

F. CONRAD.
CARBURETER.

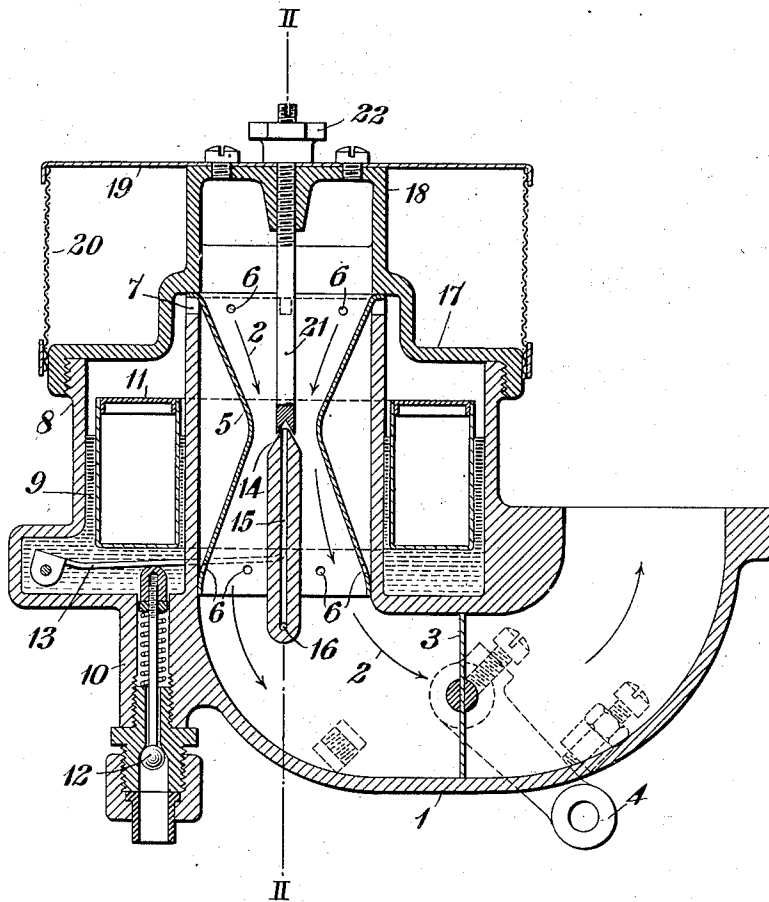
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Patented Sept. 5, 1911.

2 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

C. L. Bilcher
R. F. Pearson

INVENTOR

Frank Conrad

BY

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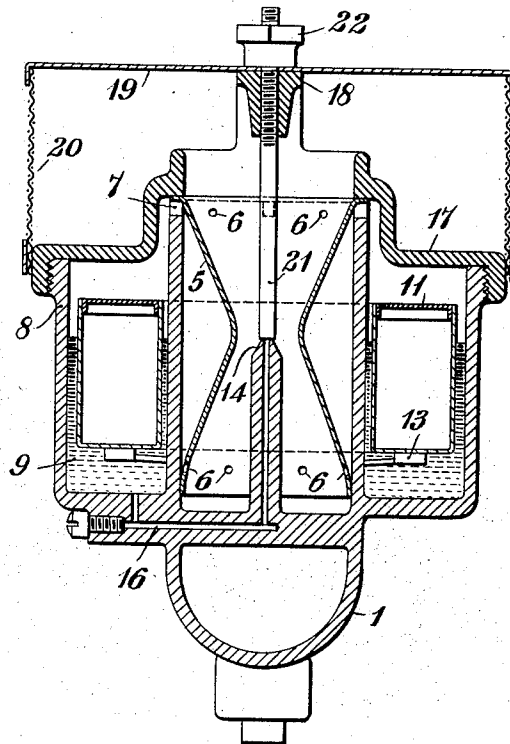
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2 SHEETS—SHEET 2.

Fig. 2.



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CARBURETER.

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To all whom it may concern:

Be it known that I, FRANK CONRAD, a citizen of the United States, and a resident of Swissvale, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Carbureters, of which the following is a specification.

My invention relates to carbureters for volatile liquid fuels, and particularly to such as provide explosive mixtures for internal combustion engines, or for other purposes.

The object of my invention is to provide a carbureter of such structure and arrangement of the parts that the proportions of the volatilized liquid fuel and air, or other constituents of a mixture, will remain substantially constant irrespective of the rate at which the mixture is supplied; *i. e.*, irrespective of the speed of operation of an engine in connection with which the carbureter may be employed.

