Jan. 12, 1926. 1,569,610

A. P. BRUSH

METHOD AND APPARATUS FOR EQUALIZING EXPLOSIVE CHARGES IN THE DIFFERENT CYLINDERS OF MULTICYLINDER ENGINES

Filed March 5, 1920 2 Sheets-Sheet 1

Fig. 1.

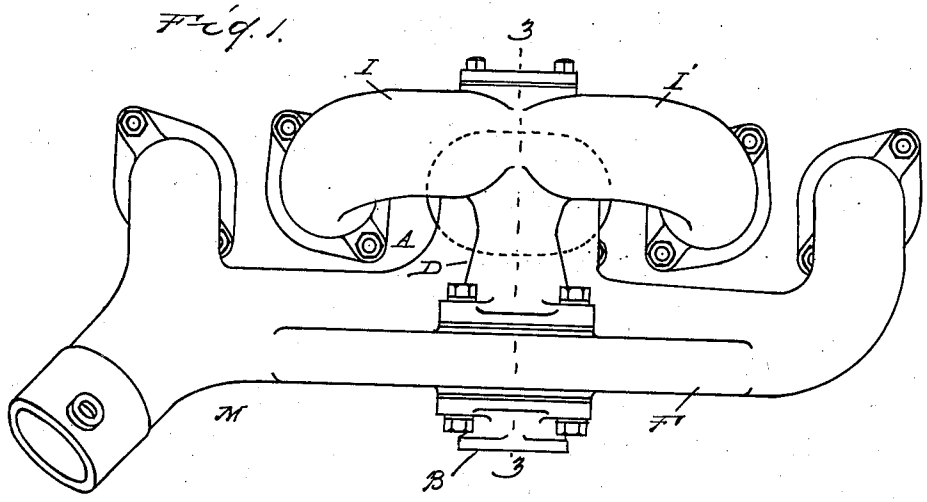
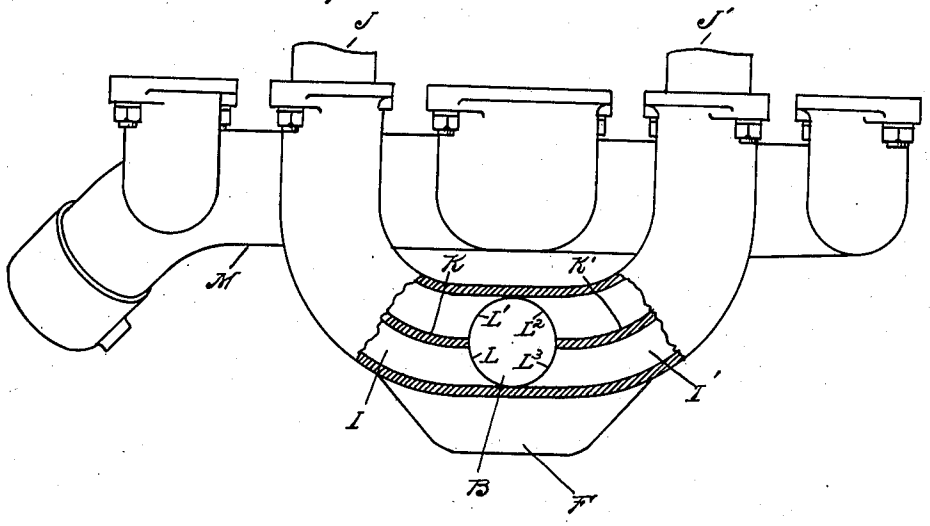



