixture after it has left the carburetor.

I provide that the initial air supply and the fuel or mixture above the carburetor of the primary fuel supply shall both be supplied with heat from the same heating unit. This maintains a constant relation of temperatures between the two, which is an important factor in maintaining a uniformly efficient fuel mixture throughout the different conditions under which the engine may be operated.

Control of the heat supply regulates the heat furnished to both the primary air supply and the fuel mixture above the carburetor of the primary fuel supply, and affords a simple means for controlling both without disturbing the ratio between them.

Since, as already explained, a dense or unexpanded mixture is essential for maximum output, very little, if any, heat is applied or supplied to other than the primary combustible supply.

Any source of heat may be used, but in the apparatus described I have made use of exhaust gases. They are available immediately that the engine is started, easily handled, and cost nothing. furnish sufficient heat for all ordinary conditions and the heat furnished by or obtained from exhaust gases is in proportion to the amount required as they vary directly with speed, load, etc., of the engine.

The apparatus is capable of adjustments, which will meet any conditions and are easily made and stable.

The secondary supply, or supplies, should, of course, be adjusted to obtain the maximum results from the engine in speed, torque and horsepower, but the primary supply may be adjusted to secure good average performance, maximum mileage or greatest acceleration without interfering with the maximum output.

As an illustration, a large motor truck making a long haul, heavily loaded one way and returning empty, requiring maximum output from the engine on the loaded journey and very little on the return. My apparatus could be adjusted to produce the maximum power, etc., in the one instance and maximum mileage (economy) in the other.

In an automobile of the pleasure car type, most of the work accomplished by the engine is in maintaining a previously established car speed, which with the exceptions of high speeds, hard pulling on hills, or in sand or mud, requires very little power. A lean mixture under this condition gives very excellent results, but fails to prove satisfactory when acceleration and actual power output are wanted.

Maximum efficiency is obtained through the use of more than one practically individual fuel supply, capable of independent adjustment and absolute control.

Tests have been conducted on an engine presenting many carbureting difficulties with highly satisfactory results. Perfect carburetion was obtained in a remarkably short time after starting the engine, when at temperatures of below 20° F., and was maintained regardless of engine temperature.

Increased performance was very noticeable under all conditions of driving with an increase of twenty-five per cent in gasoline mileage.

In the drawings, I have shown a preferable form of apparatus for carrying my invention into effect, but it is obvious that changes in the construction and arrangements of the parts can be made without in the least departing from the nature and spirit of my invention.

In the drawings, 1 indicates the casting of a multiple cylinder engine to which is bolted, or otherwise secured, a casting in the form of a coupling or connection 2. 3 indicates a conduit or pipe arranged in the casting 1 and leading from one side of said casting 1 (on which the coupling 2 is connected) to the intake valve pockets, not shown, on the opposite side of said casting 1. The intake valve mechanism forms no part of my present invention.

The pipe 3 which form a continuation of the conduits formed in the coupling 2, is divided by a wall 4 located to one side of the center line so as to form conduits or manifolds of different cross-sectional areas, one being larger than the other. Wall 4 extends throughout the length of pipe 3, and is the division wall between the small conduit or manifold leading from the small carburetor, and the larger conduit or manifold leading from the larger carburetor, which is sequentially operated.

The coupling 2 is provided with conduits 5 and 6 and around and between these conduits are spaces 7 formed by an outer housing wall 8 (see Figures 3 and 5). 9 indicates a pipe leading from the exhaust manifold to the top of the chamber 7, said pipe having a manually operable control valve 9^a therein, and 10 indicates a pipe leading from the side of chamber 7 to a muffler or to atmosphere. This chamber 7 entirely surrounds and extends between the walls forming conduits 5 and 6, and consequently the exhaust from the engine cylinder will spot heat these conduit walls on all sides at this one point.

11 indicates a thin plate closing one side of chamber 7 and forming a heating surface against which air for the small initial or primary carburetor is drawn and heated in the operation of the device. The stove for heating this air is indicated by a casting 12 (see Figure 3) in the upper part of which are openings 13 through which air is drawn, said air impinging against plate 11 and absorbing heat therefrom as it descends through the stove. The lower end of the stove connects with a coupling 14 having slots or openings 14^a in its walls and an adjustable split damper ring 15 is arranged thereon, whereby the areas of these slots may be regulated and a quantity of air at atmospheric temperature taken in at this point, controlled. In warm weather, valve 9^a may be closed and this ring 15 may be manually adjusted so as to fully expose the openings 14^a, whereas in cold weather, valve 9^a may be fully opened and this ring 15 turned so as to partially or entirely close the openings 14^a.

16 indicates a wing valve located in the coupling 14, preferably below the openings 14^a. This wing valve 16 may have a rock arm 17 on one end of its pivoted shaft to which may be connected an operating rod 18 (see Figure 2) leading to some point within convenient reach of the operator, such as the steering wheel or dashboard of the machine, whereby the operator can open and close this valve and thereby regulate and control the supply of air to the small initial carburetor.

Coupling 14 leads into the upper end of an elbow connection 19 (see Figure 3) which elbow connection supplies air to the smaller carburetor A below and to one side of the nozzle thereof.

