G. C. DAVISON & J. W. ANDERSON.
DOUBLE ACTING DIESEL ENGINE.
APPLICATION FILED MAR. 24, 1916.
Patented Sept. 25, 1917.
1,940,827.
4 SHEETS—SHEET 2.
To all whom it may concern:

Be it known that we, GREGORY C. DAVISON and JOHN W. ANDERSON, citizens of the United States, and residents of New London, in the county of New London and State of Connecticut, respectively, have invented certain new and useful Improvements in Double-Acting Diesel Engines; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to double-acting two-cylinder internal combustion engines of the Diesel type, and the primary object is to provide a compact engine of this kind employing a number of interchangeable parts and permitting the ready removal of the cylinder heads and valves for inspection and repair.

In the preferred form of the invention hereinafter described, wherein the engine is of the vertical type particularly for use on submarine boats, each cylinder is provided with two sets of valves extending horizontally into the cylinder walls at the respective ends thereof, each set comprising two scavenger valves and two fuel inlet or spray valves. Those valves are actuated periodically by four cam shafts, two extending across each side of the cylinder at opposite ends thereof. Two transmission shafts driven from the crank shaft of the engine through spiral gearing extend along one side of the cylinder, one driving the two cam shafts on one side through spiral gearing, and the other driving the two cam shafts on the other side through spiral gearing. In this way the valve actuating gearing is compactly arranged with reference to the cylinder, while permitting ready removal of the valves and cylinder heads and the transmission and cam shafts are short and readily supported from the engine so as to be noiseless at high speeds of operation. Furthermore, all the scavenger valves may be interchangeable and similarly for the fuel valves, whereas the four cam shafts may be interchangeable and similarly for the two transmission shafts.

In the accompanying drawings, which disclose the embodiment of the invention at present preferred, Figure 1 is a side elevation of the engine; Fig. 2 is an end elevation of the same, partly broken away and sectioned; Fig. 3 is a top plan view of the engine; Fig. 4 is a transverse vertical section through the cylinder; Fig. 5 is a detail sectional view taken on the line 5-5 of Fig. 4; and Fig. 6 is a view similar to Fig. 5 taken on the line 6-6 of Fig. 4.

The drawings illustrate a double-acting engine having only one cylinder, but it is to be understood that any embodiment of the invention may include any convenient number of working cylinders. The engine is provided with a crank case and engine bed, above which a cylinder 2 is properly spaced and mounted by means of columns 3. The bore of the cylinder is represented at 4, a double piston at 5, and a piston rod at 6; the last named part being connected to a cross-head 7, cross-head guides 8, a connecting rod 9 and a crank 10.

The cylinder proper is preferably cast in one piece but with separate top and bottom heads. Such cylinder is shown best in Fig. 4 and has passages 2a for the flow of water for cooling as usual, and separate heads 2b and 2b' bolted or otherwise fastened to the cylinder, the lower of the two heads 2b' having a passage for the accommodation of the piston rod 6 and glands and packing 2b to prevent leakage about the piston rod.

A common water jacket for the top and bottom of the cylinder is carried beyond the limits of both combustion chambers, so that all uncooled heavy thicknesses of metal bordering on the combustion chambers are avoided, and so that gaskets in the joints between the cylinder and its top and bottom heads may be kept cooled.

The hereinafter mentioned reference letters L, R, T and B, employed in composite relations, respectively indicate the left, right, top and bottom of the engine as shown in Fig. 2.

Inserted substantially radially in the walls of the cylinder are the valve cages or casings VLT, VRT, VLB and VRB, and let into the cylinder, substantially tangentially to the side wall of the cylinder interior, are the valve casings eLT, eRT.
of these valve casings, the first or V series are the scavenger valves, and the second or \( v \) series are the spray or fuel-inlet valves. If desired, only one fuel-inlet valve need be provided at each end of the cylinder.

Referring to Figs. 1 and 2, the scavenger valves VLB and VRB are operated respectively by the cam-shafts SLB and SRB, and the similar valves VLT and VRT are operated respectively by the cam-shafts SLT and SRT. These four cam-shafts also serve to operate the four fuel-inlet valves \( vLT \), \( vRT \), \( vLB \) and \( vRB \). The operative connections between the four duplicate operating cams C (Fig. 1 showing only two of such cams), and the duplicate scavenger-valve stems 11 (Fig. 4) are the duplicate short and light levers 12. Duplicate cams C' and short and light levers 12a (Fig. 1) are provided for the fuel-inlet valves.

The exhaust, as in most two-cycle engines, is obtained at the end of each working stroke, through the ports 13 (Figs. 4 and 6), into an exhaust header 14; or there may be two such headers, one on each side of the engine. Compressed air for scavenging and to form part of the combustible mixture is brought to the several valves of the V series by the headers 15 from a compressed air supply not shown in the drawings.

