March 27, 1928. **1,663,634**

W. E. KEMP

COMBINATION EXHAUST AND INTAKE MANIFOLD

Filed June 22, 1921 2 Sheets-Sheet 1

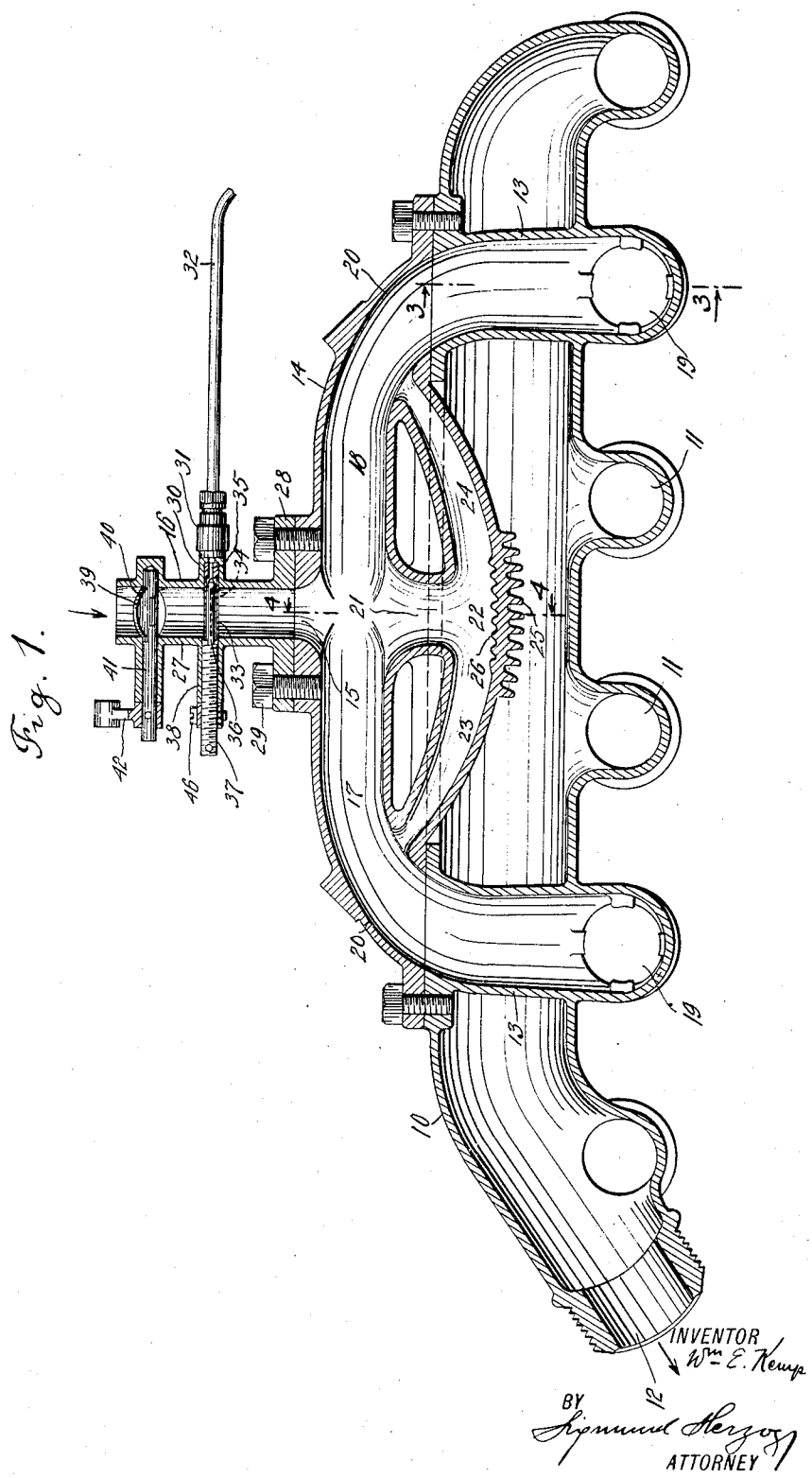

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Fig. 2.

