Feb. 17, 1942. T. V. DILLSTRÖM 2,273,025

INTERNAL COMBUSTION ENGINE

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FIG. 1

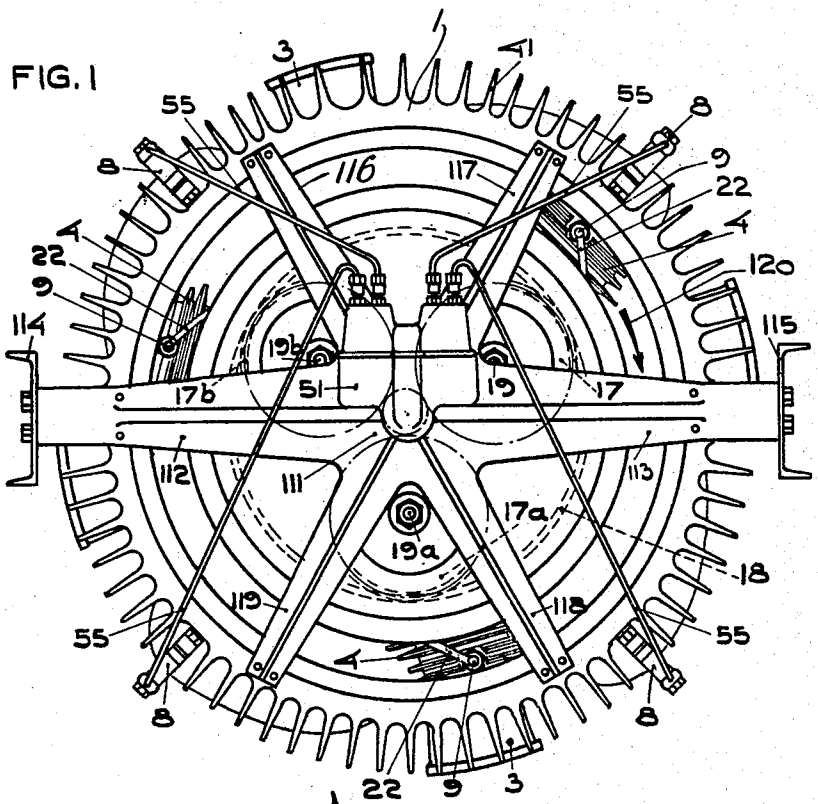
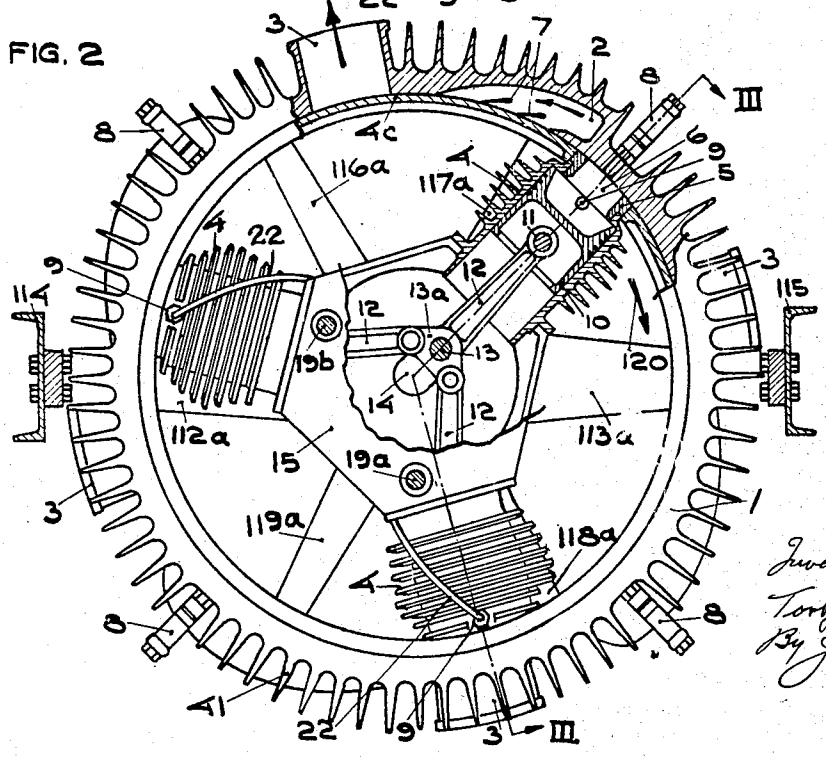


