July 5, 1932. L. M. WOOLSON 1,866,281

INTERNAL COMBUSTION ENGINE

Filed July 28, 1928 2 Sheets-Sheet 1

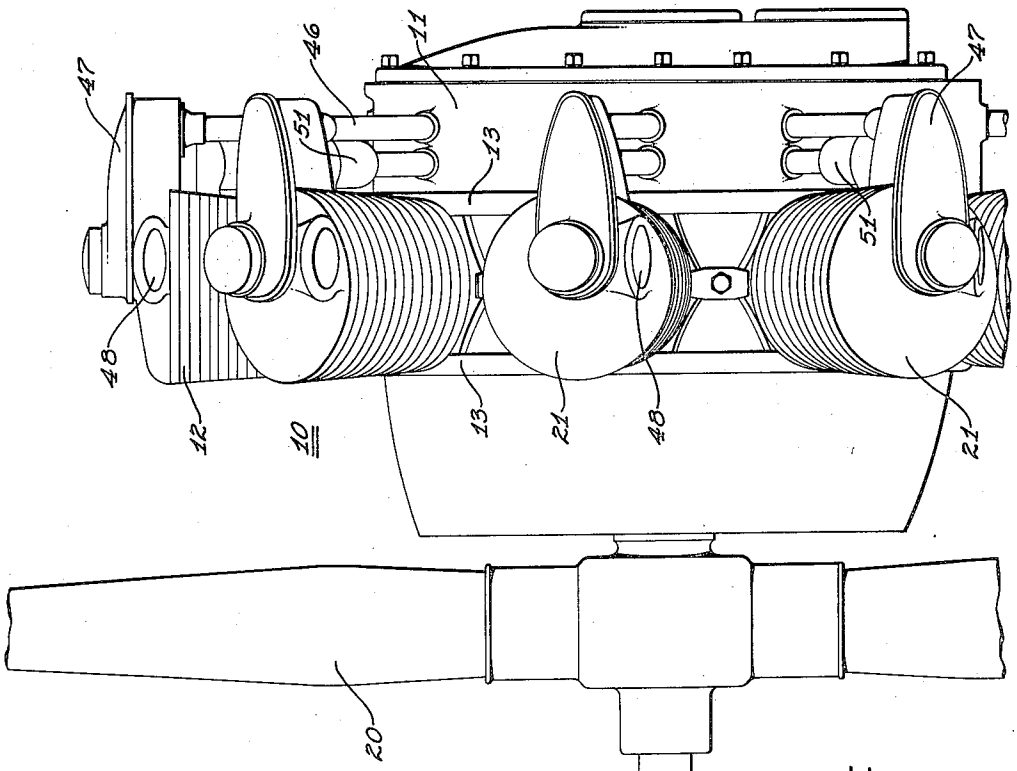


FIG. 1

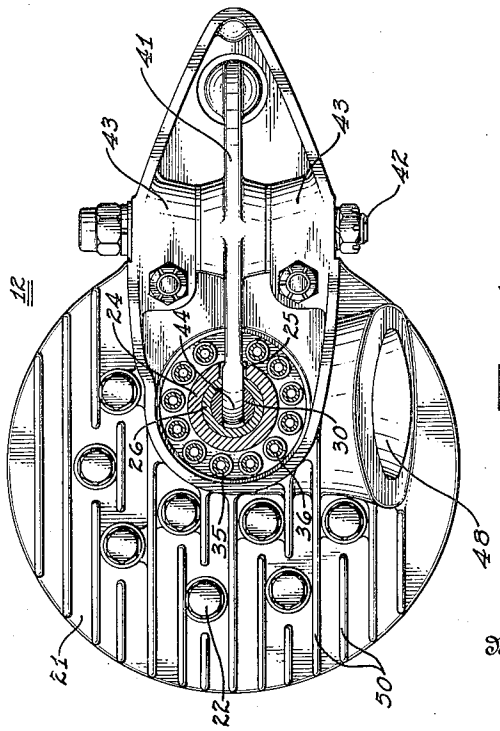


FIG. 4

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INTERNAL COMBUSTION ENGINE

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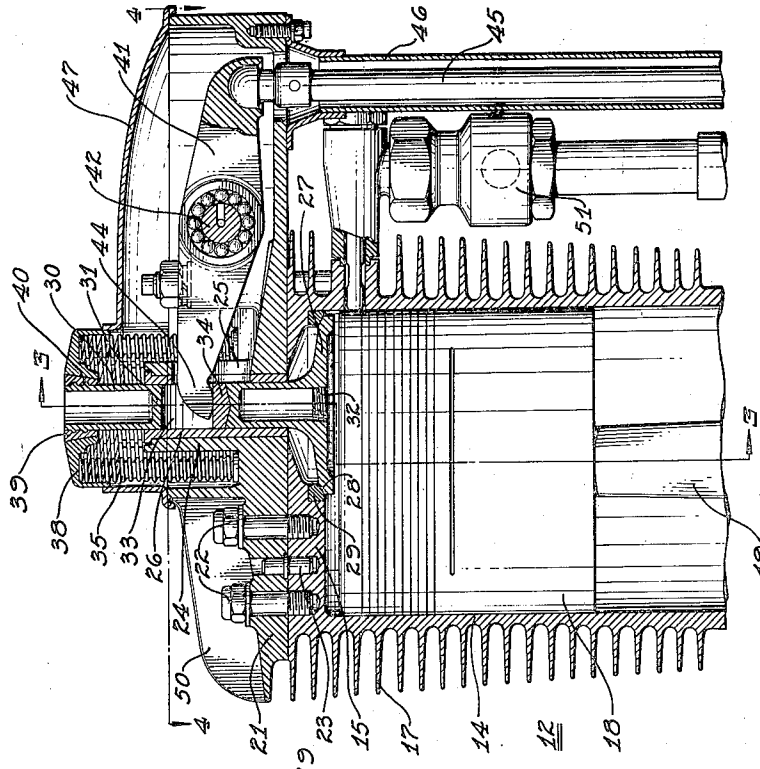


FIG. 2

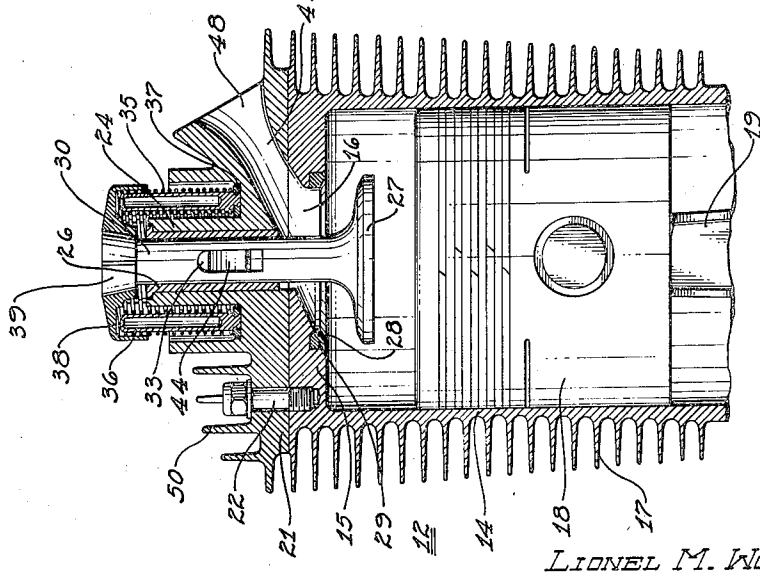


FIG. 3

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UNITED STATES PATENT OFFICE

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INTERNAL COMBUSTION ENGINE

Application filed July 28, 1928. Serial No. 295,938.

This invention relates to internal combustion engines.

One of the objects of the present invention is to provide an internal combustion engine of the compression-ignition or solid fuel injection type in which air enters the cylinder and exhaust gases are expelled therefrom through the same passage open to the atmosphere, and in which means are provided for removing the exhaust gases from the region about the open end of the passage.

Another object of the invention is to provide means, in an internal combustion engine of the overhead valve type, for reducing the height or the overall dimension of the engine in the direction of the axis of a cylinder thereof.

Another object of the invention is to provide a valve for an internal combustion engine in which the valve operating means engages the valve in the zone of the valve closing springs.

Another object of the invention is to provide a valve for an internal combustion engine in which the valve operating means engages the valves stem intermediate its ends.

Another object is to provide a valve for an internal combustion engine in which the valve operating means projects into a slot in the valve stem.

Other objects of the invention will appear from the following description taken in connection with the drawings forming a part of this specification, in which:

Fig. 1 is a side elevation of part of an internal combustion engine embodying the present invention;

Fig. 2 is a longitudinal sectional view of the upper part of one of the cylinders of the engine, the section being taken through the valve and valve operating means;

Fig. 3 is a sectional view of one of the cylinders taken on line 3—3 of Fig. 2 with the cover removed, and

Fig. 4 is a sectional view of one of the cylinders taken on line 4—4 of Fig. 3.

