

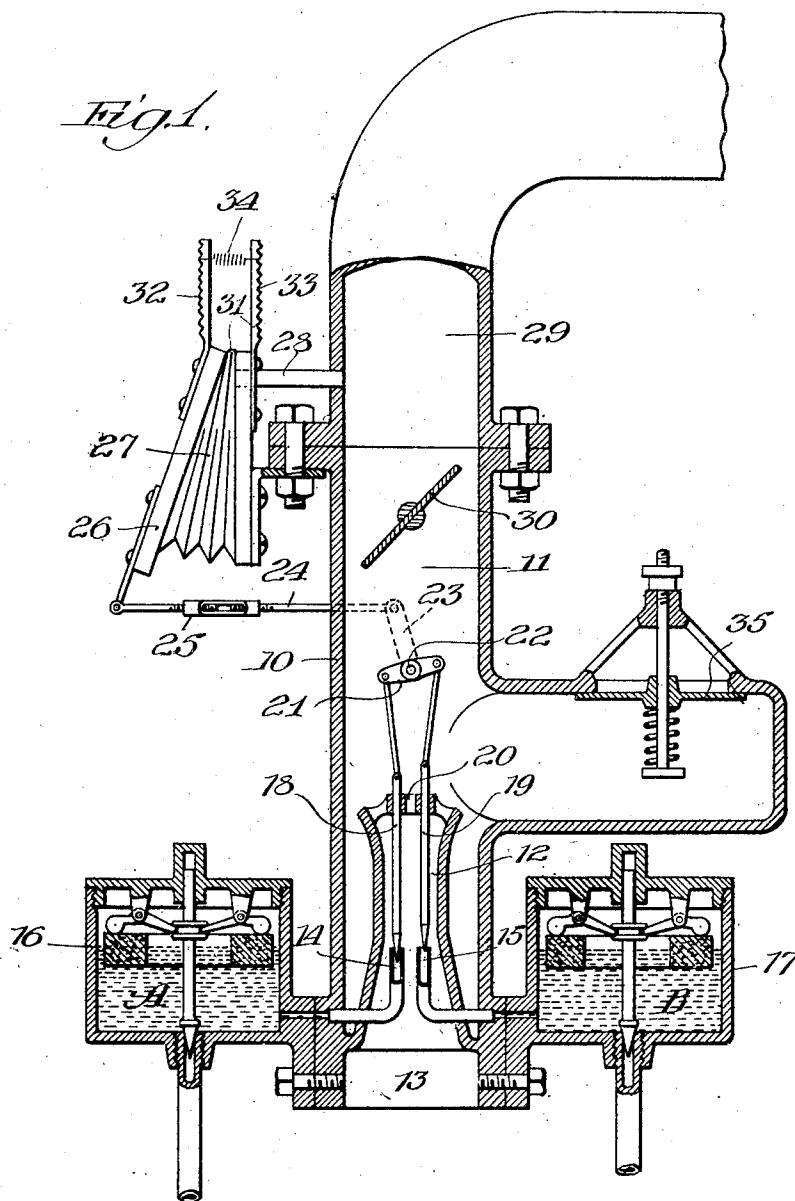
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F. A. HOWARD ET AL
METHOD OF AND APPARATUS FOR PREVENTING KNOCKING
IN INTERNAL COMBUSTION ENGINES