FIG. 2



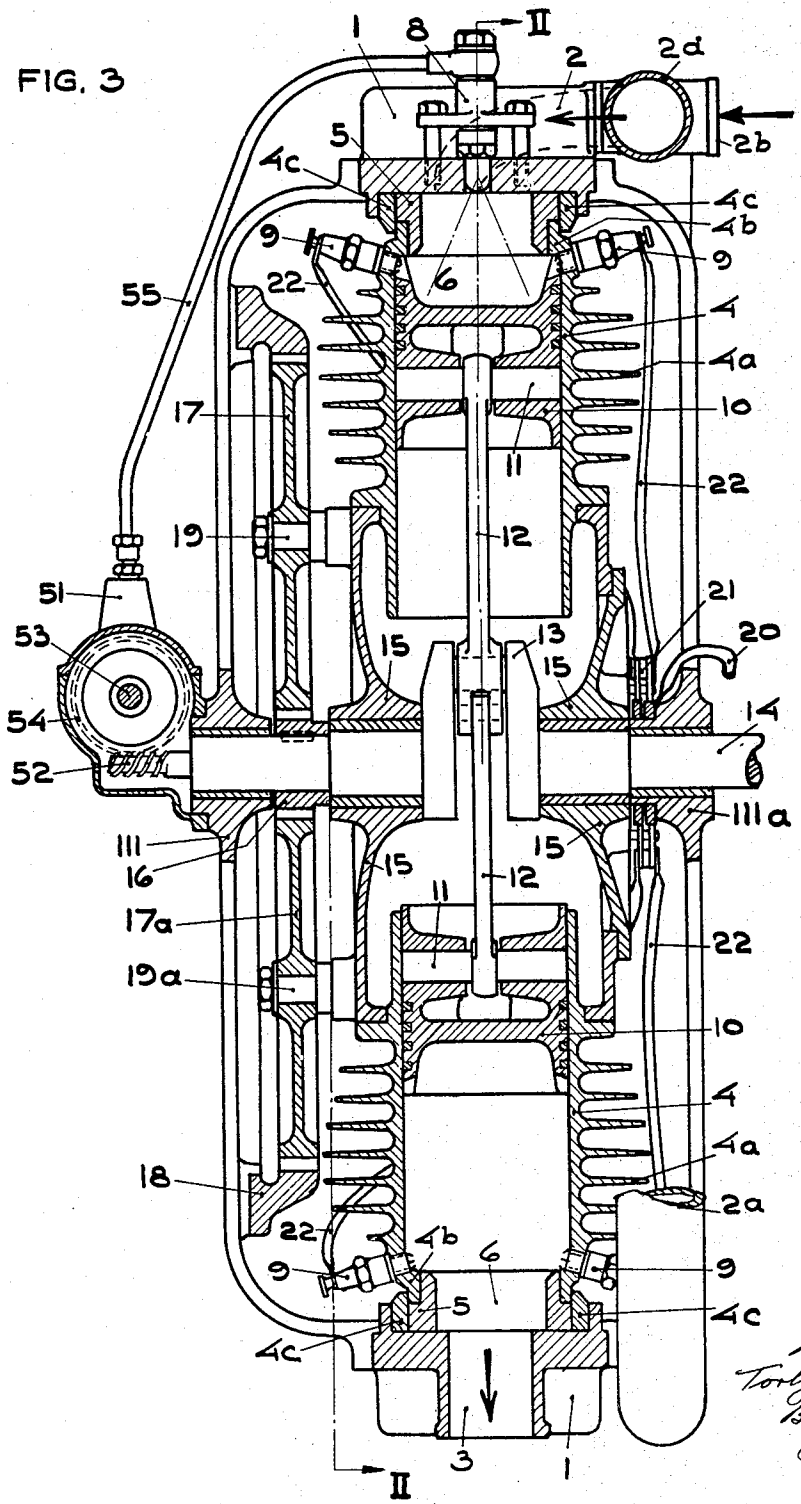
Inventor:
Torbjorn Viktor Dillstrom
By Jarvis C. Marble
his Attorney

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FIG. 3



Inventor
Torbjörn Viktor Dillström
By Jarvis C. Marble
his Attorney.

