Dec. 3, 1929. P. S. TICE 1,737,813

CARBURETING SYSTEM FOR INTERNAL COMBUSTION ENGINES

Original Filed Oct. 21, 1920 2 Sheets-Sheet 1

Fig. 1.

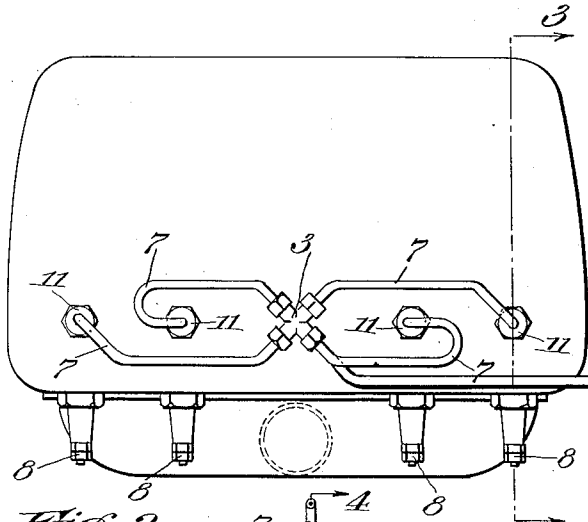


Fig. 2.

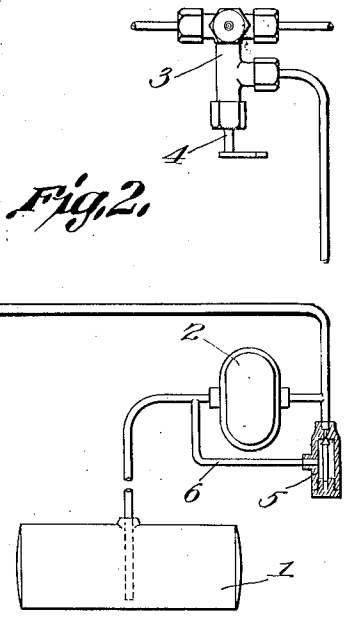


Fig. 3.

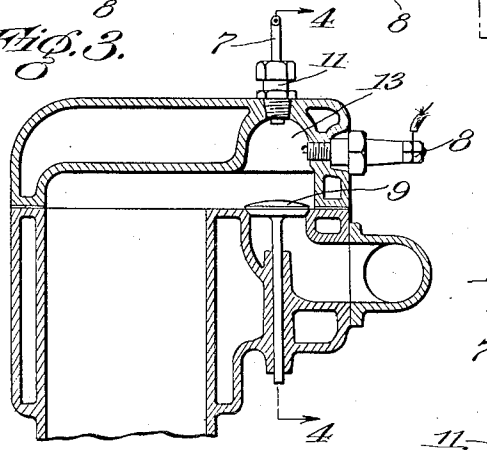


Fig. 5.

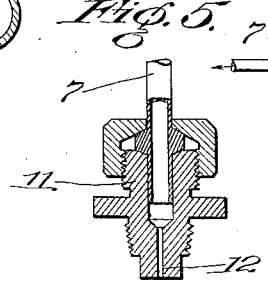


Fig. 6.

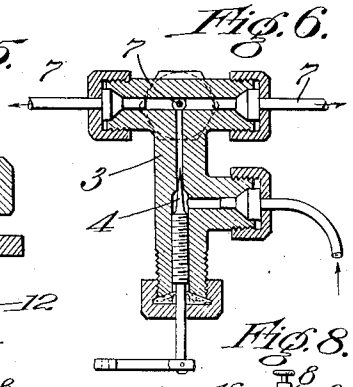


Fig. 4.

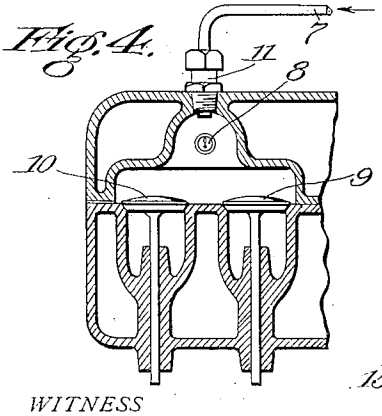


Fig. 7.