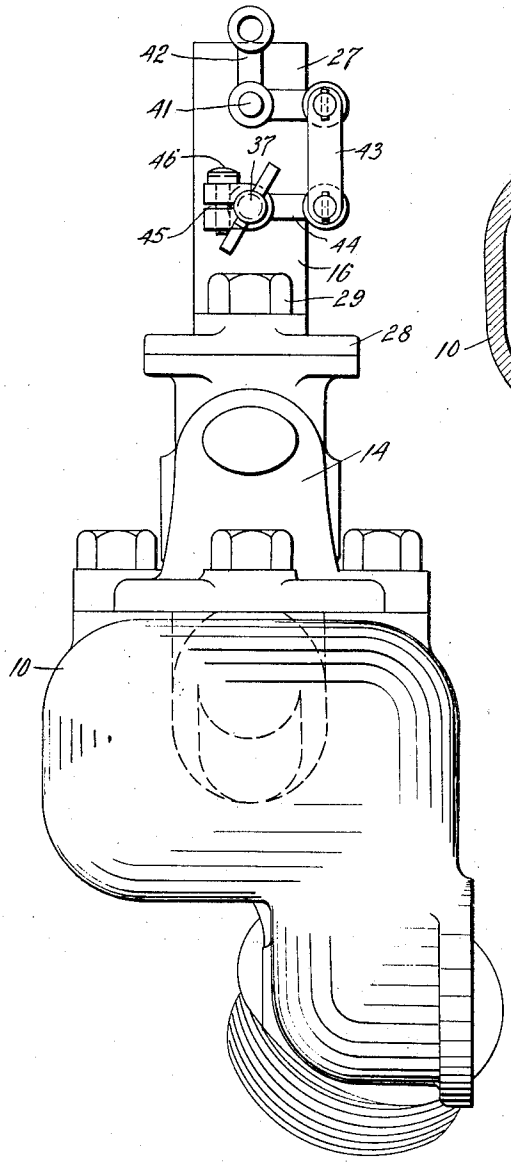


Fig. 3.

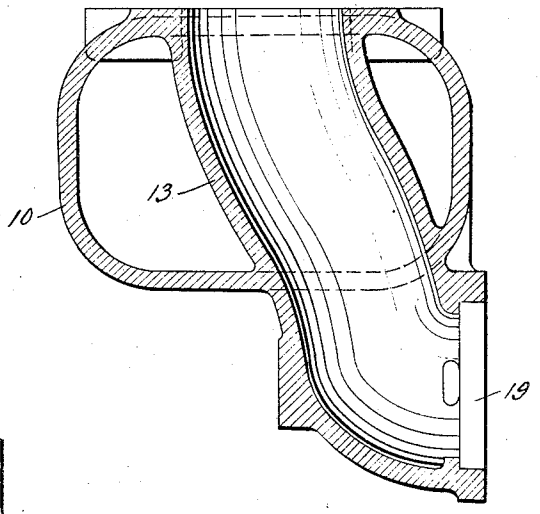
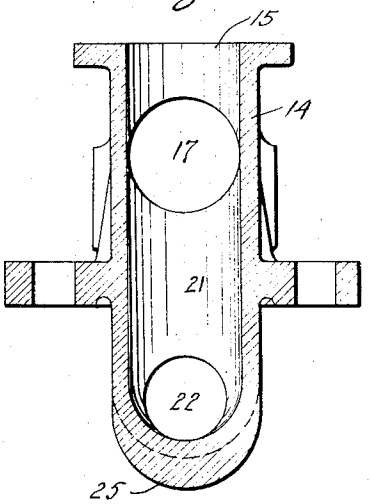


Fig. 4.



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UNITED STATES PATENT OFFICE.

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COMBINATION EXHAUST AND INTAKE MANIFOLD.

Application filed June 22, 1921. Serial No. 479,560.

The present invention relates to combined intake and exhaust manifolds of internal combustion engines.

It is commonly known that most of the carburation difficulties experienced with the present day gasolene and particularly heavier hydrocarbons is due to the fact that the heavy fuel particles settle in or on the wall of the intake manifold, particularly at low speeds, and run to the bottom, where they gather to such an extent as to seriously interfere with the normal cycle of operation of the engine. Most troubles are caused at low engine speed, because the cylinders do not receive a uniform mixture, since the combustible mixture rushing past the stagnating liquid or condensed hydrocarbon in the intake manifold is made richer than desirable. On the other hand, when the speed of the engine is increased, it misfires.

The main object of the present invention is to so construct the intake manifold and so combine the same with the exhaust manifold that the fuel settled in the intake manifold is instantaneously vaporized and caused to flow with the combustible mixture to the cylinders of the engine.

With these and other objects in view, which will more fully appear as the nature of the invention is better understood, the same consists in the combination, arrangement and construction of parts hereinafter described, pointed out in the appended claims and illustrated in the accompanying drawings, it being understood that many changes may be made in the size and proportion of the several parts and details of construction within the scope of the appended claims, without departing from the spirit or sacrificing any of the advantages of the invention.

One of the many possible embodiments of the invention is illustrated in the accompanying drawing, in which:—

Figure 1 is a central vertical section taken through a combined intake and exhaust-manifold constructed in accordance with the present invention, with a charge-forming device in position thereon; Fig. 2 is an end view of the mechanism shown in Fig. 1; Fig. 3 is a section taken on the line 3—3 of Fig. 1, on a larger scale; and Fig. 4 is a section taken on line 4—4 of Fig. 1, also on a larger scale.

