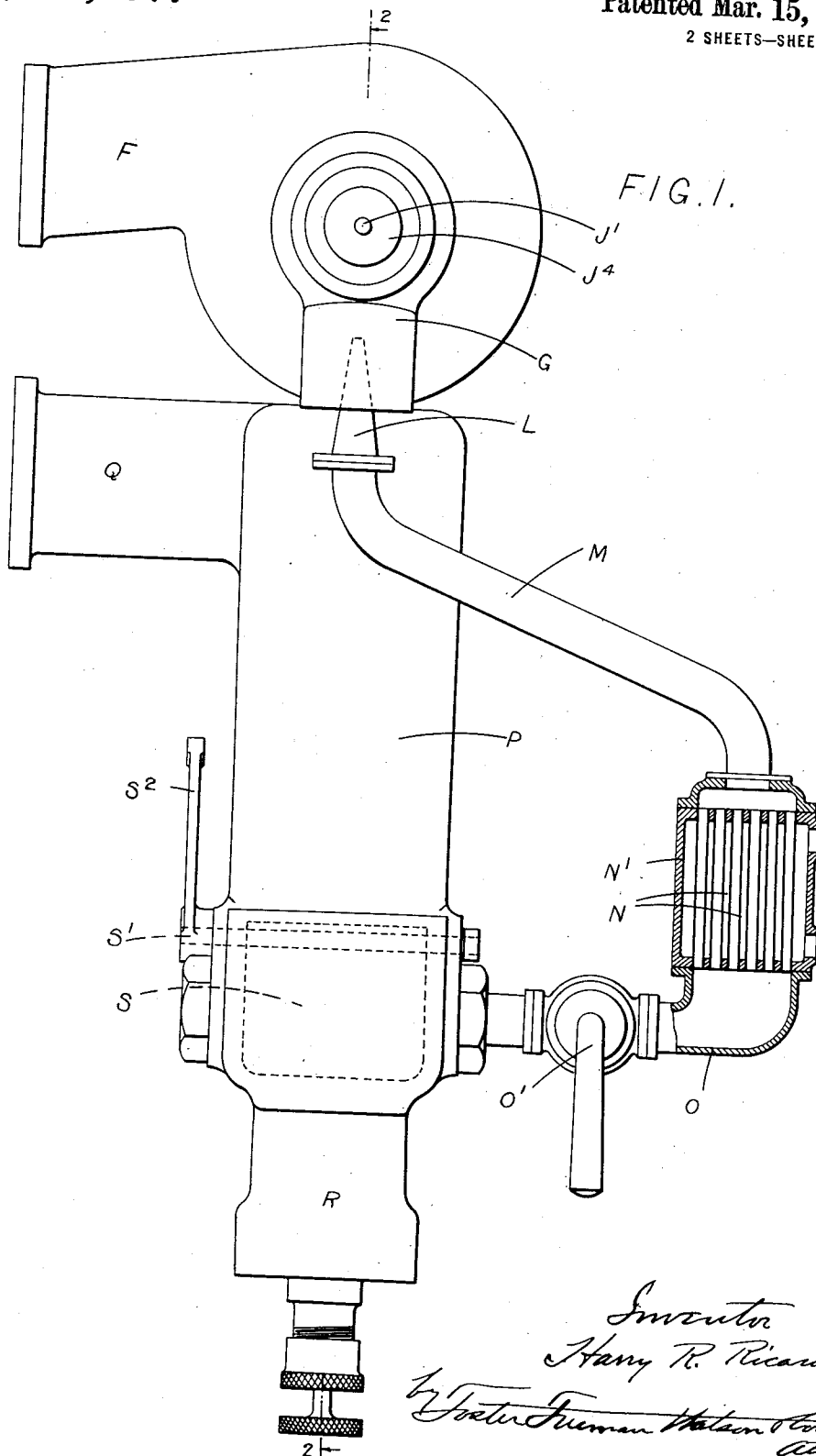


H. R. RICARDO.
 CARBURETER FOR INTERNAL COMBUSTION ENGINES.
 APPLICATION FILED SEPT. 3, 1918.

1,371,397.