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INTERNAL COMBUSTION ENGINE

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FIG. 4

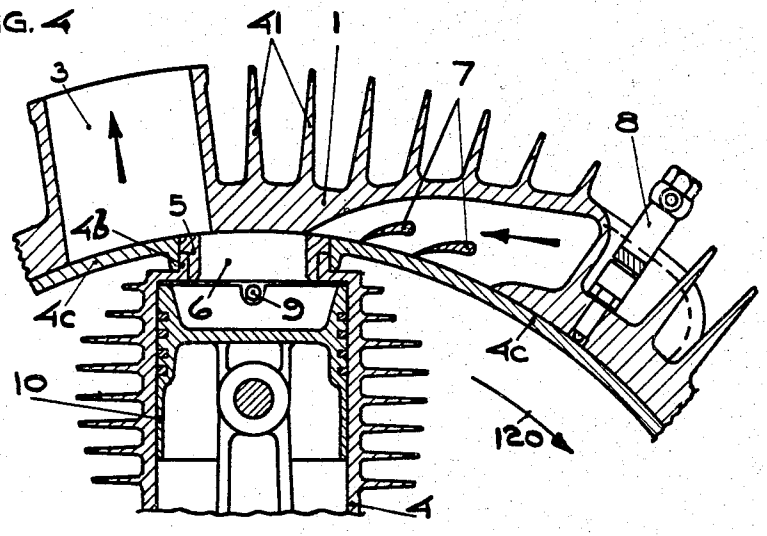


FIG. 5

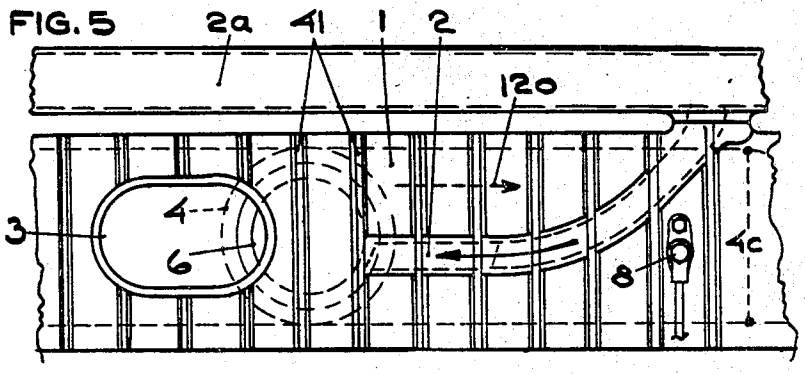
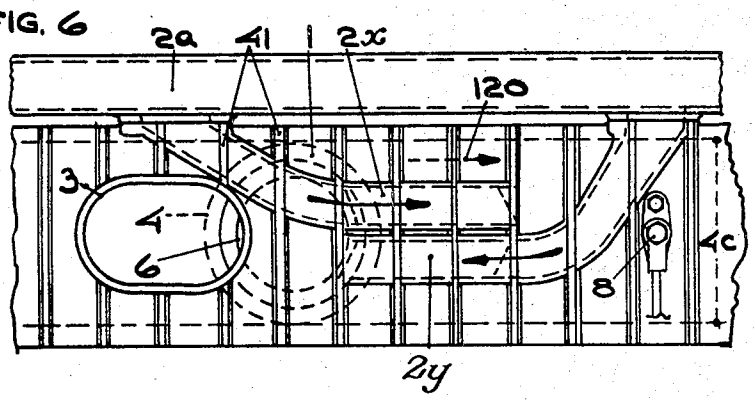


FIG. 6



Inventor
Torbjorn Viktor Dillstrom
By Jarvis L. Marble
his Attorney

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UNITED STATES PATENT OFFICE

2,273,025

INTERNAL COMBUSTION ENGINE

Torbjörn Viktor Dillström, Stockholm, Sweden, assignor, by mesne assignments, to Mawen Motor Corporation, New York, N. Y., a corporation of Delaware

Application April 6, 1938, Serial No. 200,328
In Sweden April 21, 1937

4 Claims. (Cl. 123—44)

This invention relates to internal combustion engines of the type in which fuel is injected into the combustion chamber but which are not fitted with valves. The invention is mainly intended for use in radial motors the cylinders of which rotate about the shaft of the engine and fuel is injected into the combustion chamber at the end of the compression stroke.

In engines with fuel injection, an agitation of the air in relation to the jets of fuel in the combustion chamber at the time of the fuel injection, has been found useful with a view to obtaining intimate mixture of fuel and air. In general, a rotary movement is employed, but even a turbulent one can be used or combined, with advantage, with the rotary movement. This agitation is applied both to engines working on the Diesel and on the Otto principle respectively. In order to obtain such movement, the air must be introduced into the combustion chamber with a certain velocity. The necessary velocity is generally obtained by constricting the induction passage. However, in all cases a throttling of the air takes place, resulting in decreased air pressure and in correspondingly impaired volumetric efficiency. In many types of engines, this reduction of efficiency is not so great as to entail serious inconveniences and, consequently, the aforesaid arrangements have been employed in the case of stationary, lorry or similar heavier engines. Conditions however, are different in the case of high speed engines, particularly aircraft engines, where the desired result is to obtain the highest possible performance at comparatively high engine speeds. For this reason, it is necessary to maintain the volumetric efficiency at the highest possible level, and to have the fuel thoroughly mixed with air.