Original Filed Jan. 7, 1922

2 Sheets-Sheet 1



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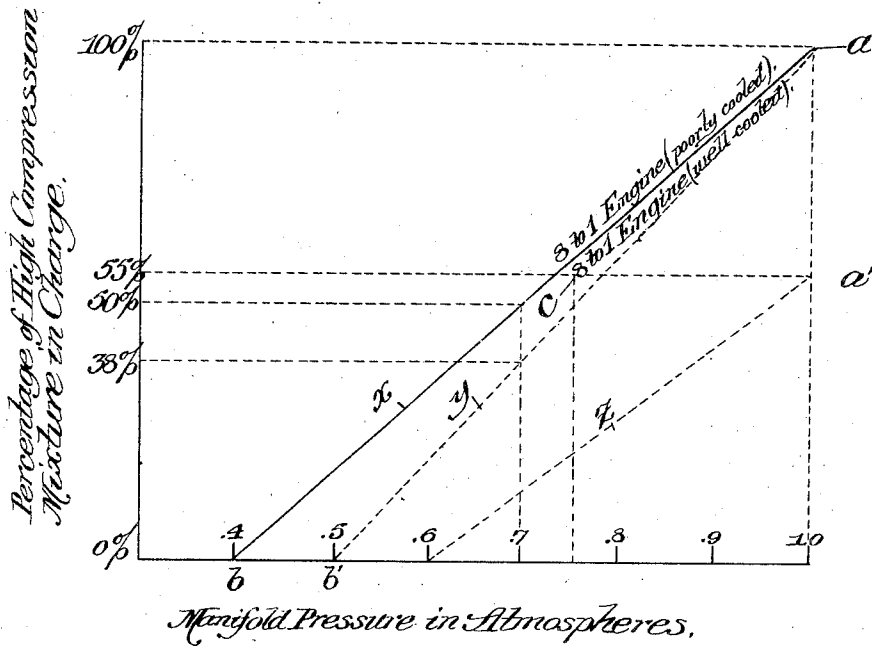
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Fig. 2.



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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR PREVENTING KNOCKING IN INTERNAL-COMBUSTION ENGINES.

Application filed January 7, 1922, Serial No. 527,666. Renewed January 5, 1928.

This invention relates to a method of and apparatus for preventing knocking in an internal combustion engine and is particularly adapted to be used on variable speed, variable load engines, such as automobile engines.

Engine designers have long known that it would be advantageous in many ways to use an engine having a much higher compression ratio than those commonly employed. This would make the engine much more efficient by allowing it to run with a higher degree of compression at its normal working loads such as are ordinarily encountered when running on the level, thereby effecting a great saving of fuel. This increased compression, however, has not been considered feasible due to the detonation, or "knocking" as it is commonly called, of the ordinary motor fuels at high compression.

This tendency of the engine to knock varies with the design and condition of the engine and with the kind of fuel. For example, with any given fuel, the degree of compression at which knocking begins depends upon the shape of the cylinder, the location and number of spark plugs, the location of the valves, the temperature of the cylinder walls and the amount and location of the carbon deposit on the cylinder walls.

With the ordinary water-cooled engine using commercial gasoline, knocking begins at about a four to one compression while with ethyl alcohol it is not yet felt at ten to one compression, depending on engine conditions as previously explained.

Referring now to the drawings, Figure 1 is a vertical section through a carbureter embodying this invention; and Figure 2 is a graph showing the operation of the carbureter.

The carbureter consists of a body 10 having a mixing passage 11, a venturi 12 and an inlet 13 communicating with the atmosphere. Two fuel jets 14 and 15 are arranged to deliver into the venturi 12 and these are supplied with fuel from the float chambers 16 and 17 in a well known manner. A low compression fuel A such as gasoline or kero-

sene is fed to the float chamber 16 and thence to the jet 14. A high compression fuel B such as alcohol or a fuel containing a "knock preventing" substance as aniline is fed through the float chamber 17 to the nozzle 15.

Needle valves 18 and 19 control the jets or nozzles 14 and 15 and are slidably mounted at the upper ends in a guide 20. These valves are connected to a rocker arm 21 which is secured on a shaft 22 which is journaled in the walls of the mixing chamber 11. The taper of the valve points is carefully determined so that at any position of the rocker arm the fuel supplied from one jet or the other or both will be just sufficient to carburet the air. One end of the shaft 22 extends outside and has keyed thereon a lever 23. A rod 24 having an adjusting turn-buckle 25 is hingedly connected to the end of the lever 23 and to the movable side 26 of the bellows 27. This bellows is supported on the carbureter body and has a tube 28 connecting the air tight interior of the bellows with the intake manifold 29 at a point posterior to the engine throttle 30.

The sides of the bellows are hinged at 31 and have outwardly extending serrated arms 32 and 33 which are preferably parallel when the bellows is in an extended position as shown in Figure 1. The spring 34 extends across the arms and normally holds the bellows open.

A well known type of auxiliary air valve 35 is placed at the side of the carbureter, this valve being relied upon to maintain the metering function of the carbureter, regardless of the position of the rocker-arm.

The operation of adjusting this carbureter is as follows:

The engine is started and placed under full load until thoroughly heated and the throttle opened wide. The spring 34 is moved outwardly so as to hold the bellows 27 open. The turn-buckle 25 is then turned so as to gradually close the high compression fuel nozzle 15 and open the low compression fuel nozzle 14 until a point is reached where knocking occurs indicating

too great a proportion of low compression fuel. The turn-buckle is then turned in the reverse direction until knocking ceases. This fixes the position of point *a* on the graph.