Patented Mar. 15, 1921.

2 SHEETS—SHEET 1.



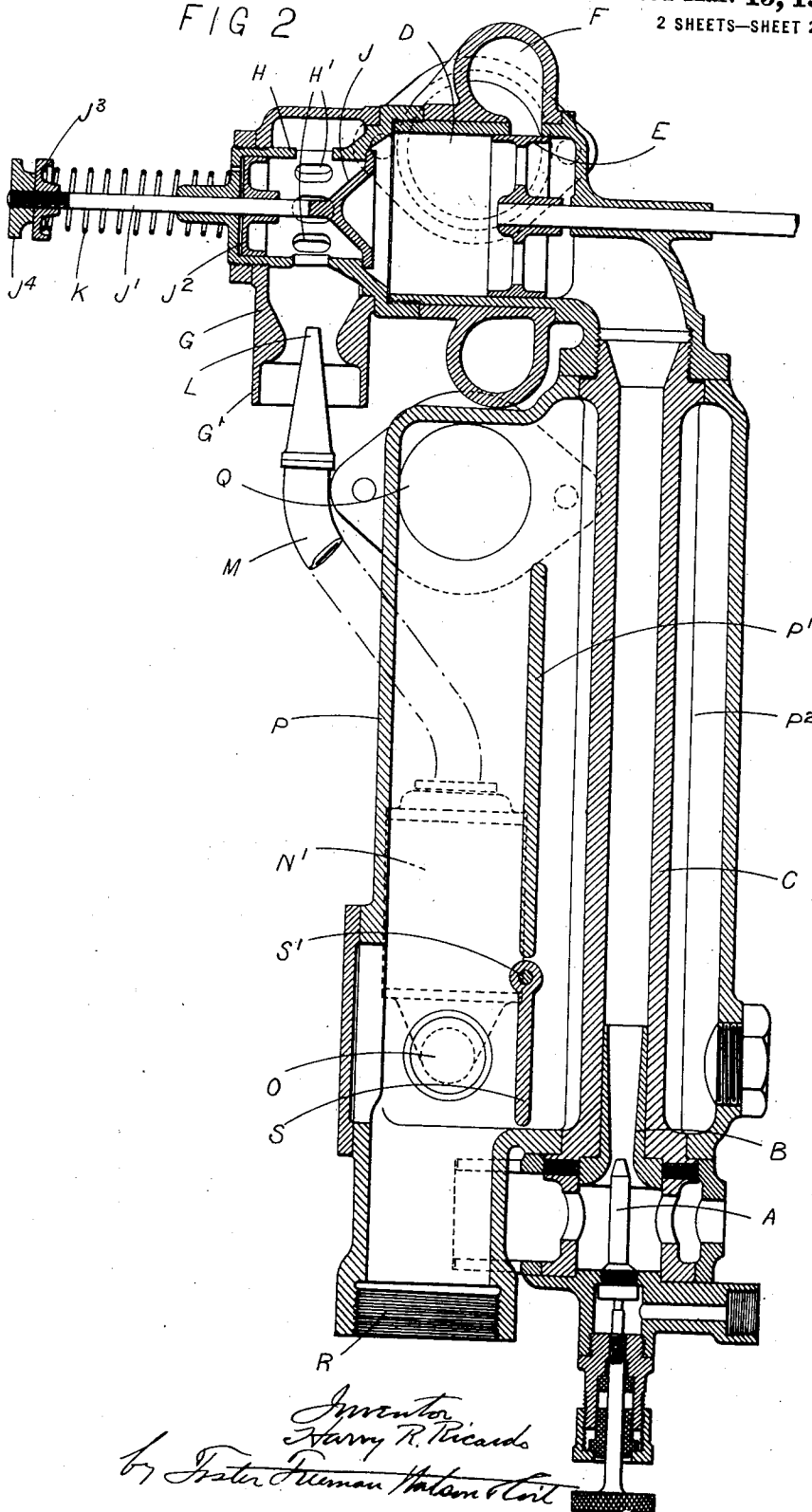
Inventor
 Harry R. Ricardo
 By Foster Furman Watson & Co.
 Attys

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FIG 2



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UNITED STATES PATENT OFFICE.

