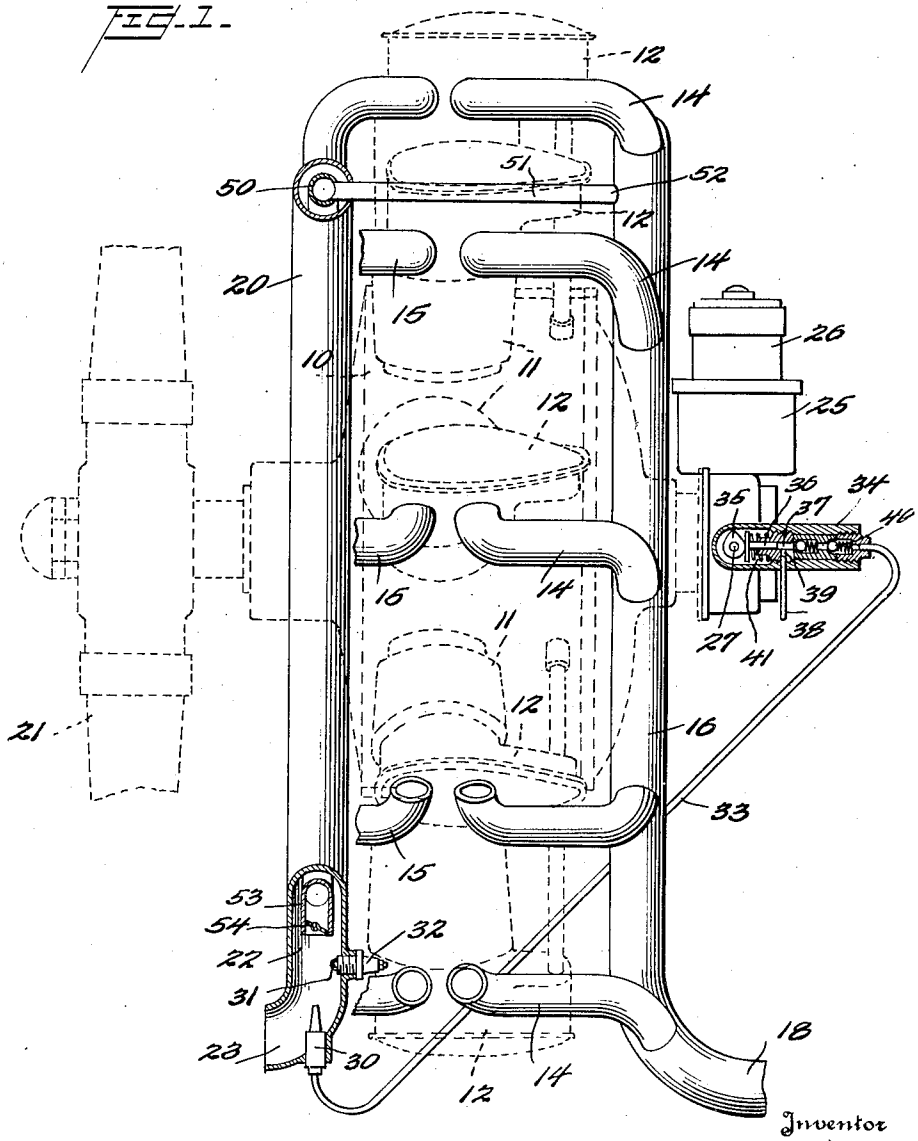
June 16, 1936. L. M. WOOLSON 2,044,113

INTERNAL COMBUSTION ENGINE

Filed Aug. 28, 1930 2 Sheets-Sheet 1

FIG. 1.