In the aforementioned type of internal combustion engines, the present invention aims at effecting a suitable movement of the combustion air in the combustion chamber and at carrying out the fuel injection in such a manner that, on the one hand, only a minimum movement of the combustion air is required, resulting in that the requisite movement entails only the slightest possible throttling of the air, whilst, on the other hand, the air and fuel mix as completely as possible. Where separate ignition of the mixture of fuel and air by means other than the heat of compression is employed the invention also indicates how the ignition device or devices should be arranged.

The invention will hereinafter be more fully explained with reference to the accompanying drawings which illustrate diagrammatically and by way of example various embodiments thereof, and in which:

Fig. 1 shows a view of a motor in accordance with the invention with three radially arranged cylinders;

Fig. 2 shows the same motor as in Fig. 1, viewed along the lower part of line II—II of Fig. 3, the crank case, however, being partly uncovered, and a cylinder, an inlet and an exhaust passage being sectioned in accordance with the upper part of said line II—II;

Fig. 3 is a vertical section along the line III—III of Fig. 2; and

Figs. 4 to 6 show details in a larger scale.

In the drawings, like parts are denoted by like reference characters.

The motor is mounted on a stand consisting of two parts 111 and 111a which are provided with arms arranged in star formation. The main arms 112, 112a and 113, 113a are fixed on bearing parts 114 and 115, e. g. on the hull of an aircraft. To the arms 116 and 116a, 117 and 117a, 118 and 118a, 119 and 119a, a crown 1 of one or several parts is fixed. The crown 1 constitutes what may be termed a valve port housing. In the crown which is provided with cooling ribs 41, are arranged induction passages 2 for combustion air and exhaust passages 3 for exhaust gases, and fuel injection devices 8. Inside the crown 1 are disposed three engine cylinders 4 with cooling ribs 4a. Within each cylinder moves a piston 10 which is connected to the crank pin 13 of the engine crank shaft 14 by means of a connecting rod 12, either directly or by means of a plate 13a on one of the rods 12. The cylinders are fixed to the crank case 15 which is rotatably arranged on the crankshaft 14. The crankshaft 14 itself is supported on bearings in the stands 111 and 111a. Keyed on the crank shaft 14 is a toothed wheel 16 gearing with three toothed wheels 17, 17a and 17b the teeth of which mesh with the teeth on a crown 18 fixed on the stand 111. The wheels 17, 17a and 17b are rotatably mounted on pivots 19, 19a and 19b fixed to the case 15. The movement of the engine pistons as a result of the combustion of the fuel-air mixture in the cylinders sets the crank shaft 14 and the toothed wheels 16, 17, 17a and 17b into rotation. The wheels 17 being compelled to run inside the crown 18, cause the case 15 and the engine cylinders 4 fixed thereon, to rotate. Rotation may occur in the direction of the arrow 120.

The crank shaft 14 is also provided with a

worm 52 driving a fuel pump 51 by means of a worm wheel 54 on a shaft 53 of the pump. As the construction and operation of the fuel injection pump are of no importance to the practical application of the invention, no further details of the pump are shown on the drawings or described herein. The pump 51 delivers fuel, accurately timed, through pipes 55 to the fuel injection devices 8.

The heads of the cylinders 4 are provided with a flange-like portion 4b engaging corresponding openings in a washer or the like 4c sliding inside the crown 1, and supporting the outer parts of the cylinders 4. Inside said openings is located a ring 5 serving as a packing. The space 6 inside the ring 5 forms a part of the compression chamber of the engine cylinder and is a connecting member between the actual combustion chamber and the passages 2 or 3 in the crown 1.

Combustion air is introduced into the cylinders 4 by the passages 2 from a common manifold 2a fixed on the crown 1 and provided with an inlet opening 2b. In accordance with the present invention the passages 2 are so arranged that the combustion air enters the space 6 eccentrically and approximately tangentially. Either one or more inlets may be provided. Several inlets 2x and 2y (Fig. 6), must be so arranged that the air streams have the same direction inside the combustion chamber. If one induction passage is employed—as in the engine shown in Figs. 1 to 5—the breadth thereof should not extend over much more than half a diameter of the space 6. The advantage by using several induction passages resides in the fact that the filling of the cylinders with combustion air and, as a result thereof, the volumetric efficiency, are greatly improved. In order to conduct the entering combustion air and obtain as nearly tangential admission as possible, guide vanes 7 may be provided as shown in Figs. 2 and 4.