HARRY RALPH RICARDO, OF LONDON, ENGLAND.

CARBURETER FOR INTERNAL-COMBUSTION ENGINES.

1,371,397.

Specification of Letters Patent.

Patented Mar. 15, 1921.

Application filed September 3, 1918. Serial No. 252,432.

To all whom it may concern:

Be it known that I, HARRY RALPH RICARDO, a subject of the King of England, and residing at London, England, have invented certain new and useful Improvements in Carbureters for Internal-Combustion Engines, of which the following is a specification.

This invention relates to carbureters for internal combustion engines employing liquid fuel.

In internal combustion engines operating on the explosion or constant volume cycle and using fuels belonging to the paraffin series and particularly to the heavier fractions of this series, trouble is experienced with detonation or unduly rapid burning under compression. Such detonation may occur when the pressure and temperature within the cylinder are very considerably below that at which self-ignition takes place and appears to be dependent upon pressure rather than temperature. In order to prevent this detonation one or other of two methods is generally adopted.

1. Water is admitted to the cylinder in a fine spray so that it is evaporated during the compression stroke, thus reducing both the temperature and pressure of compression.

2. Attempts are made to keep the fuel and air separate until just before ignition takes place.

The principal objection to the former method lies in the fact that the quantity of water must be carefully regulated to correspond with the load which the engine is carrying and that pure soft water must always be used if undue wear of the cylinder walls is to be avoided. In any case the presence of water is detrimental to the piston lubrication.

If it were really practicable to isolate the fuel and air throughout the compression stroke and then to mix them intimately, immediately prior to ignition, this would probably palliate the trouble to some extent though the rate of burning would still be dependent upon the intimacy of the mixture.

In either case it is necessary to use a very low compression, and therefore expansion ratio, in order to keep down the pressure and temperature, thus penalizing both the efficiency and output of the engine. When the heavier fractions of the paraffin series are employed the difficulties are con-

siderably aggravated by the need for preheating the fuel before its admission to the cylinder, thus still further raising the compression temperature and necessitating a further reduction in the compression ratio in order to compensate for such preheating.

Experiments have shown that the rate of burning of fuels having a high percentage of hydrogen, such as the fuels of the paraffin series can be kept in check and controlled by the addition of a small proportion of carbon, which can be conveniently supplied in the form of CO_2 , or by the addition of other inert gases, such as nitrogen. Such gases, however, play no part other than that of a diluent, so that their presence involves a corresponding reduction of the quantity of oxygen and fuel in the cylinder. This reduction, however, is compensated and more than compensated for by the increased output and efficiency obtained by the use of a high expansion ratio. Gases such as indicated can be obtained from the exhaust from the engine which consists largely of CO_2 and nitrogen.

According to this invention in a carbureter for an internal combustion engine employing liquid fuel the cooled exhaust gas from the engine or a similar inert gas is delivered to an inlet controlled by an automatic valve through which extra air passes to the engine induction pipe. This extra air inlet communicates with the induction pipe on the carbureter side of the main throttle and a nozzle is directed into this air inlet to which the inert gas passes from the cooling chamber the flow of this gas being controlled for example by a cock. The arrangement is such that the inert gas will enter the induction pipe and mingle with the combustible charge in a quantity which is proportionate to and determined by the engine load.