I have shown but one form of carburetor. It is obvious that other forms of carburetor could be employed. For the purpose of my present invention, we will say that carburetors A and B are in the same main casting 20, and that 21 is the nozzle arranged in the bottom of each carburetor chamber, 22 being the Venturi rings in each carburetor chamber, located about the upper end of said nozzles 21. The Venturi tube in carburetor A is preferably slightly smaller in its interior diameter than is the Venturi tube in carburetor B. The supply of gasoline to the nozzles in these two carburetors may be controlled by a single float valve 23, as shown, or there may be a float valve for each nozzle. A bypass may also be provided, and a double nozzle used, as shown, but these form no part of my present invention.

The upper portion of the chamber in carburetor A connects with the conduit 5 in casting 2 and the upper portion of the chamber in carburetor B connects with the conduit 6 in said casting 2.

24 indicates a throttle valve in the upper portion of the chamber in carburetor A. This valve (see Figure 8) has a rock arm 25 connected to a shaft by which it may be operated. A spring 26 connected to this rock arm and to a rock arm 27 tends to open valve 24. The full open position of valve 24 is determined when the projection 25^a on rock arm 25 engages a stop 20^a on casting 20. Valve 24 is held closed by a rod 28 having a slot in one end in which operates a pin 29 carried by the lower end of rock arm 25. This rod 28 is connected to the lower end of the rock arm 27 which is fixedly mounted on a shaft 30, which shaft carries a fixed rock arm 31 at one end. 32 indicates

a rod leading to a foot throttle in a convenient position to be operated by the driver. When this foot throttle is operated and rod 32 moved in the direction of the arrow, rod 28 will be moved so as to permit spring 26 to open valve 24. The opposite end of shaft 30 carries a bell crank composed of the arms 33 and 34, the former of which has a ball-shaped member 35 arranged in the chamber in the upper end of a tube 37 carried by a rod 38. This rod 38 carries a tube 39 at its lower end, which tube houses a spring 40 operating above a spring cap 41. The lower end of the tube is threaded to receive a plug 42.

43 is a ball shaped extremity of a pin 44 operating in a slot in the side of the tube 39 and carried by the end of a rock arm 45, said rock arm being arranged on the end of a rod 46 mounted in the steering post (not shown). This rod 46 is connected to a hand throttle, preferably cooperating with a notched segment of the steering wheel of the machine, so that when this hand throttle is adjusted up or down along the notched segment, it will control the position of the throttle valve 24 in carburetor A, or by an extreme movement, will also control the movement in carburetor B.

Bellcrank arm 34 is connected to a rod 48 having a slotted extension at one end for engaging a rock arm 49 arranged on the end of the shaft carrying throttle valve 50 of carburetor B. A spring 51 connected to arms 47 and 34 tends to hold throttle valve 50 closed, in which position an extension 49^a on arm 49 engages a lug 52 on casting 20.

In operation, the throttle valve controlling mechanism, just above described, will, by moving rod 32 in the direction of the arrow, assuming both throttle valves stand closed at the beginning of the operation, rock shaft 30 and swing both arms 27 and 34 in unison. Arm 33 connected to arm 34 will idly move downwardly with its pin in the slot of tube 37. The withdrawal of the slotted portion of rod 28 will permit pin 29 on arm 25 to follow, thus enabling spring 26 to open the throttle valve 24 in carburetor A. Before throttle valve 24 reaches its full open position, the slot in the slotted end of rod 48 will have been exhausted so that arm 49 is in readiness to be engaged by the outer end of the slotted extension of arm 48. When this engagement occurs, arm 49 will be rocked and will open valve 50 in carburetor B before valve 24 in carburetor A reaches its full open position. The slot in the tube 37 permits the downward movement of an arm 33 and pin 35, when arms 27 and 34 are actuated by the foot throttle without affecting or interfering with tube 37 and its connection with the hand throttle. The lug 20^a on casing 20 determines the full open position of throttle valve 24, but the slotted extension of rod 28 is permitted to move because such movement is necessary to enable the valve 50 in carburetor B to reach its full open position. The object of thus overlapping the opening movements of the throttle valves is to avoid any appreciable disturbance of the velocities of the fuelized air passing through the manifolds to the engine.

It is desirable to maintain a high velocity in the manifold leading from the carburetor A and if the throttle in carburetor B is suddenly fully opened, it is obvious that the suddenly increased area afforded by the manifold from carburetor B, under these conditions, will cause the velocity from carburetor A to drop. I, therefore, prefer to start to open B before A is fully opened, thus occasioning no disturbance in the efficient supply of fuelized air to the engine, the velocities in the two manifolds will be practically maintained according to the speed of the engine.

Rod 32 connected to rock arm 31 leads to the dashboard where it is operated by a foot throttle. It is possible by operating rod 32 to control the opening movements of the throttle valves independently of the rod 46.

Among the advantages claimed for the above described apparatus may be mentioned: easy starting; quick attainment of perfect carburetion; increased acceleration; quicker and smoother power; increased flexibility; instant response; increased hill climbing ability; increased top speed; greater fuel economy; less dilution of oil; less carbonization; less valve grinding; longer life of entire motor due to better lubrication and less oil dilution; and more even flow of power due to balanced expansions.