In the operation of internal combustion engines, it has been found that, in order to obtain either the maximum amount of power from an engine, or the greatest economy in fuel consumption, the proportion of liquid fuel to air in the explosive mixture should remain substantially constant for all speeds of operation. In the most usual construction of a carbureter, a nozzle that communicates with a supply of liquid fuel opens into an inlet passage for air at a constricted portion, so that the amount of fuel entering into the mixture depends upon the pressure or suction produced by the flow of the entering air past the nozzle. With such carbureters, however, the proportions of fuel to air do not remain constant for all speeds of the engine, because the suction or pressure causing the discharge of fuel from the nozzle does not vary directly with the speed of the entering air.

Various attempts have heretofore been made to cause a discharge of fuel from the nozzle at a rate proportional to the speed of the air flowing past the nozzle, but such means have effected the desired result only imperfectly, and at only a limited number of predetermined speeds of the entering air, the correct proportions of fuel and air in the mixture not being maintained at other speeds. Such means have also comprised valves and other delicately adjusted and complicated mechanical devices that render the same particularly liable to disorder and

materially increase the expense of maintenance of an engine.

Since the volume and speed of a liquid flowing out of a smooth orifice or nozzle varies approximately as the square root of the pressure effecting its discharge, the pressure produced at the fuel nozzle should vary as the square of the quantity of the passing air, in order that the liquid fuel may be discharged from the nozzle at a rate proportional to the rate at which air is supplied to the engine. In the present invention, this result is effected under all conditions of engine operation by passing the entering air through a Venturi tube into which the liquid fuel is supplied at its constricted portion, and by applying a pressure substantially proportional to the difference of pressures at the enlarged and constricted portions of the Venturi tube to effect a discharge of the liquid fuel from the nozzle. Since this difference of pressures is approximately proportional to the square of the quantity of air passing through the tube, it will be seen that the above-stated requisite conditions are fulfilled in a very effective manner, and that the means employed may be very simple and inexpensive in construction.

The manner in which the desired result is secured in the present instance will be more fully explained in connection with the accompanying drawings, Figure 1 of which is a longitudinal sectional view of a carbureter that embodies the invention, and Fig. 2 is a similar view on the line II—II of Fig. 1.

The carbureter comprises a J-shaped inlet pipe 1 through which air and the explosive mixture are drawn in the direction of arrows 2 by the engine or other device (not shown) in connection with which the carbureter is employed, a throttle 3, that is operated by a crank arm 4, being provided for governing the effective area of the inlet passage.

Closely fitted at its ends within the longer leg of the inlet pipe is another pipe or tube 5 in the form of two gradually tapering frusto-cones placed end to end with the smallest peripheries joining, the interior of the tube, as well as of the remainder of the inlet passage, being devoid of abrupt and angular changes of contour. The tube 5 is what is commonly known as a Venturi

tube and is provided near each end with apertures 6, there preferably being a larger number and, consequently, a larger total area of the apertures at the bottom of the tube than at the top. The upper end of the Venturi tube is flared outwardly and rests upon the top of the longer leg of the J-shaped inlet pipe, a suitable number of notches being provided in the end of the pipe at 7 in order to provide communication between both ends of the Venturi tube and the upper portion of an annular receptacle 8 that surrounds the inlet pipe and is cast integral therewith, the receptacle containing any suitable liquid fuel 9, such as gasoline. The liquid fuel is supplied to the receptacle through a pipe 10, and its level within the receptacle is maintained approximately constant, in the usual manner, by means of a float 11 that governs the operation of a valve 12 within the supply pipe 10, the weight of the float being partially supported by means of a forked spring 13.

Within the inlet passage and terminating at the most restricted portion of the Venturi tube, as well as slightly above the level of the liquid in the receptacle 8, is a nozzle 14 that communicates, by means of a vertical passage 15 and a horizontal passage 16, with the bottom of the receptacle 8. Screw-threaded upon the outer wall of the receptacle 8, and fitting closely upon the upper end thereof and of the flared upper end of the Venturi tube, is an annular top casting 17. Extending upwardly from the top casting and spanning the central opening therein is a bridge piece 18 that carries a supporting plate 19 for a cylindrical gauze screen 20 whereby dust and other foreign particles are prevented from entering the carbureter. Screw-threaded in the bridge piece 18 and extending downwardly into the inlet passage in alinement with the nozzle 14, is a rod 21 having its lower end shaped to fit the end of the nozzle, the said rod serving as means for adjusting the size of the nozzle opening. A lock nut 22 is provided upon the outer end of the rod 21.