The invention may be applied to carbureters of various types in which there is an automatic valve controlling an inlet for the admission of the extra air necessary for the heavier loads this valve being provided with a light spring. Exhaust gases drawn from the exhaust pipe of the engine at a point as far as possible from the cylinder are first made to pass through an exhaust cooler which also plays the part of an expansion chamber and also that of a condenser to remove the bulk of the water formed by the combination of the gases and

air and are then led to a nozzle situated within a choke tube connected to the extra air inlet valve. By this means, when the load is heavy and the extra air valve comes into operation, air and cooled exhaust gases in a proportion dependent upon the size of the nozzle are drawn into the cylinder, while on the lighter loads, when owing to throttling, the pressure in the cylinder is much reduced, the extra air valve does not open and no exhaust gases are admitted. It is desirable to provide some means for regulating the flow of exhaust gases and cutting it off altogether at reduced loads when the rate of burning is already none too rapid; and the method put forward effects this control automatically.

The accompanying drawings illustrate one method of putting the invention into practice. In these drawings,

Figure 1 is an elevation partly in vertical section showing a carbureter having the present invention applied thereto.

Fig. 2 is a vertical section on the line 2—2 of Fig. 1.

Like letters indicate like parts throughout the drawings.

The carbureter structure to which the invention is illustrated as being applied by way of example comprises a fuel jet A disposed in a choke tube B which is mounted in one end of a tube C the other end of which opens into a chamber D where is situated the throttle E and the opening controlled thereby into the engine induction pipe F. Provision is made for admitting on occasion extra air into the chamber D this extra air inlet comprising a short tube G one end of which G' is open and downwardly directed while the upper end is closed and has arranged across it a tube H having a series of openings H' through its wall. The tube H is arranged coaxially with relation to the chamber D which is preferably formed cylindrical with the throttle E constructed as a sleeve sliding within it. The outer end of the tube H is closed while the opening of the other end which leads into the chamber D is controlled by a valve J which rests on a seating formed at the end of the tube H. The valve J is mounted on the end of a spindle J' on which is a piston like member J² adapted to slide in the tube H and serve as a guide for the valve J. The end of the spindle J' passes out through the closed end of the tube H and carries a cap J³ between which and the end of the tube H is carried a spring K which tends to keep the valve J on its seat. The extent to which the spring K is compressed can be adjusted by means of the nut J⁴ which screws on to the end of the spindle J'.

Within the open end G' of the tube G lies a jet nozzle L mounted on the end of a pipe M which leads from a cooling chamber

formed by a series of pipes N surrounded by a casing N' through which water can circulate. From the other end of the cooling device N N' runs a pipe O to a chamber P part of which incloses the tube C through which the air and fuel pass from the choke tube B and jet A to the throttle chamber D. In the pipe O is a cock O'.

Exhaust gases from the engine are led into the chamber P by way of an opening Q and these gases can pass out of the chamber to exhaust through an opening R. Within the chamber P is arranged a partition P' which lies parallel to the tube C and to one side of the direct passage between the openings Q and R. At the upper end of the partition P' is an opening through which the exhaust gases entering at Q can pass into that portion P² of the chamber P which more immediately surrounds the tube C. At the lower end of the partition P' is arranged a flap S pivotally carried on a spindle S' which passes out through the wall of the chamber P and has a lever S² fixed on one end thereof. By movement of the flap S the flow of exhaust gases through the part P² of the chamber P around the tube C can be modified or checked so that the heating effect which these gases can exercise on the combustible mixture passing through the tube C may be varied. When the flap S is in the position in which it is shown in Fig. 2 the exhaust gases will flow directly through the main passage in the chamber P from the inlet Q to the outlet R and their heating effect on the mixture passing through the tube C will be at its least. If, however, the flap S is moved so as to open a passage at the lower end of the partition P' and partially obstruct the direct passage from the inlet Q to the outlet R some portion of the exhaust gases, dependent upon the position in which the flap S is set, will flow into the part P² of the chamber P and exert a heating effect on the tube C and the mixture passing through it.