When the piston is at either end of its stroke, there is formed between one end and the adjacent end of the cylinder an annular space or combustion chamber similar to that shown in the upper portion of Fig. 4, and this is the annular space into which the fuel-inlet valves (the valves of the \( v \) series) discharge their oil fuel. This form of combustion chamber is produced by reducing the diameter of the piston at each end thereof as shown in Fig. 4. The ring-like shape of each of the combustion chambers serves to cause the mixture admitted thereto to assume a rotary motion around the head of the piston and thus insures that each particle of air gets its proper proportion of oil vapor. Each of these annular combustion chambers may or may not have a uniform cross-sectional area.

Air-starting valves S may be operated pneumatically and are located conveniently with horizontal axes. They may or may not be provided and do not form an essential part of the present invention.

The four cam-shafts S are driven by two vertical transmission shafts 16L and 16R, the connections between vertical shafts and cam-shafts being spiral gears and these vertical shafts being themselves driven from the engine-shaft 17 by means of spiral gears 18 and 19 (Fig. 2).

It will be observed that the four scavenger valves are interchangeable and similarly for the four fuel valves, whereas the four cam shafts are interchangeable and similarly for the two transmission shafts.

The operation of the engine is as follows:

The piston 4, as shown in the drawings, has just completed a stroke from the bottom of the cylinder to the top thereof, and lower scavenger valves VLB and PRB have just opened, permitting an inrush of fresh compressed air into the lower part of the cylinder to drive out the spent gas through the exhaust ports 13 into the header 14. While this scavenging action is taking place in the lower part of the cylinder, fresh air previously forced into the upper part of the cylinder has been highly compressed between the piston and the upper cylinder head and has consequently become very hot. In the position shown, the fuel is being injected into the cylinder and through one or both of the spray valves \( vLT \) or \( vRT \) and combustion takes place, followed by expansion of the gases which lasts during the entire or almost the entire consequent downstroke of the piston. This downstroke of the piston at the same time compresses air previously forced into the lower part of the cylinder, which air will in turn have oil fuel injected into it through valves \( vLB \) and \( vRB \). These operations during running are alternately repeated, and a power-stroke is obtained on every movement of the piston.

It will be noted that in a multi-cylinder engine, the cylinder-heads would not be topped by cam-shafts, and hence would be quickly removable, that said heads are entirely free from valves, and, being thus free from valves, may be made symmetrical in form, may be uniformly cooled and cracks therein may be avoided.

We claim:

1. In a double-acting two-cycle internal combustion engine of the Diesel type, a cylinder comprising a cylinder proper and removable heads therefor, fuel and scavenger valves extending transversely into opposite sides of the cylinder proper at each end thereof, two transmission shafts driven from the engine shaft through spiral gearing and extending along one side of the cylinder, two cam shafts extending across one side of the cylinder at opposite ends thereof and driven from one of the transmission shafts through spiral gearing, and two other cam shafts extending across the other side of the cylinder at opposite ends thereof and driven from the other of the transmission shafts through spiral gearing.

2. In a double-acting two-cycle internal combustion engine of the Diesel type, a cylinder comprising a cylinder proper and removable heads therefor, a scavenger valve and a fuel valve extending into the cylinder in proximity to each other on each side of the cylinder and at each end thereof, two
transmission shafts driven from the engine shaft through spiral gearing and extending along one side of the cylinder, two cam shafts extending across one side of the cyl-
inder at opposite ends thereof and driven from one of the transmission shafts through spiral gearing, and two other cam shafts extending across the other side of the cylinder at opposite ends thereof and driven from
the other of the transmission shafts through spiral gearing, each cam shaft actuating the scavenger and fuel valves which are in pro-
ximity to each other.

3. In a double-acting two-cycle internal combustion engine of the Diesel type, a cyl-
inder comprising a cylinder proper and removable heads thereof, four interchangeable scavenger valves extending substantially radially into the cylinder proper, two of
said valves being located on opposite sides of the cylinder at one end thereof and the
other two being located on opposite sides of the cylinder at the other end thereof, inter-
changeable fuel valves extending trans-
versely into the cylinder at the two ends thereof, two interchangeable transmission shafts driven from the engine shaft through spiral gearing and extending along one side of the cylinder, two cam shafts extending across one side of the cylinder at opposite ends thereof and driven from
the other of the transmission shafts through spiral gearing, and two other cam shafts extending across the other side of the cylinder at opposite ends thereof and driven from the other of
the transmission shafts through spiral gear-
ing, said cam shafts being interchangeable.

In testimony whereof we affix our signa-
tures.

GREGORY C. DAVISON.
JOHN W. ANDERSON.