July 4, 1944. H. E. PETRILLI 2,353,065

DIESEL ENGINE

Filed July 16, 1941 3 Sheets-Sheet 1

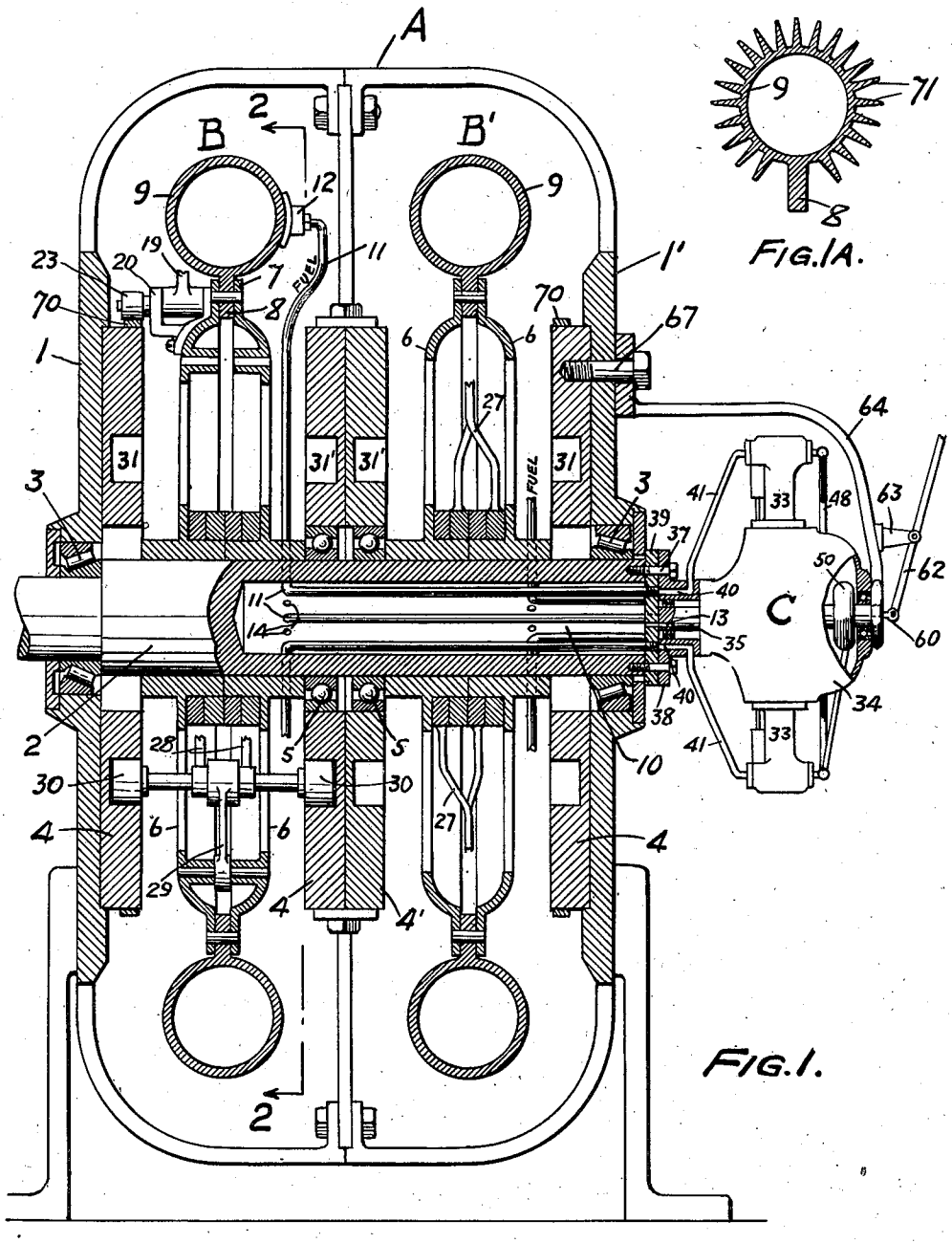


FIG. 1.

FIG. 1A.