Fig. 2




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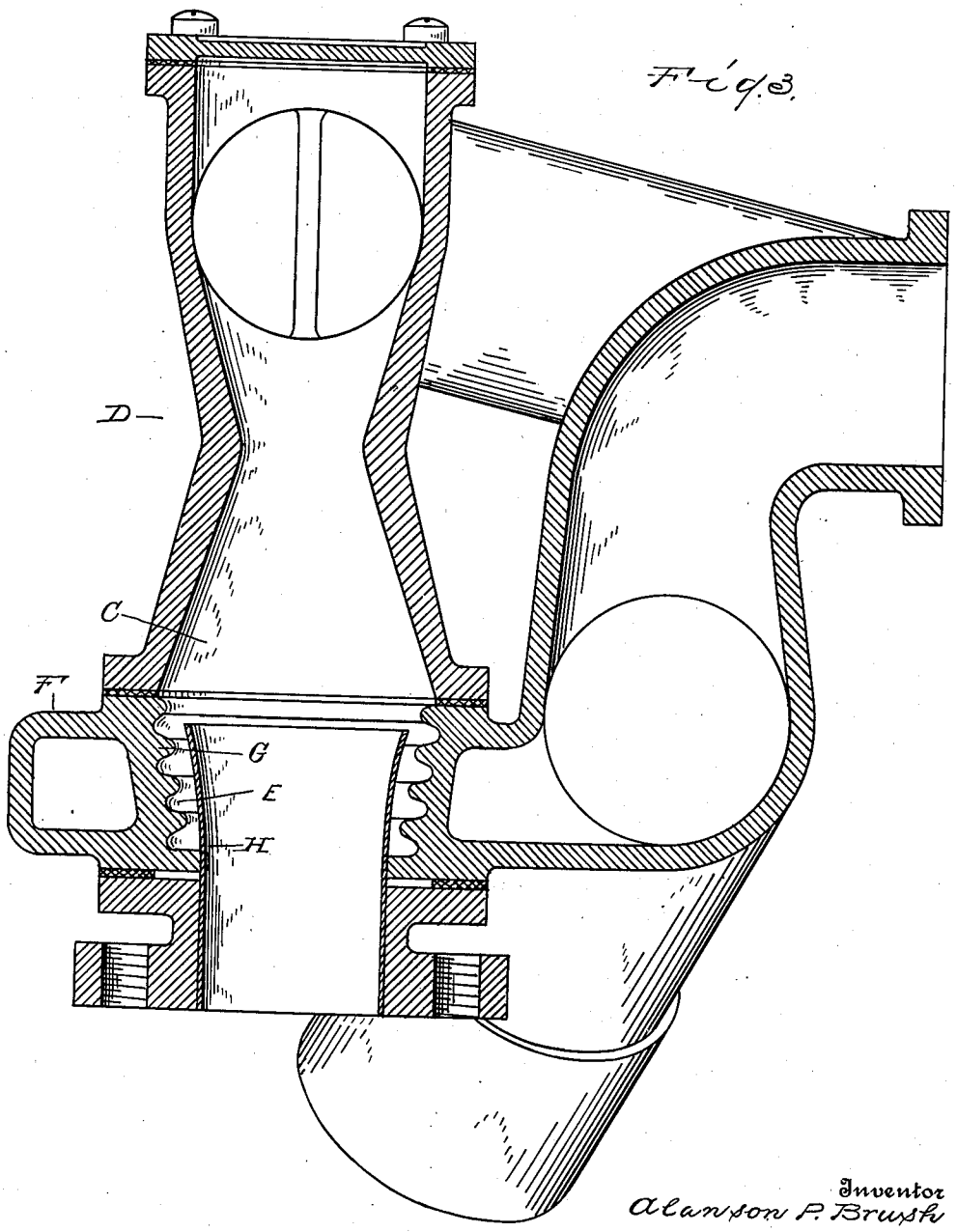
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Fig. 3.




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# UNITED STATES PATENT OFFICE.

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## METHOD AND APPARATUS FOR EQUALIZING EXPLOSIVE CHARGES IN THE DIFFERENT CYLINDERS OF MULTICYLINDER ENGINES.

Application filed March 5, 1920. Serial No. 363,490.

*To all whom it may concern:*

Be it known that I, ALANSON P. BRUSH, a citizen of the United States of America, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Methods and Apparatus for Equalizing Explosive Charges in the Different Cylinders of Multicylinder Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

The invention relates to multi-cylinder internal combustion engines of the type in which the explosive mixture for the several cylinders is obtained from a single carburetor or mixing device. It is the object of the invention to avoid uneven operation, due to inequalities in the explosive charges introduced in the respective cylinders, or to changes in velocity of the current through the intake manifold. To this end the invention consists; first, in the method; and second, in the apparatus, as hereinafter set forth.