In the drawings, the numeral 10 indicates the exhaust-manifold of an engine, in the form of a chambered body, having a plurality of inlet ports 11, connected with the exhaust ports of an internal combustion engine, and an outlet 12, through which the exhaust gases are led away in the usual manner. Through this exhaust-manifold extend conduits 13, in the present case two, which communicate with and form part of an intake-manifold 14, that is mounted upon and partly disposed within the exhaust manifold, as will presently be more fully described. The intake-manifold is mounted on top of the exhaust-manifold and is provided in its top portion with an inlet 15, communicating directly with a charge-forming device 16, the construction of which will be hereinafter more fully described. The mixture of air and hydrocarbon, entering the port 15, is adapted to flow through two curved branches 17 and 18 of the manifold 14 to the conduits 13, which communicate through ports 19 with the inlet ports of the engine, the conduits extending, as above stated, through the exhaust-manifold, which is for this purpose enlarged, as clearly shown in Fig. 3 of the drawings. The transverse cross-section of each branch of the intake-manifold is larger than the area of the port 15 and is somewhat increased in the bends 20, immediately above where it joins its respective conduit 13. In alignment with the port 15 the branches 17 and 18 of the intake-manifold communicate with a passage 21, leading to a duct 22, which has oppositely extending portions 23 and 24, communicating with the branches 17 and 18, respectively, of the intake-manifold a little distance above the levels at which the said branches are joined with the conduits 13. The major portion of the duct 22 is disposed within the exhaust-manifold and thus in direct contact with the exhaust gases flowing therethrough. Radiating ribs 25 and 26 are formed on the outer and inner faces, respectively, of the duct 22, for the well known purpose. The cross-sectional area of each branch of the duct 22 decreases gradually from the passage 21 to its point of junction with the respective branch of the intake-manifold, for a purpose hereinafter to be described.

Any suitable charge-forming device may be used in connection with the manifold herein described, the one herein disclosed being of the type described in my application for U. S. Letters Patent, Serial No. 391,948, filed June 26, 1920.

The charge-forming device includes a carbureting chamber 27, cylindrical throughout its length and provided on its inner end with a flange 28, said flange abutting against the intake-manifold and being secured thereto, for instance, by screws 29. The carbureting chamber extends vertically and communicates through the inlet 15 with the intake-manifold. Intermediate its ends the chamber is provided with a nipple 30, to which is joined, by a suitable coupling 31, a pipe 32, that leads to a tank, the latter being disposed a suitable distance below the charge-forming device and contains liquid hydrocarbon. Into the nipple fits a nozzle 33, that extends diametrically across the carbureting chamber. This nozzle is provided with longitudinal slots 34, disposed in a plane at right angles to the longitudinal axis of the carbureting chamber. The nozzle is provided within the nipple with a restricted opening 35, with which co-operates a mechanism for controlling the flow of liquid hydrocarbon into the carbureting chamber, said mechanism being, preferably, in the form of a needle valve 36, which is disposed within the nozzle, its diameter being slightly smaller than the inner diameter of said nozzle. The needle valve is carried by or made integral with a screw-threaded stem 37, the threads of which mesh with internal threads of a tubular extension 38 on the carbureting chamber, thereby permitting of adjustment of the discharge end of the liquid hydrocarbon conduit, for the well known purpose. In front, that is to say above the needle valve, there is located within the carbureting chamber a throttle 39, for instance a butterfly valve comprising a disk 40, which is attached to a spindle 41. This spindle extends in parallel relation to the needle valve and is rotatably mounted in the carbureter casing. To the spindle is fixed, outside of the carbureter casing, a bell-crank lever 42, one end of which is adapted to be connected with an actuating rod, not shown, while its other end is connected by a link 43 with a lever 44, the latter being fixed to the screw-threaded stem of the needle valve. The inner end of the lever 44 is split as shown at 45, and through the split portion extends a clamping screw 46. This construction permits of a fixing of the lever 44 to the needle valve in any adjusted position of the latter.

The operation of this device is as follows: If, in the operation of the engine on which the device is employed, air flows past the nozzle 33, more particularly past the permanently open slots 34 therein, liquid hydrocarbon is entrained and atomized or sprayed, the resulting combustible mixture being composed of air and liquid hydrocarbon gasified or vaporized in part and in part suspended in liquid form. The mixture is drawn at high velocity into the intake-manifold, where it passes through the branches 17 and 18 to the conduits 13, and through the latter to the intake-ports of the cylinders. The heavy liquid particles or less volatile hydrocarbon are carried by inertia and gravity into the passage 21 and settle on the bottom of the duct 22, more particularly on the ribbed portion 26 thereof. The intake-manifold, being in direct contact with the exhaust-manifold and partly disposed within the same, is heated by the exhaust gases flowing through the exhaust-manifold, the result being that the fuel particles on the bottom of the duct 22 are heated and consequently evaporated, flowing through the duct 22 into the branches of the intake-manifold in a direction at an angle to the direction of flow of the combustible mixture through the said branches, thereby properly intermingling with the main charge. The cross-sectional areas of the portions 23 and 24 of the duct 22 decrease gradually toward their outlets in order to cause the evaporated fuel in the said duct to pass into the main fuel streams in the intake-manifold at relatively high velocity and also to prevent wire drawing of the fuel, as it flows from the said duct into the intake-manifold proper. Should the evaporated fuel flow back into the branches 17 and 18 through the passage 21, it will intermingle with the main charge, as the same enters through the inlet 15.