Starting now with a load on the engine and the throttle nearly closed, the spring 34 is pushed inwardly on the arms 32, 33, one notch at a time. The throttle is moved from closed to full open position after each change in the position of the spring. At first the engine will not knock at any position of the throttle, but as the spring is moved inwardly, knocking will begin at partly open throttle. It should then be moved outwardly just far enough to prevent an audible knock. This adjustment fixes the point *b* on the graph shown in Fig. 2.

The air valve is adjusted in the ordinary way, as is common with any fixed-jet, automatic-air-valve, carbureter.

Referring now to the graph shown in Fig. 2, the line (X) shows the curve of a poorly cooled engine having an eight to one compression ratio using gasoline as fuel A and ethyl alcohol as the high compression fuel B. It is assumed that with the other adjustments made as indicated, the spring 34 is of such an initial tension as to cause the bellows to open at a manifold pressure of four tenths of an atmosphere as indicated by the lower end *b* of the line (X) to prevent knocking as the throttle is opened. According to this graph, the charge would consist of gasoline only for all manifold pressures less than four tenths of an atmosphere. Once the two ends of the line are known, we can find the proportion of fuel B to the total fuel for a given manifold pressure by running a line from the given pressure vertically until it strikes the line (X) and then running horizontally across to the scale at the left. Thus for a manifold pressure of seven tenths of an atmosphere the proportion of fuel B to the total fuel required is substantially fifty per cent.

It will be understood that the actual compression pressure will be a product of the compression ratio for that engine which is a fixed quantity and the density of the charge which is shown in the graph (Fig. 2) as manifold pressure in tenths of atmospheres. Thus a manifold pressure of six tenths of an atmosphere gives in this eight-to-one ratio engine a compression pressure (on an isothermal basis) of six tenths times eight or four and eight tenths atmospheres.

The line (Y) is the curve of a well cooled eight-to-one compression engine using gasoline and ethyl alcohol as fuels A and B respectively. At full engine compression the lines (X) and (Y) meet at *a* on the graph, while at low manifold pressures these lines diverge, the line (X) crossing the zero line of the high compression fuel at *b'* or five

tenths of an atmosphere. At half an atmosphere and all points below, this engine is running entirely on gasoline. This means that this engine operates up to five tenths (.5) times eight, the compression ratio, or four atmospheres before any high compression fuel is admitted.

The percentage of high compression fuel in the mixture represented by the line (Y) may be determined as described for (X) for any given manifold pressure by projecting a line vertically until it intersects the line (Y) and then horizontally from this intersection to the scale at the left. The reading on the scale is the corresponding percentage. Thus for seven tenths (.7) of an atmosphere manifold pressure, projecting up to the intersection of the line (Y) and across, we find the reading on the scale is about thirty-eight per cent, which is the percentage of high compression fuel in the mixture at this manifold pressure.

The curve (Z) on the same graph represents a six-to-one compression engine moderately cooled. No high compression fuel is fed for manifold pressures below six tenths of an atmosphere or three and six tenths atmospheres compression pressure. At full compression or six atmospheres, the total percentage of high compression fuel required, is approximately fifty-five. The point *a* is found from the graphs (X) and (Y) by finding the percentage required for a point *c* midway between these curves corresponding to six atmospheres or a manifold pressure of seventy-five hundredths of an atmosphere, as previously explained. At full load, the high compression fuel forms 55% of the charge.

In the same way the curves (X) and (Y) may be used to find the correct operating curve for any other engine having a lower compression ratio than eight-to-one when this engine is operated on this carbureter and using these same fuels, i. e., gasoline and ethyl alcohol.

With a fuel like alcohol which requires approximately one and eight tenths times as much fuel to carburet a given quantity of air, the jet 15 will have to be made larger than the jet 14 to preserve the proper balance and obtain the required condition that at any position of the rocker arm the total delivery of the two grades of fuel will be just sufficient to carburet the air passing through the carbureter.

While we have shown and described certain embodiments of our invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims, in which it is our intention to claim all novelty inherent in our invention as

broadly as possible in view of the prior art.