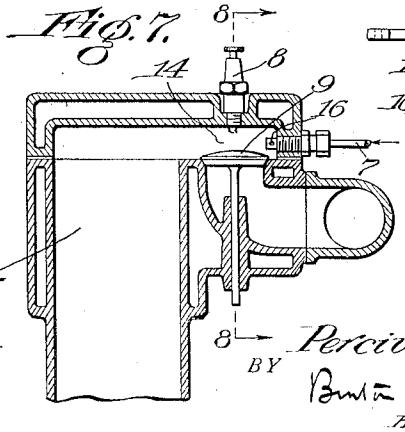
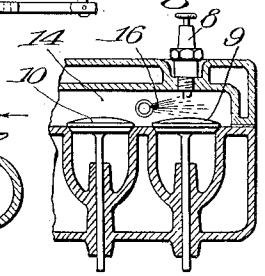


Fig. 8.



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CARBURETING SYSTEM FOR INTERNAL COMBUSTION ENGINES

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Fig. 9.

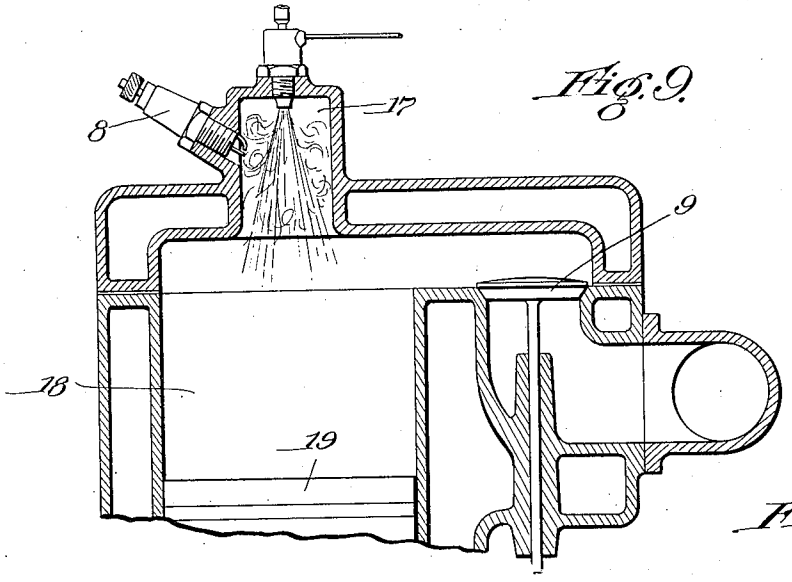


Fig. 10.

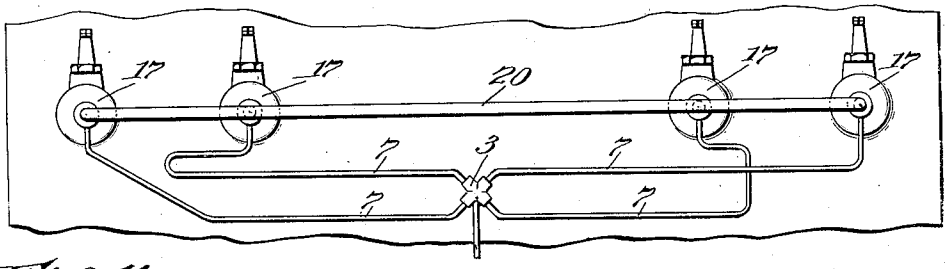


Fig. 11.

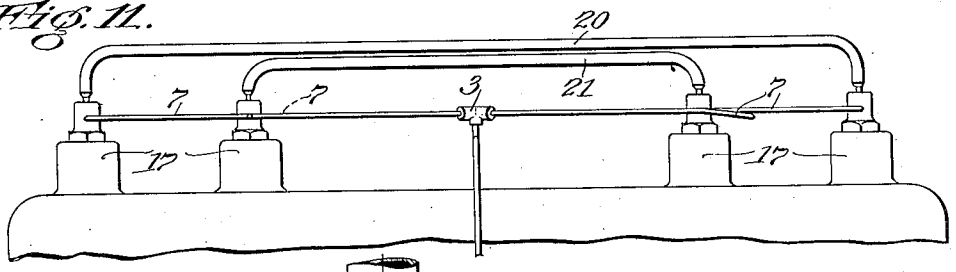
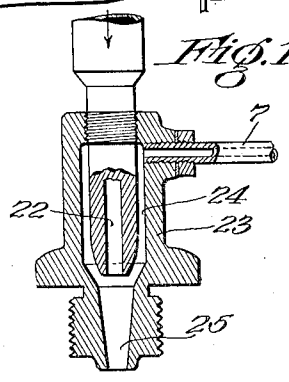


Fig. 12.



