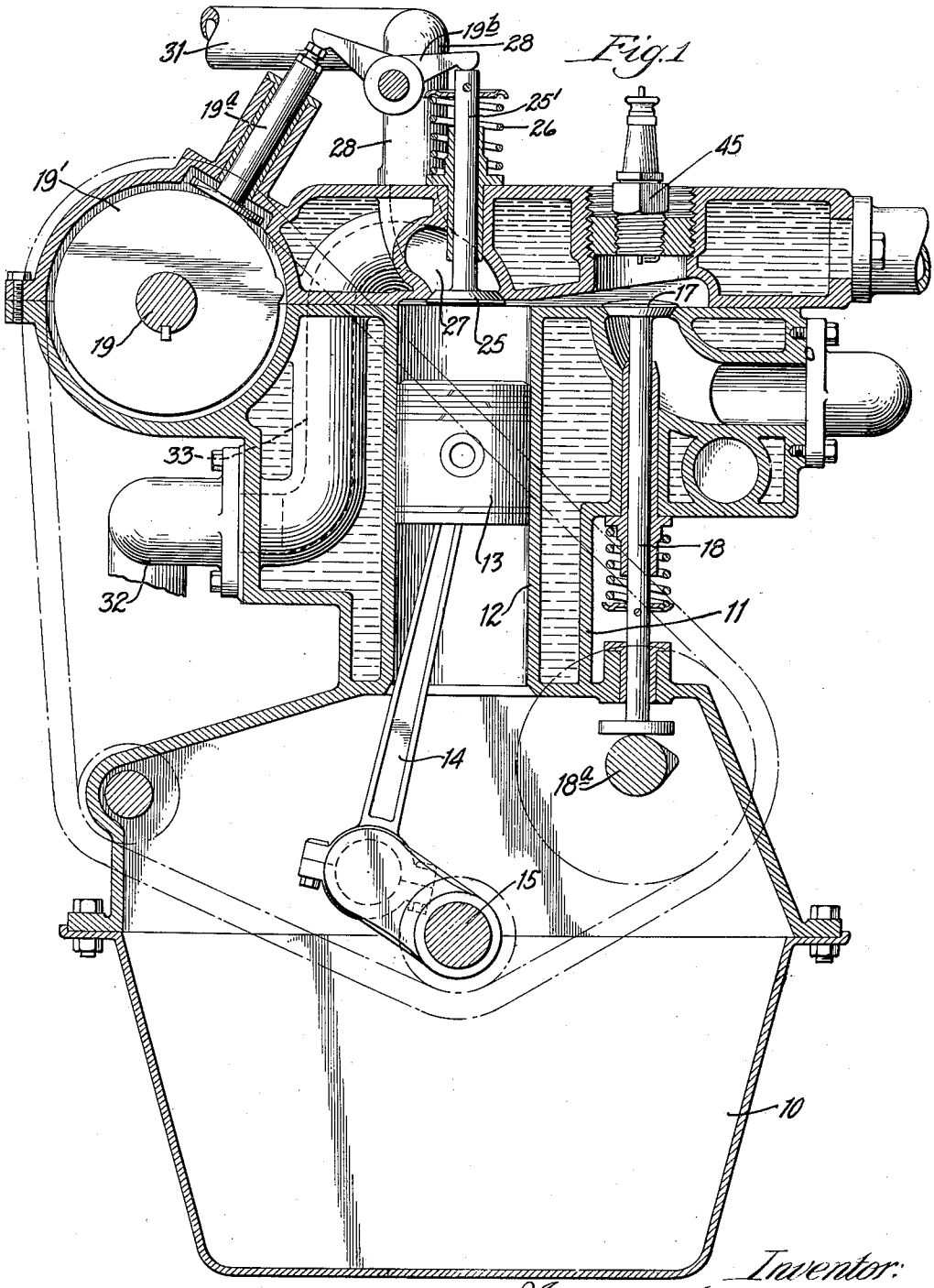
Jan. 6, 1931. W. M. ZAIKOWSKY 1,788,077

INTERNAL COMBUSTION ENGINE AND METHOD OF OPERATING THE SAME

Filed Feb. 16, 1929 2 Sheets-Sheet 1

Fig. 1



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Fig. 2

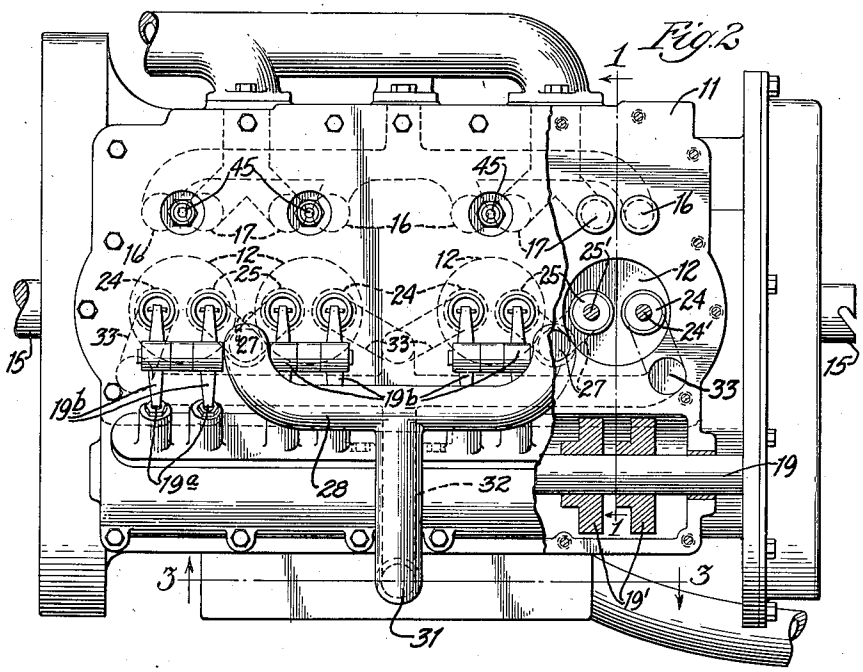
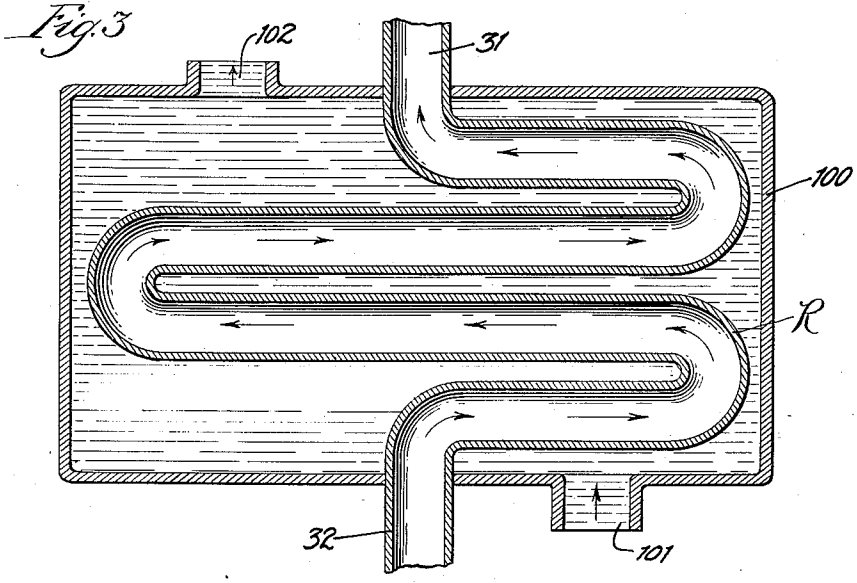


Fig. 3



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Patented Jan. 6, 1931 1,788,077

UNITED STATES PATENT OFFICE

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INTERNAL-COMBUSTION ENGINE AND METHOD OF OPERATING THE SAME

Application filed February 16, 1929. Serial No. 340,439.

This invention relates to improvements in internal combustion engines, and method of operating the same.

One of the features of the invention is the utilization and cooling of a portion of the exhaust gases for scavenging the cylinder.

Another feature of the invention is the utilization of a portion of the cooled exhaust gases for the scavenging of the cylinder near the end of the exhaust stroke of the piston in order to increase the weight of the residual exhaust remaining in the clearance by lowering its temperature.

Other features and advantages of my invention will appear more fully as I proceed with my specification.

In the accompanying drawings, I have shown, as an example, a four-cylinder engine, but it is understood that the engine may have fewer or more cylinders, as desired.

In the accompanying drawings, Figure 1 is a vertical sectional view taken as indicated by the line 1, 1, of Fig. 2; Fig. 2 is a broken plan view; and Fig. 3 is a vertical sectional view of the cooling chamber, as indicated by the line 3, 3, of Fig. 2.

I need describe but one cylinder. As shown in the drawings, 10 indicates the usual crank case; 11, the block; and 12, the cylinder. Numeral 13 indicates the piston; 14 the connecting rod; and 15, the usual crank shaft.

The usual inlet and exhaust valves are indicated by 17 and 16, respectively, and these may be operated in any convenient manner, as by means of the valve rods 18 and cam shaft 18^a, driven at half engine speed.

This much of the engine may be of any well known construction in a four cycle engine, the type illustrated being that commonly found in automobile engines.

To this well known construction I have added two additional valves 24 and 25 which are opened by means of cams on the cam shaft 19, but normally held closed by means of springs 26. The cams 19′ on the cam shaft 19 operate through push rods 19^a operating the rocker arms 19^b which depress the valve stems 24′ and 25′, respectively.