The device is extremely simple and requires no special attention. No adjustments are needed beyond those made in the shop or assembling plant and no derangements are liable except accidental. The "double" carburetor can be purchased in the open market and only one extra moving part is added thereto to adapt it for use in my improved construction. There are few wearing joints and practically no maintenance cost. The balanced application of heat eliminates a special hot air stove and tubing. In fact, the entire apparatus constituting my improvement can be assembled as a complete unit within itself and installed in position on a commercial car by simply removing the single carburetor and manifold and attaching my improved device, making the necessary connections thereto, providing such extra controls are deemed desirable or necessary.

What I claim is:

1. The combination of a carbureter having a plurality of carbureting chambers co-

extensive with each other and of different cross sectional areas, independently operable throttle valves arranged therein, means for admitting fuel to said carbureter, an intake manifold leading from said carbureter and having separate passages for said carbureting chambers, said passages extending the full length of said intake manifold and being proportioned to the desired velocity of the mixture passing therethrough, means for yieldingly bringing one of said valves into a closed position and positively opening the same, means for yieldingly moving the other one of said valves into an open position and positively closing the same, and operating means for both of said means for sequentially operating said valves.

2. The combination of a carbureter having a plurality of separate carbureting chambers of different cross sectional areas, independently operable throttle valves arranged in said chambers, means for admitting fuel to said carbureter, an intake manifold leading from said carbureter and having formed therein throughout its entire length a partition wall dividing said intake manifold into two separate passages of different cross sectional areas for connection to said carbureting chambers, yielding means for moving one of said valves into a closed position, yielding means for moving the other one of said valves into an open position, and means cooperating with said yielding means for positively actuating each valve in opposite direction to said respective yielding means and operable to actuate said valves in time relation with each other so as to maintain efficient velocities through said carbureting chambers and said manifold passages.

3. The combination of a carbureter having a plurality of separate carbureting chambers of different cross sectional areas, throttle valves for controlling said chambers, means for admitting fuel to said carbureter, an intake manifold having formed therein throughout its entire length, a partition wall dividing said manifold into two separate passages of different cross sectional areas and leading from the respective carbureting chambers whereby the fuel mixture of each chamber is caused to traverse throughout its travel to the engine through a passage of a given cross sectional area yielding means for closing one of said valves, yielding means for opening the other valve, and means cooperating with said yielding means and having positive operative connection with said valves for actuating the latter in predetermined relation with each other.

4. The combination of a carbureter having a plurality of independent carbureting chambers of different cross sectional areas, independently operable throttle valves in said chambers, means for admitting fuel to said carbureter, a single piece coupling secured at one end to said carbureter and having its opposite end adapted to be secured to the intake manifold of an engine, said coupling being provided throughout its entire length with a partition wall dividing said coupling into two independent passages of different cross sectional areas, thereby delivering the fuel mixture of each carbureting passage to the engine independently of each other and at varying velocities, an arm fixed to each valve, a spring connected to each arm for moving respective valve in one direction, and operating means having lost motion connection with each arm for positively actuating both of said valves in opposite directions to each other and against the influence of the respective springs.

5. The combination of a carburetor having two carbureting passages of different cross sectional areas, means for admitting fuel to said carburetor, a throttle valve arranged in each passage, a single piece pipe connection secured at one end to said carburetor and having its opposite end adapted to be secured to the intake of an engine, said pipe connection being provided throughout its entire length with a partition wall dividing said pipe into two passages of unequal cross sectional areas for delivering the fuel mixtures of the carbureting passages to the engine independently of each other, a spring for opening the valve of the smaller carbureting passage, a link for positively closing said valve, a spring for closing the valve of the larger carbureting passage a link for positively opening the last mentioned valve, and means for simultaneously actuating said links, said links having lost motion connection with said valves whereby the latter are sequentially operated.

6. The combination of a carburetor having two carbureting passages, means for admitting fuel to said carburetor, a throttle valve arranged in each passage, an arm fixed to each throttle valve, a link having a slot and pin connection with each arm, a rock shaft, a rock arm fixed to said shaft and connected to each link for actuating the same, a spring connected to each valve arm, the spring of one valve being connected to said arm at a point intermediate the axis of said valve and the slot and pin connection of said arm with the respective link thereby maintaining said valve positively closed by said link and adapted to be yieldingly opened by said spring, and the spring of the other valve being connected to the valve arm at a point diametrically opposite to the slot and pin connection of said valve arm with the respective link whereby the last mentioned valve is held yieldingly closed by said spring and is adapted to be posi-

tively opened by the respective link, thereby providing sequential operation of said valves, and a single piece casting having one end connected to said carburetor and having the opposite end adapted to be connected to the intake manifold of an engine, said casting being provided with coextensive passageways for delivering the fuel mixtures of the two carbureting passages to the engine independently of each other.

In testimony whereof I hereunto affix my signature this 16th day of February, 1921.

SAMUEL J. PINGREE.