In the operation of the carbureter, air is drawn through the screen 20 and the inlet passage in the direction of the arrows 2, and, as it passes through the Venturi tube, a reduction in the pressure first occurs with the decrease in the diameter of the tube and the consequent increase in the speed of the air, and then an increase in the pressure occurs as the diameter of the tube increases and the speed of the air again decreases. The fuel within the receptacle 8 is cut off from atmospheric pressure but, because of the communication provided by the notches at 7 and the apertures 6 between the upper portion of the receptacle and the enlarged portions of the Venturi tube, the surface of the fuel is subjected to a pressure substan-

tially proportional to the mean or average of the pressures respectively at the enlarged portions of the Venturi tube, while the liquid at the nozzle is subjected to a pressure substantially proportional to that at the constricted portion of the inlet pipe. Thus, the head or pressure tending to effect a discharge of liquid fuel from the nozzle is proportional to the difference between the pressure at the constricted portion of the Venturi tube and the mean or average of the pressures respectively at the enlarged portions of the Venturi tube. There is, of course, some loss of pressure between the two ends of the Venturi tube inevitably due to friction and similar causes, and if the two frusto-conical portions of the tube are similar, substantially equal losses will occur respectively between the upper end of the tube and its most constricted portion, and between the most constricted portion of the tube and its lower end. Because of these losses of pressure in the two ends of the tube, the difference between the pressure at the upper end of the tube and that at its most constricted portion will be greater than the theoretical difference of pressure, and the difference between the pressure at the most constricted portion of the tube and that at its lower enlarged end will be less than the theoretical difference of the pressures at these points, the theoretical differences of pressure being those that would occur if there were no losses due to friction and similar causes. The difference, however, between the average or mean of the pressures respectively at the enlarged portions of the Venturi tube and that at its most constricted portion is substantially the same in amount as the theoretical difference of the pressures respectively at the enlarged and constricted portions of the tube. Since the apertures 6 and the notches at 7 provide communication between both ends of the tube and the upper portion of the fuel receptacle, and thus permit of applying to the surface of the fuel within the receptacle a pressure that is proportional to the average or mean of the pressures at the two ends of the Venturi tube, it will be seen that the difference of the pressures tending to effect a discharge of liquid fuel from the nozzle is substantially the same as the theoretical difference of the pressures. The quantity of liquid fuel discharged from the nozzle follows the law for the quantity of fluid that flows from a smooth orifice, which is represented by the formula,

$$Q = C \times A \times \sqrt{2gH},$$

in which C is a constant, A the area of the orifice, and H the head or pressure tending to effect such discharge, which, in the present instance, is the difference of pressures respectively at the enlarged and constricted

portions of the inlet pipe. The quantity of fluid flowing through a Venturi tube follows the formula,

$$Q' = K \times A' \times \sqrt{2gH},$$

in which K is a constant, A is the area of the tube at its most constricted portion, and H is again the difference of head or pressure between the enlarged and constricted portions of the tube. From this it is readily seen that the pressure tending to effect a discharge of liquid fuel from the nozzle is proportional to the square of the quantity or speed of the air passing through the inlet pipe. From this formula, also,

$$H = \frac{Q'^2}{2g \times K^2 \times A'^2}.$$

Substituting in the above formula for the discharge of liquid fuel from the nozzle,

$$Q = \frac{C \times A}{K \times A'} \times Q',$$

from which it is seen that the quantity of liquid fuel discharged from the nozzle is proportional to the quantity of air passing through the inlet pipe, and the proportions of air and fuel in the mixture remain substantially constant irrespective of the quantity and speed of the entering air, or of the speed of the engine in connection with which the carbureter may be employed. However, the substantial constancy of the ratio of the quantities of fuel and air in the mixture for all velocities of the entering air can be maintained only by the elimination, as far as possible, of losses of pressure, and particularly those due to eddies and throttling, which losses vary with the velocity of the entering air and according to no definite laws, with the result that the pressures within the inlet pipe would be differently affected at different velocities of the entering air. By reason of the gradual tapering of the two frusto-conical portions of the Venturi tube in the present device, and of the avoidance of all abrupt and angular changes of contour upon the interior of the inlet pipe, and particularly in the vicinity of the passages that communicate with the receptacle 6, the formation of eddies and throttling of the air within the inlet passage are substantially obviated, and no loss of pressure, therefore, occurs within the Venturi tube, except, of course, that inevitably due to friction. Consequently, the proportions of the fuel and air in the mixture are always substantially the same.

Because of the presence of the nozzle 14 in the lower end of the Venturi tube, and also because of the fact that vaporized fuel is mixed with the air in the lower end of the tube, the losses of pressure respectively in the upper and lower portions of the tube

are, in the present instance, not the same, and it has, therefore, been found desirable to provide the apertures 6 at the lower end of the tube with a larger total area than those at the upper end. However, the relative areas of the apertures at top and bottom of the Venturi tube may, within the spirit of the invention, be adjusted in accordance with any given conditions or construction and arrangement of the parts.

It will, of course, be understood that the device will operate approximately as above explained if communication is afforded between the upper portion of the fuel receptacle and only one of the enlarged portions of the Venturi tube, though its operation is greatly improved by the provision of means affording communication between both the enlarged portions of the Venturi tube and the upper portion of the fuel receptacle.