In the drawings:

Figure 1 is a side elevation showing a construction of intake for a multi-cylinder internal combustion engine embodying my invention;

Figure 2 is a plan view thereof;

Figure 3 is a vertical section on line 3—3 of Figure 1.

In the present state of the art in the operation of multi-cylinder explosive engines having more than two cylinders difficulty is experienced in obtaining uniform quality of charges in the several cylinders, particularly when the engine is cold, as in starting. This is primarily due to the fact that the intake passages to the several cylinders are not symmetrically arranged in relation to the carburetor, or common portion of the manifold, and therefore the charge which is introduced in one cylinder is subjected to different conditions than that introduced into another cylinder. Inasmuch as the liquid fuel is largely carried in suspension by the air, there is a tendency for more of the fuel to be carried to one cylinder than to another, resulting in an over-rich mixture in the one and an over-lean mixture in the other. Thus some of the cylinders may misfire or develop less power than other cylinders. Another cause of irregularity is due to changes in velocity of the current passing through the intake manifold, there being a tendency for the liquid fuel to fall out of suspension when the current is traveling slowly and to be maintained in suspension under higher velocity.

With my invention the difficulty is overcome by substituting for the unsymmetrical arrangement of intakes to the several cylinders a symmetrical arrangement, the construction being such that each cylinder receives its charge under precisely similar conditions to that of the others. I have also provided means for collecting and re-introducing the portion of the liquid fuel which falls out of suspension during passage through the intake, thereby producing uniform mixtures when traveling under different velocities. Other features of the invention relate to the means employed for obtaining a comparatively homogeneous mixture of the air and liquid fuel.

In the construction shown, A is an intake manifold for a multi-cylinder explosion engine having more than two cylinders and, as specifically illustrated, four cylinders. It is usual in four-cylinder engines to divide the manifold into two branches leading to ports in the engine block, from each of which there are two branch passages leading to different cylinders. With such an arrangement it has been found in practice that the fuel carried in suspension by the air current is not uniform, but more will be conveyed through one of the branch passages than through the other. In other words, the mixture is not homogeneous and some portions of the air current are more heavily charged with the liquid fuel than other portions. Therefore, during the changes of direction incident to passing through the manifold, there will be a segregation of the heavily charged portions of the current from the lightly charged portions, and one cylinder may derive its charge from the one and another from the other.

To avoid this result, I first provide means for obtaining a fairly homogeneous mixture of the air and suspended fuel. Various specific constructions may be employed for this purpose, but as shown, the portion B of the manifold receiving the charge directly from the carburetor is vertically arranged and is provided with an expanding portion C and

a Venturi portion D. The expanding portion C will slow the velocity of the current and where this velocity is initially slow, there will be a tendency for the suspended fuel to drop out at this point. I, therefore, provide means for collecting the liquid which is thrown out and for vaporizing the same and re-introducing into the air current without materially heating the air. This means specifically consists of an annular pocket E communicating with the manifold at the point of greatest expansion C, the outer wall of said pocket being heated, preferably by being formed integral with a portion F of the exhaust conduit. The heated wall, as shown at G, is stepped and the liquid dropping down from one step to another will be completely vaporized and forced upward into the main passage. The pocket E is separated from the main passage by a flaring inner tube H and as this is out of mechanical contact with the heated wall and as the heat in said wall is absorbed by evaporization of the liquid, very little heat will be conducted into the main air current.

The effect of the construction just described is that when the engine is running at high speed, or where the velocity of the current through the manifold is comparatively high, the liquid fuel in suspension will be carried into the explosion chambers without pre-heating or vaporization, this being a desirable condition to obtain the maximum power and speed from the engine. On the other hand, if the velocity of the current is comparatively slow, a portion of the suspended fuel will drop out and after being vaporized will be re-introduced into the main current so as to produce a more homogeneous mixture. The functions of the Venturi portion D of the passage is to more thoroughly commingle the different portions of the current to increase the homogeneity thereof.