When the cylinders 4 rotate inside the stator 111, 111a their combustion chambers pass the passages 2 or 3 respectively and the injection devices 8. The speed of rotation of the cylinder star, the strokes and speeds of the pistons 10, the operation of the fuel injection pump and the distances between the passages in the crown 1 and between the passages and the injection devices 8 are so selected that the cylinders when their pistons are on a suction stroke, are filled with combustion air from a passage 2, when their pistons are at the end of a compression stroke, are supplied with fuel from an injection device 8, and, after ignition of the cylinder load, exhaust the gases during an exhaust stroke through a passage 3.

The most suitable location for the injector or injectors 8 for liquid level, is in the crown 1. The injector is thus disposed in a stationary part of the engine. This is the most suitable means of spreading the fuel in the combustion chambers. A double movement is thus set up between the injected fuel and the air, as on the one hand, the air rotates in the cylinders during the injection and, on the other hand, the injector, because of the movement of the cylinders, travels across the combustion chambers. These two movements cause the most complete mixing of fuel and air in the combustion chamber and substantially reduce the requirements as regards the rotational velocity of the air. The latter results in smaller losses in pressure by throttling and, therefore, is naturally of advantage for the volumetric efficiency of the engine.

When electric spark plugs 9 or the like are employed for igniting the charge of fuel and air in the cylinder, the plugs are preferably mounted in the cylinder 4. The fact that in such case, they are located in a moving part of the engine does not lead to any greater difficulty in supplying the plugs with the current required for the ignition. A suitable arrangement of two plugs for example, is shown in the drawings. Electric current is supplied to the plugs from a line 20 via a rotary distributing device 21 and the distributing lines 22.

As mentioned at the outset of this specification, the engine illustrated is primarily intended for use in aircraft, but it may of course also be used in other spheres of application.

It will also be apparent that the invention is not limited in its application to aspirated engines, but may also be applied to supercharged engines.

It will be apparent that changes in the specific embodiment of structure illustrated by way of example may be made without departing from the invention, and also that within the scope of the invention certain of the features disclosed may be used to the exclusion of others.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In an internal combustion injection engine, a cylinder having an inlet for combustion air, a fuel injection device mounted independently of the cylinder and adapted to be in communication therewith for injecting liquid fuel in finely divided state into said cylinder, means adapted to supply liquid fuel to said injection device, and means for obtaining uniformity of distribution of said fuel in said cylinder, said means comprising means for introducing air through said inlet adapted to provide a whirling action to the air charge within said cylinder and means for providing relative movement between said cylinder and said fuel injection device whereby the combined action of said movement and said whirling action will effect said uniformity of distribution in the cylinder of the finely divided liquid fuel injected thereinto by said injection device while said cylinder is moving with respect to said injection device and after said air has been introduced into said cylinder.

2. Apparatus as set forth in claim 1 in which the inlet for combustion air comprises a port at the combustion chamber end of the cylinder, the means for introducing air through said inlet comprises a passage arranged to direct air tangentially into the cylinder to produce a whirling action of the air charge around the longitudinal axis of the cylinder, and in which said fuel injection device is located to inject the finely divided fuel generally longitudinally of the axis of the cylinder and transversely of the plane of rotation of the air charge.

3. Apparatus as set forth in claim 1 in which the inlet for combustion air comprises a port at the combustion chamber end of the cylinder, and in which said fuel injection device is mounted in a valve port housing relatively rotatable with respect to the cylinder, said valve port housing having an air admission passage registering with said cylinder port and arranged to direct the combustion air thereinto tangentially

in the plane of relative rotation between the cylinder and the valve port housing and in a direction in said plane generally opposed to the direction of relative rotation of the cylinder with respect to the valve port housing, whereby to create a whirling action of the air charge in the cylinder generally about the longitudinal axis of the cylinder, and said fuel injection device being located to inject the finely divided fuel generally transversely of the plane of rotation of the rotating air charge.

4. Apparatus as set forth in claim 1 in which the inlet for combustion air comprises a port at the combustion chamber end of the cylinder, and in which said fuel injection device is mounted in a valve port housing relatively rotatable with respect to the cylinder, said valve port housing having an air admission passage arranged to direct the combustion air tangentially of the cylinder to create an air charge in the cylinder whirling generally about the longitudinal axis of the cylinder, said injection device being located to inject fuel generally transversely of the plane of rotation of the whirling air charge to form an explosive charge of fuel and air in the cylinder for subsequent ignition therein, and an ignition device for igniting the pre-formed fuel-air mixture in the cylinder at a predetermined time in the cycle of engine operation.

TORBJÖRN VIKTOR DILLSTRÖM.