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UNITED STATES PATENT OFFICE

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CARBURETING SYSTEM FOR INTERNAL-COMBUSTION ENGINES

Application filed October 21, 1920, Serial No. 418,543. Renewed February 15, 1929.

The purpose of this invention is to provide an improved method of distributing liquid fuel to the explosion chambers of an internal combustion engine, and also to provide apparatus for operating the engine in accordance with such method. It consists of the scheme of operation together with the features and elements of construction hereinafter described and shown in the drawings as indicated by the claims.

In the drawings:

Figure 1 is a side elevation of a fuel distributing fitting utilized for employing the method which comprises this invention.

Figure 2 is a top plan view of an engine provided with a fuel distributing fitting with connections leading therefrom to the explosion chambers, and showing diagrammatically a fuel supply tank with a supply pump and suitable connections therefrom to the distributing fitting.

Figure 3 is a transverse section of the upper portion of the engine cylinders, taken as indicated at line 3—3, on Figure 2.

Figure 4 is a detail section taken as indicated at line 4—4, on Figure 3.

Figure 5 is an axial section of a feed nozzle for the explosion chamber.

Figure 6 is a sectional view of the distributing fitting shown in Figure 1.

Figure 7 is a sectional view similar to Figure 3, showing the invention applied to an engine cylinder of standard design.

Figure 8 is a detail section taken as indicated at line 8—8, on Figure 7.

Figure 9 is a sectional view similar to Figure 3, showing a modified form of combustion chamber.

Figure 10 is a top plan view of a fragmental portion of an engine with a modified system of fuel distributing passages applied thereto.

Figure 11 is a side elevation of the parts shown in Figure 10.

Figure 12 is an axial section of a modified form of feed nozzle suitable for use in the arrangement shown in Figures 9, 10 and 11.

The fundamental principle upon which this invention is based, is utilization of the cylinder pressures, as they vary in the respective cylinders of an internal combustion engine, for distributing and delivering fuel to said cylinders at the proper times and at most advantageous points in the cylinders to insure ignition. As indicated in Figure 2, the fuel in the usual liquid form may be supplied from a tank, 1, and lifted by any suitable type of continuously acting pump, 2, to a distributing fitting, 3, which is preferably provided with an adjustable needle valve, 4, for controlling the rate of supply. If the piping which connects the pump, 2, with the fitting, 3, includes a by-pass valve, 5, and return pipe, 6, the pump may operate at a uniform speed, delivering a uniform quantity while the actual quantity passing through the fitting, 3, may be regulated by the valve, 4, and the surplus passed round and round through the by-pass. On the other hand, it may be understood that, if preferred, the rate of delivery of the fuel may be governed by varying the speed or efficiency of the pump 2.

As shown in Figure 2, the fitting 3, is branched at its upper end having in the present instance four symmetrically disposed branches, each connected by a delivery pipe, 7, of relatively small bore with the combustion chamber of one of the four cylinders of the engine. For an engine having more or less cylinders, it may be understood that the fitting, 3, will have a corresponding number of branches.

The delivery pipes 7, are of equal length, these leading to the cylinders nearer the fitting 3, being formed with return bends to absorb some of the length in order that distribution to the four cylinders may be under uniform conditions. Each cylinder is provided with the usual spark plug 8, for igniting the explosion charge and may also have inlet and exhaust valves 9 and 10 respectively of the common type. In operating according to the present method, however, inlet valve 9, merely supplies air for admixture with the liquid fuel delivered through the pipes 7, to give the proper explosive quality thereto. Each of the pipes 7, connects into a nozzle fitting 11, which may be constructed with a relatively small bore 12, through which the

liquid fuel will be discharged in finely divided form.