What we claim as new, and desire to secure by Letters Patent, is:

1. A carbureter for variable speed, variable load internal combustion engines comprising a mixing tube, a fuel nozzle delivering to said mixing tube and connected to a source of low compression fuel, a second fuel nozzle delivering to said mixing tube and connected to a source of high compression fuel and means responsive to the load condition of the engine for controlling the flow of fuel from said nozzles to cause the proportion of the high compression fuel in the mixture to increase as the compression pressure in the cylinder of the engine is increased.

2. A carbureter for variable speed, variable load internal combustion engines comprising a mixing tube, a fuel nozzle delivering to said mixing tube and connected to a source of low compression fuel, a second fuel nozzle delivering to said mixing tube and connected to a source of high compression fuel, a throttle valve posterior to said nozzles and means for controlling the flow of fuel from said nozzles to cause the proportion of the high compression fuel in the mixture to increase as the compression pressure in the cylinder of the engine is increased.

3. A carbureter for variable speed, variable load internal combustion engines comprising a mixing tube, a fuel nozzle delivering to said mixing tube and connected to a source of low compression fuel, a second fuel nozzle delivering to said mixing tube and connected to a source of high compression fuel, a throttle valve posterior to said nozzles and means responsive to the suction in the intake manifold beyond said throttle for controlling the flow of fuel from said nozzles to cause the proportion of the high compression fuel in the mixture to increase as the compression pressure in the cylinder of the engine is increased.

4. A carbureter for variable speed, variable load internal combustion engines comprising a mixing tube, a fuel nozzle delivering to said mixing tube and connected to a source of low compression fuel, a second fuel nozzle delivering to said mixing tube and connected to a source of high compression fuel and means responsive to the vacuum of the intake manifold for restricting the flow of fuel from one of the nozzles and increasing the flow of fuel from the other nozzle as the vacuum in the intake manifold varies.

5. A carbureter for variable speed, variable load internal combustion engines comprising a mixing tube, a fuel nozzle delivering to said mixing tube and connected to a source of low compression fuel, a second fuel nozzle delivering to said mixing tube

and connected to a source of high compression fuel and valves responsive to the suction in the intake manifold for shutting off the flow of fuel from the low compression fuel nozzle and opening up the flow of fuel from the high compression nozzle as the vacuum decreases.

6. A carbureter for variable speed, variable load internal combustion engines comprising a mixing tube, a fuel nozzle delivering to said mixing tube and connected to a source of low compression fuel, a second fuel nozzle delivering to said mixing tube and connected to a source of high compression fuel, a bellows operable by the vacuum in the intake manifold, a spring normally holding said bellows open, and valves operably connected to said bellows and operating to close one of said nozzles and to open the other nozzle as the bellows moves due to change of pressure in the intake manifold.

7. The method of operating a variable speed, variable load internal combustion engine consisting of feeding a low compression fuel which will knock at full engine compression and simultaneously feeding alcohol, decreasing the feed of low compression fuel and increasing the feed of alcohol as the density of the engine charge increases.

8. The method of operating a variable speed, variable load internal combustion engine consisting of feeding a low compression fuel which will knock at full engine compression and simultaneously feeding alcohol, decreasing the feed of low compression fuel and increasing the feed of alcohol as the vacuum of the intake manifold decreases.

9. The method of operating a variable speed, variable load internal combustion engine consisting of feeding a low compression fuel which will knock at full engine compression and simultaneously feeding a high compression fuel, decreasing the feed of low compression fuel and increasing the feed of high compression fuel as the density of the engine charge increases, the amount of said high compression fuel fed being an appreciable part of the total fuel fed.

10. The method of operating a variable speed, variable load internal combustion engine consisting of feeding a low compression fuel which will knock at full engine compression and simultaneously feeding a high compression fuel, decreasing the feed of low compression fuel and increasing the feed of high compression fuel as the vacuum in the intake manifold decreases, the amount of said high compression fuel fed being an appreciable part of the total fuel fed.

11. The method of operating a variable speed, variable load internal combustion engine consisting of feeding a low compression fuel which will knock at full engine com-

pression, said lower compression fuel being the only fuel fed in conditions of under-load upon the engine, simultaneously feeding said low compression fuel, and a high compression fuel at medium engine load. positively and simultaneously decreasing the feed of low compression fuel and increasing the feed of high compression fuel as load upon the engine increases to the point where under maximum compression in the engine the feed of low compression fuel is cut off and high compression fuel only is fed to the engine. 10

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