Referring to the drawings, 10 represents generally a nine-cylinder radial compression-ignition or solid fuel injection engine adapted for aircraft use embodying the present invention. The engine has a substantially cylindrical crank case 11 upon which is mounted radially thereof, individually formed cylinders represented generally at 12. The cylinders are secured to the crank case by two continuous bands 13 extending around the crank case and engaging flanges provided at the lower ends of the cylinders, this securing means forming the subject matter of my co-pending application, Serial No. 287,963, filed June 25, 1928. Each cylinder of the engine comprises a cylindrical casting 14, preferably of steel, and closed at one end to form a cylinder head 15 having a single port 16, preferably positioned eccentrically with respect to the axis of the cylinder, as shown. The cylinder wall is preferably of increasing thickness toward the head and the crank case ends thereof, as shown, to withstand the greater stresses occurring during operation of the engine at and near these ends, and the outside of the wall is provided with a series of fins 17 to facilitate the radiation of heat from the cylinder. Each cylinder has movable therein a piston 18 connected by means of a connecting rod 19 to the engine crank shaft, not shown, upon which, in the form shown, is mounted a propeller 20.

An auxiliary cylinder head 21, preferably of aluminum, is removably secured to cylinder head 15 by bolts 22 or other suitable securing means, and spaced dowels 23 on cylinder head 15 cooperate with suitable apertures in the auxiliary cylinder head to properly locate or position the latter on the cylinder head 15. Auxiliary cylinder head 21 is provided with a cylindrical valve stem guide 24 having an aperture 25, and an apertured bushing 26 is pressed into the guide with its aperture registering with the aperture in the valve stem guide. The base of the cylinder head 21 is formed with a lateral extension 9, and with an endless flange 8 which projects from the periphery of the extension and from a portion of the upper surface of the cylinder head. The space bounded by the flange 8 forms a housing for the upper end of the valve and its guiding means and for the valve actuating mechanism.

Cylinder port 16 is controlled by a valve

27 adapted to rest on a seat 28 when in closed position, the seat 28 preferably being formed in an annulus 29 of suitably hard material pressed into a recess in the cylinder head 15. Valve 27 has a stem 30 adapted to be guided by the guide 24 and preferably formed integrally with the valve, the stem being formed with a solid central portion 31 and hollow at both ends, as shown, the open end of the stem at the valve preferably being closed by a plug 32 or other suitable means. The solid central portion 31 of the valve stem is apertured to provide a slot 33 adapted, when the stem is mounted in its guide, to register with the apertures in the valve stem guide and its bushing. A wear resisting member 34 of suitably hard material is mounted in the solid central portion 31 of the valve stem at the end of the slot 33 nearer the valve. The valve 27 is adapted to be resiliently pressed to closed position, in the form shown, by a series of coil springs 35 spaced about the valve stem guide. The springs 35 are mounted on spaced rod-like spring guides 36, suitably secured at one end to a collar 37, adapted to rest on the auxiliary cylinder head 21. The springs 35 are compressed between the collar 37 and a substantially cup-shaped valve spring seat 38 secured to the end of the valve stem 30 by means of a split frusto-conical collar 39 adapted to engage spaced annular projections 40 formed on the valve stem.

The valve is adapted to be opened against the resistance of springs 35 by means of a rocker arm 41 pivotally mounted intermediate its ends on a shaft 42, carried in suitable bosses 43 on auxiliary cylinder head 21. As shown, the valve operating end 44 of the rocker arm extends between two of the springs 35, through the slots in the valve stem guide and its bushing and into the slot 33 in the valve stem and engages the wear resisting member 34. The rocker arm is actuated by a push rod 45 engaging the end thereof opposite the valve operating end 44, the push rod being actuated by a suitable cam, not shown, driven from the crank shaft of the engine. In the form shown, the push rod is enclosed in a cylindrical housing 46 secured at one end to the auxiliary cylinder head 21 and the exposed parts of the valve and the associated parts mounted on the auxiliary cylinder head 21 are enclosed by a suitable cover 47 secured to the auxiliary cylinder head against the flange 8.

Formed in cylinder head 15 and auxiliary cylinder head 21 and communicating with the port 16 of each cylinder is a passage 48 opening into the atmosphere and arranged with its axis preferably substantially normal to the axis of the crank shaft of the engine. As shown, the passage has a restricted portion 49 preferably adjacent its outer end, and is of substantially elliptical form for the greater part of its length inwardly from the outer open end. The auxiliary cylinder head 21 is provided with a series of parallel cooling fins 50 to facilitate the radiation of heat from the cylinder head. A fuel pump represented generally at 51, is secured to the cylindrical casting 14 of each cylinder 12 with its outlet adjacent the upper end of the cylinder, as shown, and is adapted to be actuated by a suitable cam, not shown, driven from the crank shaft of the engine for forcing a predetermined quantity of solid or liquid fuel into the combustion chamber at the proper time during the compression stroke of the engine.