The principles herein set forth may also be applied in the measurement of the quantity of a medium flowing through a pipe, as, for instance, by providing the pipe with a constricted portion and by connecting the extremities of a U-tube containing water, mercury or other suitable liquid respectively with the constricted portion of the pipe and with both the adjacent enlarged portions. With such an arrangement, the accuracy of the measurements will be substantially unaffected by losses due to friction in the Venturi tube. Other suitable devices may, of course, be employed instead of the U-tube, if desired.

I claim as my invention:

1. A carbureter comprising a receptacle for liquid fuel, an inlet pipe for the explosive mixture, a nozzle opening into the pipe and communicating with the receptacle, and means affording communication between the upper portion of the said receptacle and the inlet pipe upon both sides of the nozzle opening.

2. A carbureter comprising a receptacle for liquid fuel, an inlet pipe for the explosive mixture having a constricted intermediate portion, means affording communication between the lower portion of the receptacle and the constricted portion of the inlet pipe, and means affording communication between the upper portion of the receptacle and the inlet pipe upon both sides of its constricted portion.

3. The combination with a pipe for directing the flow of a fluid having an intermediate constricted portion, of a receptacle for a liquid having communication with the constricted portion of the pipe and also with both the adjoining enlarged portions thereof.

4. In a carbureter, the combination with an inlet pipe devoid upon its interior of abrupt and angular changes of contour and comprising a gradually constricted portion,

of a receptacle for liquid fuel, means affording communication between the lower portion of the receptacle and the inlet pipe, and means providing communication exclusively between the upper portion of the receptacle and an enlarged portion of the inlet pipe.

5. In a carbureter, the combination with an inlet pipe devoid upon its interior of abrupt and angular changes of contour and comprising two similar frusto-conical portions joined at their smaller circumferences, of a receptacle for liquid fuel, and means for applying substantially exclusively the differences of the pressures respectively at the enlarged and constricted portions of the inlet pipe to effect discharge of liquid fuel into the inlet pipe.

6. In a carbureter, the combination with an inlet pipe devoid upon its interior of abrupt and angular changes of contour and comprising two similar frusto-conical portions joined at their smaller circumferences, of a receptacle for liquid fuel, means affording communication between the lower portion of the receptacle and the inlet pipe, and means providing communication exclusively between the upper portion of the receptacle and an enlarged portion of the inlet pipe.

7. In a carbureter, the combination with an inlet pipe devoid upon its interior of abrupt and angular changes of contour and comprising a gradually constricted portion, of a receptacle for liquid fuel, means affording communication between the lower portion of the receptacle and the constricted portion of the inlet pipe, and means providing communication exclusively between the upper portion of the receptacle and an enlarged portion of the inlet pipe.

8. In a carbureter, the combination with an inlet pipe, devoid upon its interior of abrupt and angular changes of contour and comprising a gradually constricted portion, of a receptacle for liquid fuel the upper portion of which has communication with the exterior only through the inlet pipe, and means for applying the differences of the pressures respectively at the enlarged and constricted portions of the inlet pipe to effect a discharge of liquid fuel into the inlet pipe.

9. A carbureter comprising an inlet pipe

devoid upon its interior of abrupt and angular changes of contour and having a gradually constricted portion, and a receptacle for liquid fuel, a communicating passage being provided between the lower portion of the fuel receptacle and the constricted portion of the inlet pipe and another passage being provided that connects the upper portion of the fuel receptacle exclusively with an enlarged portion of the inlet pipe.

10. In a carbureter, the combination with an inlet pipe devoid upon its interior of abrupt changes of contour and comprising a gradually constricted portion, of a receptacle for liquid fuel, and means for applying substantially exclusively the differences of the pressures respectively at the enlarged and constricted portions of the inlet pipe to effect a discharge of liquid fuel into the inlet pipe.

11. A carbureter comprising an inlet pipe having a gradually constricted portion, a receptacle for liquid fuel, means providing a communicating passage between the lower portion of the receptacle and the constricted portion of the inlet pipe, and means providing another communicating passage exclusively between the upper portion of the receptacle and a larger portion of the inlet pipe, the inlet pipe being unobstructed adjacent to the opening of the latter passage thereinto.

12. A carbureter comprising an inlet pipe having a gradually constricted portion, a receptacle for liquid fuel, means providing a communicating passage between the lower portion of the receptacle and the constricted portion of the inlet pipe, and means providing another communicating passage exclusively between the upper portion of the receptacle and a larger portion of the inlet pipe, the inlet pipe being unobstructed adjacent to the opening of the latter passage thereinto by means substantially affecting the hydrostatic pressure at that point.

In testimony whereof, I have hereunto subscribed my name this 21st day of February, 1908.

FRANK CONRAD.

Witnesses:

DEAN HARVEY,
BIRNEY HINES.