Inventor

L. M. Woolson deceased
by Emma C. Woolson, Executrix

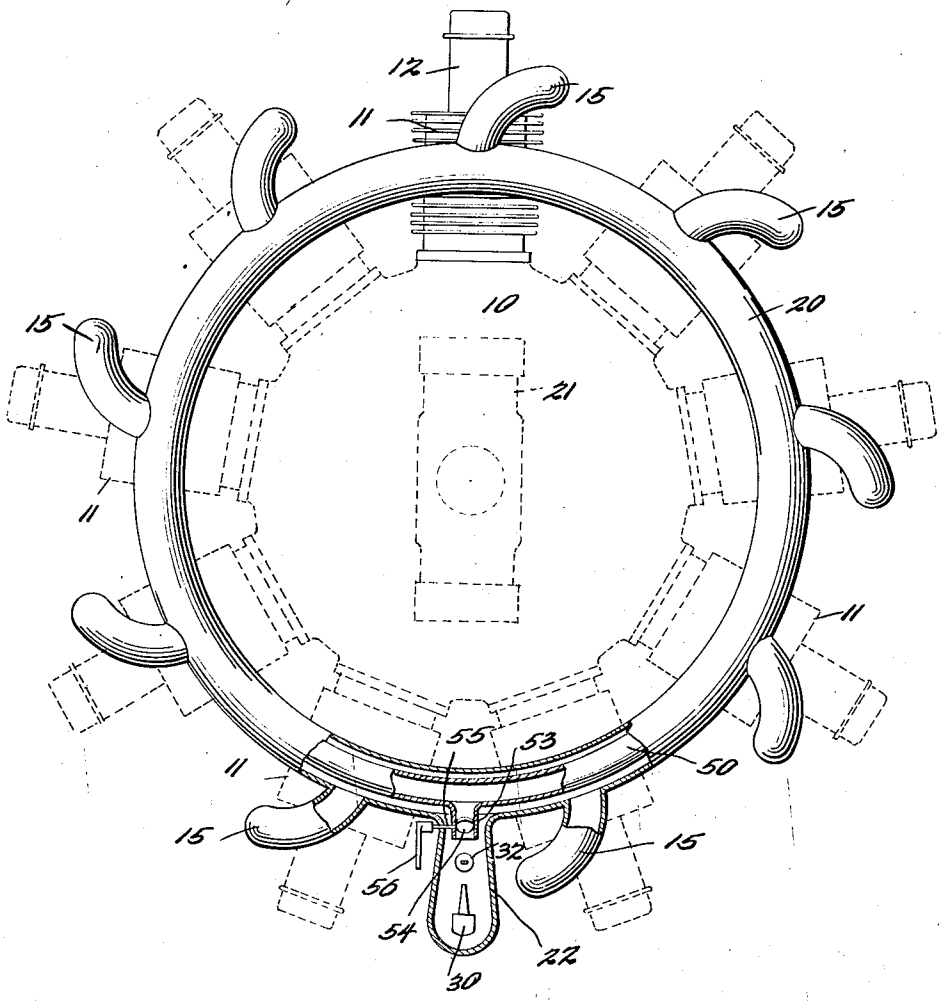
By Watson, Cole, Morse & Grindle
Attorneys

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INTERNAL COMBUSTION ENGINE

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FIG. 2.



Inventor

L. M. Woolson, deceased

by Emma F. Woolson, Executrix

By Watson, Cole, Morse & Grindle

Attorneys

Patented June 16, 1936 2,044,113

UNITED STATES PATENT OFFICE

2,044,113

INTERNAL COMBUSTION ENGINE

Lionel M. Woolson, deceased, late of Detroit, Mich., by Emma F. Woolson, executrix, Bloomfield Village, Mich., assignor to Packard Motor Car Company, Detroit, Mich., a corporation of Michigan

Application August 28, 1930, Serial No. 478,460

7 Claims. (Cl. 123—179)

This invention relates to Diesel engines and particularly to apparatus for heating the intake air for Diesel engines.

It is a general object of the present invention to provide novel means for heating the intake air for Diesel engines.

More particularly it is an object of the invention to provide means for heating the intake air for Diesel engines prior to and during the cranking operation and during idling or low speed running.

One of the important features of the invention resides in the provision of means for burning a quantity of fuel at the entrance to the intake manifold prior to and during the cranking operation of the engine.

Another feature of the invention resides in a pump mechanism associated with the starter apparatus for providing fuel for heating the intake air for starting purposes.

Another important feature of the invention resides in the provision of means for heating the intake air from the exhaust together with means for adding a quantity of exhaust gases to the intake air for improving the idling operation of the engine.