If the cock O' in the pipe O is opened some of the exhaust gases from the chamber P will pass into the pipe O through the cooling device N N' and pipe M to the jet L. The chamber P acts to some extent as an expansion chamber so that the pressure of the exhaust gases is reduced before they pass to the jet L. The cooling device insures that these gases are considerably cooled in transit to the jet L.

When the throttle E is open and the suction in the induction pipe F increases the valve J will be lifted and extra air will be drawn in through the opening G'. If the cock is then set so as to allow exhaust gases to pass to the jet L a proportion of cooled inert gas will be drawn into the throttle chamber D together with the extra air and this air and inert gas will mingle with the

combustible mixture and all will pass into the induction tube F. The inert gas will then act as a diluent in the combustible charge and the proportion in which it is drawn in will vary in accordance with the engine suction and the setting of the cock O'. The introduction of the inert gas will be automatic as the cock O' may be set so that some inert gas from the chamber P will constantly flow to and out of the jet nozzle L but this gas together with the extra air will only be drawn into the cylinder as and when the engine suction causes the valve J to be lifted.

The construction of carbureter more particularly described above and illustrated in the drawings is intended for use with paraffin or a liquid fuel of a similar nature and if it is desired to apply the invention to a carbureter designed for use with a lighter fuel in which the mixture does not require to be heated by the exhaust gases, the construction may be modified for this purpose.

What I claim as my invention and desire to secure by Letters Patent is:—

1. In an internal combustion engine the combination of an induction pipe, means for delivering a combustible mixture into this pipe, an inlet for the admission of extra air into the induction pipe, an automatic valve controlling this inlet, and adjusted to open due to engine suction to admit air when and only when, the engine is heavily loaded, and means for delivering an inert gas to this inlet whereby the combustible mixture is diluted only when the engine is heavily loaded, for the purpose set forth.

2. In an internal combustion engine the combination of an induction pipe, means for delivering combustible mixture into this pipe, a choke tube constituting an inlet for the admission of extra air into the induction pipe, an automatic valve controlling this inlet, a nozzle disposed in the choke tube, and means for delivering an inert gas to this nozzle as set forth.

3. In an internal combustion engine the combination of an induction pipe, a throttle valve in this pipe, a carbureter which supplies combustible mixture to the induction pipe, an inlet for the admission of extra air into the induction pipe and positioned therein on the carbureter side of the throttle valve, an automatic valve controlling this inlet, and adjusted to open due to engine suction to admit air when and only when, the engine is heavily loaded, and means for delivering an inert gas to this inlet whereby the combustible mixture is diluted only when the engine is heavily loaded, for the purpose set forth.

4. In an internal combustion engine the combination of an induction pipe, a throttle valve in this pipe, a carbureter which supplies combustible mixture to the induction

pipe, a choke tube constituting an inlet for the admission of extra air into the induction pipe and positioned therein on the carbureter side of the throttle valve, an automatic valve controlling this inlet, a nozzle disposed in the choke tube, and means for delivering an inert gas to this nozzle as set forth.

5. In an internal combustion engine, in combination, an induction pipe, means for delivering combustible mixture into this pipe, an air inlet in said induction pipe between said means and the engine, an automatic valve controlling said air inlet adapted to open only when the engine is heavily loaded, a chamber into which the exhaust gases from the engine are discharged and whence they can pass to the atmosphere, means for conveying gas from this chamber to the extra air inlet, and means for cooling the gas after it leaves the chamber and before delivery at the inlet so that a mixture of air and cooled gas enters the inlet whenever the automatic valve is opened.

6. In an internal combustion engine the combination of an induction pipe, means for delivering combustible mixture into this pipe, a choke tube constituting an inlet for the admission of extra air into the induction pipe, an automatic valve controlling this inlet and adjusted to open due to engine suction to admit air when and only when, the engine is heavily loaded, a nozzle disposed in the choke tube, means for delivering exhaust gas from the engine to this nozzle, and means for cooling such gas before delivery as set forth.