Such heavy particles of the combustible mixture which are carried in the main stream through the branches 17 and 18 impinge against the bends 20 of the intake-manifold. Inasmuch as the intake-manifold, as a whole, is heated by the exhaust gases, these particles will be vaporized before passing into the conduits 13. The cross-section of each branch of the intake-manifold is increased in the bends 20 to permit of an expansion of the charges due to the rise in temperature to which they are subjected by the heated intake-manifold.

From the foregoing it appears that the fuel, while flowing through the intake-manifold, is thoroughly vaporized by heat, maintaining its substantially gaseous state until it is received in the engine cylinders, settling of heavy fuel particles or less volatile hydrocarbon oils is thoroughly prevented, so that the engine cylinders do always receive a uniform mixture.

Attention is called to the fact that part of the intake-manifold is heated to a higher degree than other parts thereof, more particularly the duct 22 which is disposed within the exhaust-manifold. The main passages of the intake-manifold, that is to say the branches 17 and 18 above referred to, are heated by convection only. The purpose of this arrangement is to prevent undue expansion of the main charge as it flows through the branches 17 and 18, while super-

heating the liquid fuel which settles on the bottom of the conduit 22. It is obvious that, if the entire intake-manifold were heated to the same degree by disposing the same wholly within the exhaust-manifold, the entire charge would be overheated and consequently expanded, resulting in a loss of power of the engine. Moreover, the overheated charge would travel at such speed through the intake-manifold to prevent a settling of the heavy or less volatile hydrocarbon particles.

It is to be observed that, generally speaking, the device herein described automatically separates the heavy fuel or less volatile hydrocarbon particles from the charges flowing through the intake-manifold, evaporates the said particles and causes the same, after vaporization, to intermingle with the main charges, without unduly expanding the latter. These functions of the device are made possible by the fact that the combustible charges have, on entering the intake-manifold, a downward flow, permitting inertia and gravity to cause a settling of the heavy and less volatile fuel particles.

What I claim is:—

1. In a device of the character described, the combination with the exhaust-manifold of an internal combustion engine, of a branched intake-manifold having a duct extending into said exhaust-manifold and tapped into each branch of said intake-manifold, said intake-manifold being provided with an inlet at the point of junction of the branches thereof situated to permit of an initial vertical downward flow of the combustible charges thereinto, and a passage in said intake-manifold wholly disposed below said branches in alignment with said inlet and leading downwards to said duct.

2. In a device of the character described, the combination with the exhaust-manifold of an internal combustion engine, of a branched intake-manifold having a duct extending into said exhaust-manifold and communicating with the branches of said intake-manifold, said intake-manifold being provided with an inlet at the point of junction of the branches thereof situated to permit of an initial downward flow of the combustible charges thereinto, and a passage in said intake-manifold wholly disposed below said branches in alignment with said inlet and leading downwards to said duct, the transverse cross-sectional areas of said duct decreasing gradually from said passage to the points of junction with said branches.

3. In a device of the character described, the combination with the exhaust-manifold of an internal combustion engine, of a branched intake-manifold having an inlet at the point of junction of its branches situated to permit of a downward flow of the combustible charges thereinto, and a duct extending into said exhaust-manifold communicating with the inlet to said intake-manifold and being tapped into branches of the latter, said duct being spaced throughout its length from said branches.

4. In a device according to claim 3, the cross-sectional areas of said duct decreasing gradually from a plane in alignment with said inlet toward the points of junction thereof with said branches.

5. In a device of the character described, the combination with the exhaust-manifold of an internal combustion engine, of a branched intake-manifold having parts only of its branches disposed in said exhaust-manifold, said intake-manifold being provided with an inlet at the point of junction of the branches thereof situated to permit of an initial vertical downward flow of the combustible charges thereinto, the portion of said intake-manifold extended into said exhaust-manifold being provided with a pocket in alignment with and below said inlet, said pocket being connected by a duct with the branches of said intake-manifold, the transverse cross-sectional areas of said duct decreasing gradually from said pocket to its points of junction with said branches.

Signed at New York, in the county of New York and State of New York, this 29th day of April A. D. 1921.

WILLIAM E. KEMP.