To maintain uniformity in the portions of the current which are drawn through the several cylinders, separate passages are provided for each of the cylinders and the openings into these several passages are symmetrically arranged around the vertical portion B. Thus, as shown, I and I′ are branch conduits leading from the vertical conduit B to the ports J and J′ in the cylinder block, each of which supplies a pair of cylinders (not shown). K and K′ are division walls in the branches I and I′ for dividing each into a pair of separate conduits, and L, L′, $L^2$ and $L^3$ are segmental ports distributed around the vertical conduit B and communicating respectively with the separate conduits. Inasmuch as each of these segmental ports is in the same relation to the vertical portion of the manifold, it is evident that the explosive charge passing through each will be the same in quantity and quality, which insures equal action in each of the engine cylinders.

The exhaust manifold M is preferably designed to cooperate with the intake-manifold and as shown is provided with the outwardly projecting portion F, which forms a section of the intake manifold, as previously described. The exhaust gases passing through this section will maintain the step wall G at the proper temperature, so as to function in the manner previously described.

In operation, when the engine is running at low speed, a portion of the liquid fuel in suspension will be thrown out of the current, collecting on the contracting wall of the venturi, or dropping into the annular pocket, and will eventually pass by gravity down upon the heated steps G. Here vaporization will take place and by expansion the vapor will be forced upward and commingled with the main stream. In passing through the venturi D there will be a thorough commingling so as to produce a homogeneous mixture in the conduit above the point of greatest contraction. This homogeneous mixture will be successively drawn into the different conduits formed by the branches I and I′ and the division walls K and K′ thereof, and each cylinder will receive its proper proportion of uniform quality. If the speed of the engine is increased, the accelerated velocity of the current passing through the vertical portion of the intake will carry all, or the greater portion, of the suspended liquid, so that a much denser charge is introduced into the explosion chamber. This will increase the power, but as soon as the velocity is diminished, a portion of the liquid will again fall out and will be vaporized and re-introduced, as previously described.

The effect of the venturi is to produce uniformity of mixture in all segments of the cross-section thereof around the central axis. Consequently, the current may be sub-divided into any number of divisions drawn off from different segments and in each division there will be the same quality of proportion of mixture. Thus the same construction can be used for sub-dividing the current to any number of different cylinders, as well as to the four cylinders, as specifically shown in the drawings.

What I claim as my invention is:

1. The combination with a multi-cylinder internal combustion engine provided with more than two cylinders, of an intake conduit symmetrically sub-divided into separate branches leading to the respective cylinders. and means for symmetrizing a stream of explosive mixture passing through said conduit in advance of the subdivision thereof said means including a restriction in said conduit.

2. The combination with a multi-cylinder internal combustion engine provided with more than two cylinders, of an intake manifold including a vertically extending conduit for receiving the explosive mixture directly from the carburetor, a venturi in said vertically extending portion for commingling the mixture passing therethrough, and a plurality of branch conduits symmetrically arranged and connected into said vertical conduit and leading to the respective cylinders.

3. The combination with a multi-cylinder internal combustion engine provided with more than two cylinders, of an intake manifold including a vertical conduit directly connected to the carburetor, a portion of said vertical conduit expanded in diameter, means for collecting, vaporizing and returning to the main stream the liquid fuel drawn out of suspension in the expanded portion of said conduit, a venturi portion of said conduit beyond said expanded portion, and a plurality of separate branch conduits symmetrically arranged and connected with respect to said vertical conduit and leading to the respective cylinders.

4. The method of operating multi-cylinder internal combustion engines, comprising the forming of a mechanical mixture of air and unvaporized fuel, passing said mixture through a venturi to obtain uniformity in proportion of ingredients in all symmetrical segments of the cross-section of the stream and in dividing the current in different segments of the cross section and leading the same to different cylinders.

5. The combination with a substantially vertical conduit having a venturi portion, of a pocket out of the path of the gaseous stream through said conduit and below said portion for collecting liquid fuel dropping out of suspension, and means for heating said pocket.

6. The combination with a substantially vertical conduit having a venturi portion and having an expanded portion below said venturi portion, of a pocket out of the path of the gaseous stream through said conduit and below said expanded portion for collecting liquid fuel dropping out of suspension, and means for heating said pocket.

In testimony whereof I affix my signature.

ALANSON P. BRUSH.