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DIESEL ENGINE

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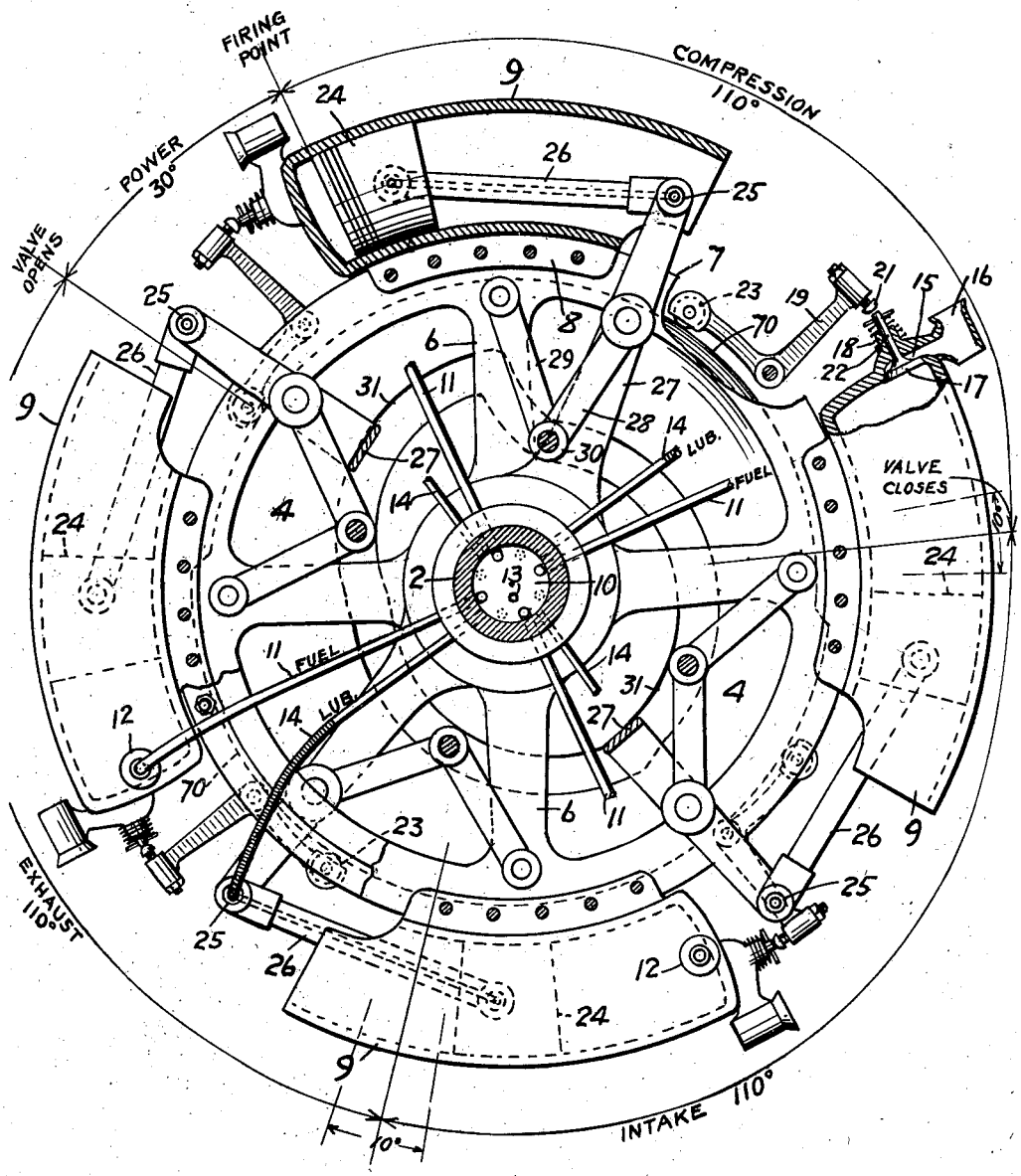


FIG. 2.