7. In an internal combustion engine the combination of an induction pipe, means for delivering combustible mixture into this pipe, a choke tube constituting an inlet for the admission of extra air into the induction pipe, an automatic valve controlling this inlet, a nozzle disposed in the choke tube, a chamber into which the exhaust gases from the engine are led and whence they can pass to the atmosphere, means for conveying gas from this chamber to the nozzle, and means for cooling the gas after it leaves the chamber and before it reaches the nozzle as set forth.

8. In an internal combustion engine, in combination, an induction pipe, a throttle valve in said induction pipe, a carbureter which supplies combustible mixture to the induction pipe, an inlet for the admission of extra air into the induction pipe, said inlet being located between the carbureter and throttle valve, an automatic valve controlling said inlet and adapted to open only when the engine is heavily loaded, a chamber into which the exhaust gases from the engine are led and whence they can pass to the atmosphere, means for conveying gas from this chamber to the extra air inlet and

means for cooling the gas after it leaves the chamber and before delivery at the inlet so that a mixture of air and cooled gas enters the inlet whenever the automatic valve is

5 opened.

9. In an internal combustion engine the combination of an induction pipe, a throttle valve in this pipe, a carbureter which supplies combustible mixture to the induction
10 pipe, a choke tube constituting an inlet for the admission of extra air into the induction pipe and positioned therein on the carbureter side of the throttle valve, an automatic valve controlling this inlet, a nozzle disposed
15 in the choke tube, a chamber into which the exhaust gases from the engine are led and whence they can pass to the atmosphere, means for conveying gas from this chamber to the nozzle, and means for cooling the gas
20 after it leaves the chamber and before it reaches the nozzle as set forth.

10. In an internal combustion engine, in combination, an induction pipe, a throttle valve in this pipe, a carbureter, a chamber
25 into which exhaust gases from the engine are led and whence they can pass to the atmosphere, a passage leading from the carbureter to the induction pipe, said passage passing through the chamber for the ex-
30 haust gases and serving to convey combustible mixture to the induction pipe, an inlet for the admission of extra air into the induction pipe and positioned therein on the carbureter side of the throttle valve, an auto-
35 matic valve controlling this inlet and adapted to open only when the engine is heavily loaded, means for conveying gas from the chamber to the extra air inlet, and means for cooling the gas after it leaves the
40 chamber and before delivery at the inlet so that a mixture of cooled gas enters said inlet whenever the automatic valve opens.

11. In an internal combustion engine the combination of an induction pipe, a throttle
45 valve in this pipe, a carbureter, a chamber into which exhaust gases from the engine are led and whence they can pass to the atmosphere, a passage leading from the carbureter through the chamber to the induction pipe and serving to convey combustible
50 mixture thereto, a choke tube constituting an inlet for the admission of extra air into the induction pipe and positioned therein on the carbureter side of the throttle valve, an automatic valve controlling this inlet, a
55 nozzle disposed in the choke tube; means for conveying gas from the chamber to the nozzle, and means for cooling the gas after it leaves the chamber and before it reaches the nozzle as set forth.
60

12. In an internal combustion engine the combination of an induction pipe, a throttle valve in this pipe, a carbureter, a chamber
65 into which exhaust gases from the engine are led and whence they can pass to the atmosphere, a passage leading from the carbureter through the chamber to the induction pipe and serving to convey combustible mixture thereto, means for varying the heating effect of the gases in the chamber on
70 the combustible mixture in the passage, a choke tube constituting an inlet for the admission of extra air into the induction pipe and positioned therein on the carbureter side of the throttle valve, an automatic valve
75 controlling this inlet, a nozzle disposed in the choke tube, means for conveying gas from the chamber to the nozzle, and means for cooling the gas after it leaves the chamber and before it reaches the nozzle as set
80 forth.

In witness whereof I have signed my name to this specification.

HARRY RALPH RICARDO.