As a four cylinder engine is commonly designed, the cycle of operation, subdivided into half strokes of the pistons, may be represented in tabulated form as follows:

Cylinder	No. 1	No. 2	No. 3	No. 4
	Working	Exhaust	Compression	Intake
	Exhaust	Intake	Working	Compression
	Intake	Compression	Exhaust	Working
	Compression	Working	Intake	Exhaust

Thus during the working stroke,—that is the explosion stroke,—of cylinder #1, the valves of cylinder #4, are arranged for intake. In other words, when cylinder #1, is under its maximum pressure cylinder #4, is subject to suction,—that is, negative pressure. The distributing fitting 3, is arranged with the pipes 7, leading respectively to cylinders #1 and #4, connected to directly opposite branches of the fitting substantially aligned with each other, permitting of free interchange of gases between these two cylinders.

From the tabulation, it will also be noted that during the working stroke of cylinder #4, the intake stroke of cylinder #1 occurs, while cylinders #2 and #3 are similarly related, in that the working stroke of each occurs during the intake stroke of the other. During the working stroke of cylinder #1, cylinder #2 is exhausting and cylinder #3 is compressing. There is much less difference of pressure therefore between cylinders #2 and #3 than between cylinders #1 and #4.

The result is that with the liquid fuel being supplied to the distributing fitting 3, which freely communicates at all times with all four cylinders through its branches and connecting pipes 7, the greatest difference of pressure at any time, exists across those openings in fitting 3, which are in line with each other and interchange of gases between the cylinders directs the fuel perfectly to the cylinder requiring it, though simultaneously causing some aspiration of gas from the other branches of the distributing fitting 3.

It is important that the fuel distributing passages, by which the cylinders are thus interconnected, be not so large as to materially reduce the working pressures in the engine. Preferably instead of making the pipes 7, themselves of capillary dimensions, there may be restricted portions provided in the passages, as for example, at the discharge bore 12, of each of the terminal nozzles 11, with which the cylinders are fitted. The area of this bore 12, may thus be so small as to result in a negligible loss in mean working pressure within the cylinders.

It may be understood that the air admitted through inlet valves 9, during the intake stroke of each cylinder, may preferably be drawn through an air cleaner, not shown, but the system does not necessarily contemplate any throttling means upon the air supply. Preferably the cylinders are permitted to secure the maximum possible air charge under all conditions since with a possibility of certain and regular ignition of the fuel charge, this will result in the greatest economy of fuel. The control of the power output of the engine under this system is accomplished through the regulation of the quantity of fuel admitted into the distributing fitting 3, either by adjusting the valve 4, or varying the pressure produced by the pump 2. A reduction in the fuel supply reduces the output, and an increase in the amount of fuel supply increases the output, until the supply rate of fuel is in such relation to the rate at which air is drawn in by the cylinders as to secure a full charge of perfectly combustible mixture in each cylinder at the end of the compression stroke.

In order to secure steady and dependable firing of the charge in each cylinder throughout the entire range from light load to full load, it is necessary to locate the igniting means, such as the spark plug 8, rather near the point of entry of the liquid fuel so that in the event of admission of only a small quantity of fuel, it may be ignited before it has diffused too far through the air content of the cylinder; otherwise by reason of such diffusion, the mixture would become so lean that it would not be inflammable. As shown in Figure 3, this may be accomplished by locating the delivery nozzle 11, in a pocket or sub-combustion chamber, 13, so designed as to be in free communication with the remaining and larger portion of the combustion chamber but having mounted in its wall the spark plug, 8. Under the smallest loads, the amount of fuel supplied may be just enough to charge this pocket or sub-combustion chamber, 13, with ignitable mixture of fuel and air, and the nearness of the ignition means insures that such a charge will be regularly fired. As the amount of fuel supplied is progressively increased for increasing the power output of the engine, the pressures in the cylinders which cause the interchanging flow of gas through the distributing manifold, 3, will also increase, causing the fuel to be diffused through a greater portion of the air charge in each cylinder resulting in a heavier explosion during the working stroke but always insuring ignition of the charge since the portion in pocket 13, will be ignitable and from there the flame may be spread into the remainder of the combustion chamber.