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DIESEL ENGINE

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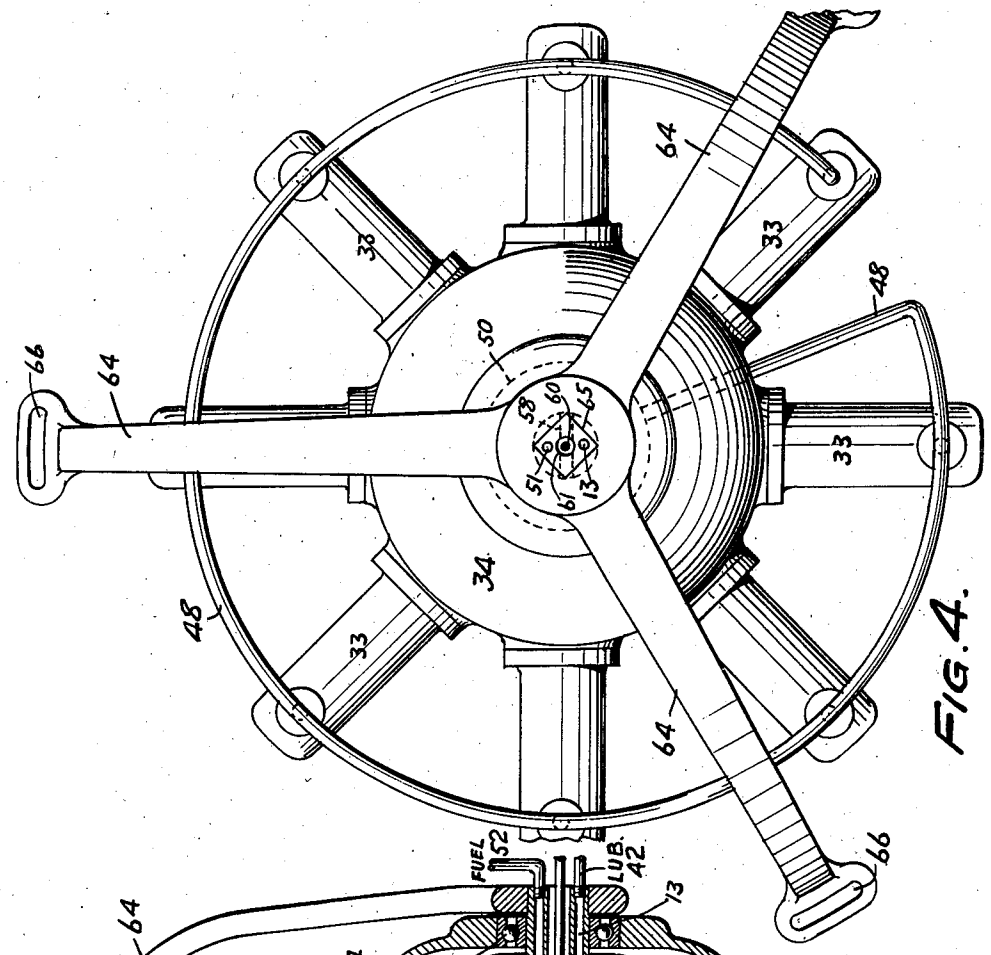


FIG. 4.