The engine shown is adapted to operate on the four-stroke cycle and from the foregoing description, its operation will be clear. Upon the suction stroke of the piston of each cylinder, valve 27 will be open and air will be drawn into the cylinder through the passage 48 and port 16. Due to the eccentric location of the passage and port with respect to the axis of the cylinder, together with the restricted or contracted portion 49 of passage 48, the air drawn into the cylinder on the suction stroke will enter the cylinder at relatively high velocity and will move rapidly in substantially circular paths in the cylinder. At or near the end of the suction or intake stroke, the valve 27 will be closed and the air in the cylinder is compressed on the succeeding or compression stroke of the piston. At the proper time during this compression stroke, a predetermined quantity of fuel in solid or liquid form is injected into the cylinder by the pump 51 and mixes with the rapidly moving air therein. The heat produced during compression of this combustible mixture ignites the mixture, and upon expansion thereof the piston 18 is impelled outwardly of the cylinder on its power stroke. At or near the end of the power stroke of the piston, the valve 27 is opened and the burned or exhaust gases will be forced from the cylinder through the port 16 and passage 48 into the atmosphere upon the exhaust stroke of the piston.

During operation of the engine, the propeller 20 causes a stream of air to flow over and past the engine, the direction of flow of this stream of air being substantially parallel to the axis of the crank shaft of the engine and across the open ends of the passages 48 of each cylinder, substantially normal to the axis of each passage, so that the exhaust gases expelled from each cylinder on the exhaust stroke will be quickly removed from the region or area about the open end of the passage. Thus, during operation of the engine, it will be apparent that fresh air only, or air undiluted by exhaust gases will be drawn into each cylinder through the same passage 48 and port 16 through which

the exhaust gases are expelled from the cylinder.

In an engine employing the valve and valve actuating mechanism of the present invention, it will readily be apparent that the over-all dimension of the engine in the direction of the axis of a cylinder of the engine will be less than the corresponding dimension in an overhead valve engine in which the valve actuating mechanism engages the end of the valve stem. This arrangement is particularly advantageous in radial engines adapted for aircraft use where the over-all diameter of the engine is an important factor.

While the invention has been illustrated and described as embodied in a radial engine of the compression-ignition or solid fuel injection type, adapted for aircraft use, it will be understood that the invention is susceptible of use in other types of internal combustion engines. It will further be understood that for stationary operation, a suitable pump or blower may be used, instead of the propeller shown, for removing the exhaust gases from the region about the open end of the cylinder passages.

The form of the invention herein shown and described is to be considered a preferred form only and it will be understood that the invention is not to be limited except by the scope of the appended claims.

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

1. In an internal combustion engine, in combination, a valve, a stem for the valve having a laterally extending aperture therethrough, resilient means encircling the stem in a plane with the aperture for closing the valve, and means projecting into the aperture for opening the valve.

2. In an internal combustion engine, in combination, a valve, a stem for the valve, a spring for closing the valve, and means for opening the valve having engagement with the valve stem in the zone of the spring.

3. In an internal combustion engine, in combination, a valve, a stem for the valve, a plurality of springs for closing the valve, and means for opening the valve having engagement with the valve stem in the zone of the springs.

4. In an internal combustion engine, in combination, a valve, a plurality of springs for closing the valve, and means extending between two of the springs for opening the valve.

5. In an internal combustion engine, in combination, a valve, a stem for the valve having an aperture, a plurality of coiled springs for closing the valve, and a rocker arm extending between two of the springs and into the valve stem aperture.

6. A valve for internal combustion engines comprising a head, a stem having hollow end portions and an intermediate portion having a transversely extending aperture therethrough.

7. A valve for internal combustion engines comprising a head and a stem, said stem having a transversely extending aperture through an intermediate portion and being hollow adjacent the head.

8. A valve for internal combustion engines comprising a head and a stem, said stem having hollow end portions and a transversely apertured portion intermediate the hollow end portions.

9. In an internal combustion engine, a cylinder head having an angularly disposed passage therethrough, an axially disposed valve for closing the interior end of the passage, a valve stem guide projecting from the head, a bearing for the valve stem carried by the guide, a plurality of coil springs arranged circularly around the guide and bearing against the cylinder head at one end, a seat secured to the valve stem beyond the guide and the bearing, said springs engaging said seat, a housing inclosing the springs, said guide and bearing having aligned slots therein, and a rocker lever extending through the slots and engaging an intermediate portion of the valve stem.

In testimony whereof I affix my signature.

LIONEL M. WOOLSON.