Other and further features and objects of the invention will be more apparent to those skilled in the art upon a consideration of the accompanying drawings and following specification wherein is disclosed a single exemplary embodiment of the invention with the understanding, however, that such changes may be made therein as fall within the scope of the appended claims without departing from the spirit of the invention.

In said drawings:

Figure 1 is a side elevation of an engine of the Diesel type to which the present invention has been applied, certain parts being shown in section; and

Figure 2 is a front elevation of the engine showing certain parts in section.

Diesel engines of the solid fuel injection type, and other types, when used in the smaller sizes for such purposes as on automotive equipment are sometimes found difficult to start in extremely cold weather, for the heat necessary for igniting the fuel in an engine operating on the Diesel cycle must come from the compression of the air in the cylinders. Starting with a completely cold motor means that a great quantity of the heat imparted to the air during the compression stroke is dissipated by radiation to the cold metal of the cylinders and pistons. In accordance with the present invention, means are provided to preheat the air for starting purposes prior to its entrance into the cylinders to make up to a large extent for the heat lost by this radiation.

The idling characteristics of a Diesel engine, it has been found, are improved by heating the incoming air and by mixing with the incoming air a quantity of the exhaust products of combustion. This invention includes means for heating the air, from the exhaust of the engine, and for mixing with the air controlled quantities of the exhaust products.

The invention has, in the present instance, been illustrated in connection with a Diesel engine of the air-cooled type having radial cylinders such as used for aircraft. For purposes of this application, the engine may be of the standard two valve type wherein air alone is admitted through the intake valve and the exhaust products vented through the exhaust valve or it may be of the less conventional single valve type wherein one valve performs the dual function of controlling the air inlet and the scavenging. In this latter case, owing to the manifolding required a selector valve is necessary for each cylinder to prevent the exhaust products from entering the intake manifold and vice versa. Since both of these features are well known, they have not been illustrated more than conventionally in the drawings.

Referring now to the drawings, the engine will be seen to comprise essentially a central or crank case portion 10 of barrel formation supporting the radial cylinders 11 provided with fins for air cooling. In the present instance, the valve-in-the-head type of cylinder is used and the valve operating mechanism is housed in suitable stream lined chambers 12 from which the exhaust products are conducted, by either of the valve arrangements previously mentioned, to the individual exhaust pipes 14. Air is conducted to each cylinder through an individual air intake pipe 15. The exhaust pipes 14 all lead into a ring shaped exhaust manifold 16 which is provided with a tail pipe 18 for conducting the exhaust products beneath the fuselage of the airplane.

The intake pipes 15 are similarly connected to a ring shaped inlet manifold 20 on the front of the engine and just behind the propeller 21. This manifold is provided with a depending inlet pipe 22 which is bent forward to provide the scoop portion 23 in the slip stream. The portion 22 enters the manifold between the junc-

tion of the two lower inlet pipes 15 therewith. It will be appreciated that the inlet manifold is of sufficient capacity to provide adequate air for all of the cylinders.

In the present instance, the engine is started by means of the well known inertia starter 25 mounted on the rear of the crank case and serving to crank the motor for starting purposes in a manner fully described in the patent to Lansing, No. 1,739,469. Briefly, it may be stated, that such a starter comprises a small fly wheel element adapted to be brought up to speed by means of an electric motor 26 or a hand crank on the end of the shaft 27 and that after this fly wheel has been brought up to speed it is connected through a train of reducing gears and a manually operable clutch to the shaft of the engine and turns over the engine until the energy of the fly wheel is dissipated. This form of starter is particularly valuable for the present invention for it operates from 10 to 20 seconds prior to the cranking while the fly wheel is being brought up to speed and continues to operate during the cranking operation. The shaft 27 for the hand cranking operation rotates at a fairly low speed and is made use of to supply fuel to a jet 30 in the air inlet pipe 22, which is burned upon coming in contact with the incandescent element 31 of a glow plug 32 suitably connected in circuit with the starting battery to glow during the starting operation. The jet is directed upwardly so that atomized fuel strikes the plug and is ignited and heats the air in the intake manifold both prior to and during the cranking operation and at the same time dilutes it with certain products of combustion. This ensures quick and easy starting.