The application of the same principles is by no means impossible in the engine of present standard design such as that shown in section in Figures 7 and 8. In this arrangement the valve chamber 14, will serve the purpose of sub-combustion chamber and the

fuel injecting nozzle may be located in its side wall directly opposite to the open side of the valve chamber at which it communicates with the main combustion chamber 15. If desired, the nozzle may be formed with a side outlet indicated at 16, so as to discharge in the direction of the inlet valve, 9, for securing prompt admixture of the fuel with the air.

A further modification in respect to the sub-combustion chamber is illustrated in Figure 9, in which a pocket, 17, is formed in the head of the cylinder, 18, and coaxially therewith so that the force of the explosion, whether of a partial charge or full charge, may operate as directly as possible upon the piston indicated at 19. Obviously this will be especially effective with small fuel charges.

As a modification of the distributing system Figs. 10 and 11 show connecting pipes or passages 20 and 21, which may be of larger bore than the fuel distributing pipe 7. The pipe 20 connects cylinder #1 with cylinder #4 while the pipe 21 connects cylinder #2 with cylinder #3. Cylinders are represented as formed with sub-combustion chambers 17, similar to that shown in Fig. 9. The interchange of gas between the cylinders is accommodated by the larger pipes 20 and 21 but this flow is utilized for spraying the fuel into the combustion chamber as it issues from the small bore pipe 7. The construction of the spray nozzle may be such as shown in section in Fig. 12 in which the gas from the working cylinder is admitted through the central nozzle 22, around which the fitting 23, is formed with an annular space 24, into which the feed pipe 7 opens. The fuel arriving in this annular space 24 will thus be entrained by the flow of gas at the nozzle 22 and in passing therewith through the restricted discharge bore 25, will be finely subdivided so as to mix readily with the air as it arrives in the combustion chamber. Thus, it will be seen that notwithstanding the provision of the pipes 20 and 21, the fuel supply passage leading to the fitting 3, is in constant communication with the passages 20 and 21 at all times, and the distribution of fuel is therefore determined entirely by the relative pressures in the cylinders.

In summarizing, the advantages of the foregoing method of carburetion are: (*a*) combustion of the fuel in the presence of an excess of oxygen, insuring completeness of combustion and economy of operation; (*b*) maintenance of a substantially fixed and high value of the compression pressure throughout the load range through the absence of throttling means on air intake and resulting in high thermal efficiency, especially at small loads; (*c*) material increase in volumetric efficiency of the engine by reason of the fact that the charge may be ignited with certainty even though the air is not preheated and the density of the air will therefore be greater and will also be greater owing to the absence of fuel vapor in the intake passages. It will be obvious from examination of the drawings that the difference in the structure between that required for this system and present standard methods of fuel distribution will not involve any serious additional expense in building the engine, and further that as indicated in Figures 7 and 8, the system may be applied, even to existing standard types so as to secure its principal advantages even without any special modification in the design of the combustion chamber.

I claim:

1. In combination with a multiple cylinder internal combustion engine, a supply passage for liquid fuel comprising a branched fitting having a single passage leading from said fitting to each of the cylinders of the engine, the passages to the cylinders whose respective working or explosion strokes and suction or intake strokes coincide, having communication with each other through said fitting, whereby the difference in pressures between said cylinders serves to carry the fuel from the branched fitting to the cylinder which is on the inlet stroke.

2. In the combination defined in claim 1, the passages leading to the respective cylinders from the branched fitting being of equal length.

3. In the combination defined in claim 1, an ignition device in each cylinder disposed adjacent the point of fuel discharge from the branched fitting thereinto.

4. In the combination defined in claim 1, the branched fitting and passages leading therefrom to their respective cylinders, being constantly open to afford free access of pressure therethrough.

5. In combination with a multiple cylinder internal combustion engine, passages which connect the cylinders in pairs for interchange of gas pressure between them, independently of any connection of either with a source of fuel, the cylinders of each pair having the working or explosion strokes of one and the suction or intake strokes of the other respectively coincident; a supply passage for liquid fuel in constant communication with all said passages, and means for delivering liquid fuel through said supply passage to said passages which connect the cylinders in pairs, under an initial pressure which is equal at all said last mentioned passages; whereby the distribution of fuel to the several cylinders is determined wholly by the relative pressures in said cylinders respectively.

In testimony whereof, I have hereunto set my hand at Chicago, Illinois, this 18th day of October, 1920.

PERCIVAL S. TICE.