The value 24 connects with a passage 33 which, in turn, connects to a manifold 32 leading to the pipe coil R in a cooling chamber 100. Gases, after being cooled in the pipe coil R, leave the same through the pipe 31 which is connected to the manifold 28 leading to the passage 27 controlled by the valve 25. The pipe coil R in the cooling chamber 100 may be cooled by water surrounding the same. For example, water may be introduced at 101 and permitted to escape at 102. For example, water may be introduced into the opening 101 by the regular water pump (not shown) of a motor vehicle, such pump obtaining the water from the radiator. After leaving the cooling chamber through the opening 102, the water may be introduced into the water spaces of the cylinder block and head in the usual manner for cooling the same. The direction of flow of gases into and out of the cooling chamber is indicated by the arrows in Fig. 3. The pipe 32 receives the hot gases from the cylinders and the pipe 31 delivers them back in cooled condition to the cylinders. For convenience, the valve 24 which receives the hot gases from the cylinder may be referred to as the hot valve and the valve 25 which returns the cooled gases to the cylinder may be referred to as the cold valve.

The cycle of operation of this engine is that of the ordinary Otto cycle, except that this cycle is modified by the action of the additional valves 24 and 25. In general, it may be stated that the hot valve 24 is opened late in the explosion stroke and the cold valve 25 is opened near the end of the exhaust stroke, to scavenge the hot exhaust gases remaining in the clearance space with cooled exhaust gases.

The exact timing of the additional valves will vary with different usages and practices and may be made as desired. In general, it seems that it may be advisable to open the hot valve 24 at the end of the explosion or expansion stroke just before the regular exhaust valve begins to open. Hot gas will, therefore, flow from the cylinder into the cooling chamber. As soon as the regular exhaust valve opens, the pressure in the cylinder will drop rapidly; but the valve should be so timed that before the pressure in the cylin-

der drops below the pressure that is desired in the cooling chamber, the valve 24 should close, thus preventing back flow of gases from the cooling chamber through the valve 24. For example, it appears that the hot valve may commence to open about 80° before lower dead center and completely close about 40° before lower dead center on the expansion stroke. The opening of the valve may be later than this if less pressure is desired in the cooling chamber.

The cold valve should open at the end of the exhaust stroke in order to scavenge the clearance space of the hot exhaust gases. The exact timing of this valve to produce the best results will vary with different usages. It appears, for example, that the cold valve 25 may commence to open about 75° before top dead center and completely close about 15° before top dead center on the exhaust stroke.

The elimination of some of the hot exhaust gases, and replacing the same with cooled exhaust gases, serves to lessen the detonation in the operation of the engine.

Each cylinder, in turn, communicates with the cooling coil R during the latter part of its working stroke to deliver hot burned gases to the cooling coil and receives from the cooling coil a cooled flow of burned gases at the end of the exhaust stroke to scavenge the cylinder of hot exhaust gases.

It will be seen that the cold valve 25 is in the head of the motor so that the cooled gases entering the cylinder during the supercharging are directed more or less against the piston, thus serving to cool it. The hot valve 24 is also in the head, thus facilitating flow of hot exhaust gases from the cylinder to the cooling coil R. The cold valve 25 is also so arranged that the supercharging or diluting cooled exhaust gas enters the cylinder at a point removed from the spark plug 45, thus interfering less with ignition. It is to be noted, also, that the cold valve 25 is substantially diametrically opposite the regular exhaust valve 16, thus increasing the efficiency of the scavenging.

While I have shown and described certain embodiments of my 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 my intention to claim all novelty inherent in my invention as broadly as possible, in view of the prior art.

It is to be noted that when the cooled exhaust replaces the hot exhaust gas the temperature of the charge is lowered, and the proportion of the exhaust in the charge is increased without substantial reduction in the volumetric efficiency of the engine.

What I regard as new, and desire to secure by Letters Patent, is:

1. An internal combustion engine having a cylinder, a piston slidable therein, inlet and exhaust valves, a cooling chamber, auxiliary means for opening communication between said cylinder and chamber during the latter part of the expansion stroke to force burned gases into the chamber, and means for opening communication between said cylinder and chamber during the latter part of the exhaust stroke to permit cooled exhaust gases to re-enter the cylinder.

2. An internal combustion engine as claimed in claim 1, in which the cooling chamber is tubular, the exhaust gases leaving the cylinder entering one end of said tubular chamber and returning to the cylinder from the other end of said tubular chamber.

3. An internal combustion engine as claimed in claim 1, in which the communications between the cylinder and the cooling chamber are controlled by valves.

4. The method of operating an internal combustion engine, consisting of trapping a portion of the exhaust gases, cooling the same, and re-introducing such cooled exhaust gases into the cylinder toward the end of the exhaust stroke.

5. The method of operating an internal combustion engine, consisting of trapping a portion of the exhaust gases during the expansion stroke, cooling the same, and re-introducing such exhaust gases into the cylinder during the exhaust stroke.

6. An internal combustion engine having a cylinder with an opening or openings in the head, a cooling chamber in communication with said opening or openings, and means controlling said opening or openings whereby hot exhaust gases are introduced into the cooling chamber near the end of the explosion stroke and re-introduced into the cylinder near the end of the exhaust stroke.

7. An internal combustion engine having a cylinder with two openings in the head thereof; a tubular cooling chamber, with its ends in communication with said openings; valves controlling said communications; and means for opening one of said valves during the explosion stroke and the other of said valves during the exhaust stroke.

In witness whereof, I have hereunto set my hand this 6th day of February, 1929.

WLADIMIR M. ZAIKOWSKY.