Fuel oil of the type used in the engine is supplied to the pipe 33 leading to the jet by means of a plunger pump 34 actuated by the cam 35 on the shaft 27 of the starter. This pump may comprise a simple plunger 36 operating in the cylinder 37 which is supplied with oil under low pressure through the pipe 38 and inlet 39 When the plunger is in the position shown in the drawings, oil flows into the space above the piston or plunger and as the cam lifts the plunger and it closes off the inlet 39, the oil is forced through the check valves 40 and into the pipe 33. The plunger is returned by means of the helical spring 41.

It will be obvious that the apparatus just described functions only during the starting operation and is not satisfactory for maintaining heated air in the intake manifold during idling or slow speed running. This latter heating can be effected by making use of the heat in the exhaust of the engine. For this purpose a coaxial tube 50 is arranged within the air intake manifold 20 and is connected at the top by means of a pipe 51 to the exhaust manifold at 52. At the lower side the tube 50 is provided with an outlet in the form of a neck 53 concentric within the inlet portion 22 of the air manifold. This neck is provided with a butterfly throttle valve 54 controlled by means of a shaft 55 and operating crank 56.

In the use of this device the butterfly valve 54 is opened the desired amount during idling to permit a flow of exhaust products through the tube 50 due not only to the pressure in the exhaust manifold but also to the aspirator action of the air. The quantity of exhaust products flowing through the tube 50 and into the intake manifold is regulated by the position of the butterfly valve so that not only is the air heated by contact with the surface of the tube 50 but it is also given a certain quantity of heat by the mixing of the exhaust products therewith so that the engine can be operated satisfactorily at idling and at low speeds.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patents is:

1. In an internal combustion engine, in combination, an air intake manifold for a plurality of cylinders, an entrance duct for said manifold through which all the air to the cylinders passes during normal operation of the engine, a fuel burner jet directly in said duct and means to supply fuel to said jet automatically only prior to and during cranking of said engine.

2. In an internal combustion engine of the solid fuel injection Diesel type, in combination, a manifold for a plurality of cylinders to supply air only, a fuel jet in said manifold, means in said manifold to ignite fuel from the jet therein, a starter for said engine, a fuel pump to supply fuel to said jet and means to actuate said pump from said starter only.

3. In a Diesel engine of the solid fuel injection type, in combination, an intake pipe for all the air to the cylinders, means to spray fuel into said intake pipe during cranking of the engine, means to ignite the fuel in the intake pipe and means to simultaneously inject solid fuel into the cylinders.

4. In an internal combustion engine of the solid fuel injection type, in combination, a main air intake duct for the cylinders, a fuel jet directly in said duct, an impulse starter for said engine, means actuated by said starter to eject fuel from said jet prior to cranking the engine and means to ignite the fuel in said duct.

5. In a multi-cylindered solid fuel injection type Diesel engine, in combination, an air inlet manifold for the cylinders having an entrance duct, a fuel jet in said duct, a glow plug positioned to ignite fuel issuing from said jet, an impulse starter for said engine having a rotatable inertia element, a pump to supply fuel to said jet and means to drive the pump from the inertia element of said starter while it is attaining speed and during the cranking of the engine.

6. In a Diesel engine of the solid fuel injection type, in combination, an inlet pipe for all the air supplied to the cylinders, a fuel jet in said pipe, means to ignite fuel issuing from said jet to burn only in said air and in said pipe, a starter for said engine having a part which moves before and during the actual cranking of the engine and a pump driven by said part to supply fuel to said jet.

7. In an internal combustion engine of the solid fuel injection type, in combination, an air intake passage to provide all of the air to the cylinders during normal and starting operations of the engine, means to supply some of the fuel regularly used by the engine to said passage, and means to burn said fuel directly and entirely in said passage by combination with a portion of said air, prior to and during cranking of the engine to start the same.

EMMA F. WOOLSON,
Executrix of the Estate of Lionel M. Woolson, Deceased.