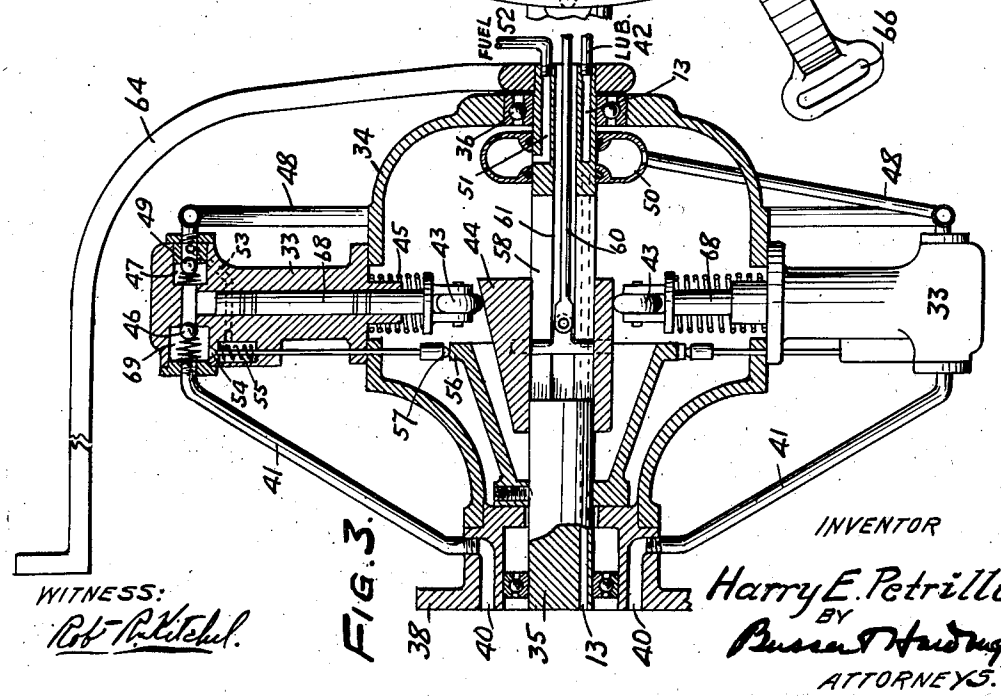


FIG. 3.

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Patented July 4, 1944 2,353,065

UNITED STATES PATENT OFFICE

2,353,065

DIESEL ENGINE

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Application July 16, 1941, Serial No. 402,571

6 Claims. (Cl. 123—43)

This invention relates to an improvement in Diesel engines and more particularly relates to a Diesel engine of rotary type.

The engine in accordance with this invention will be readily and economically constructed with desired power within wide limits, will afford great accessibility for repair and adjustment and in comparison with Diesel engines as heretofore known will comprise relatively fewer parts, will afford more complete combustion and scavenging, will have a relatively low weight per horsepower and a high effective horsepower for its displacement, will be readily lubricated and cooled with maximum efficiency, and, in general, will operate with maximum economy and efficiency and at speeds which for many uses may be such as to obviate the necessity for reduction gearing.

Generally speaking, the engine according to this invention will comprise a bank or banks of cylinders of arcuate extension connected for rotation with a shaft, and provided with pistons connected to cam followers adapted to follow a cam track in a fixed cam. The cylinders respectively are provided with a single mechanically operated valve for exhaust and air intake, and with a fuel injector supplied with fuel from a pump driven from the engine shaft.

The engine will operate on the four cycle principle in that in each revolution the piston in each cylinder will make a power, an exhaust, an intake, and a compression stroke, but, at the same time, it will operate in the two cycle principle in that in each revolution the piston in each cylinder will have a power stroke.

In operation the cylinders will rotate with the shaft about the axis of the shaft and will act as a fly-wheel, and, at the same time, they will be subjected to effective cooling by radiation. The several strokes of the pistons will vary in rate to insure maximum effective combustion, scavenging, intake and compression and effective lubrication of the cylinders, piston pins and connection rod bearings will be accomplished with utilization of the centrifugal force set up.

Having now indicated in a general way the nature of this invention, I will proceed to a detailed description thereof with reference to the accompanying drawings in which:

Figure 1 is a sectional view of a Diesel engine embodying this invention.

Figure 1A is a sectional view of a cylinder provided with cooling fins.

Figure 2 is a sectional view on line 2—2, Figure 1.

Figure 3 is a sectional view of the fuel pump shown in Figure 1.

Figure 4 is an end view, partly broken away and showing a detail of the fuel pump.

Referring more particularly to Figure 1, A indicates a casing covering an engine comprising two banks of cylinders indicated by B, B′ and equipped with a fuel pump C.

The banks of cylinders B, B′ may, for example, each comprise four cylinders and are identical; and it will be apparent that with cylinders of a given displacement engines of increased power may be obtained by merely adding additional banks of cylinders respectively arranged about the shaft with respect to their power strokes to obtain a balanced effect, as are the banks B, B′.

The base or frame of the engine comprises the plates 1, 1′ in which the main shaft 2 is supported through the roller bearings 3, 3. Secured to the plates 1, 1′ are fixed cam plates 4, 4 and identical fixed plates 4, 4′ are supported between the banks of cylinders B, B′, and provide intermediate support for the shaft 2 through ball bearings 5, 5. The banks of cylinders B, B′ are secured to the shaft 2, for rotation with it, through the medium of spiders 6, 6, the hub of which is keyed or splined on the shaft 2 and the rims 7, 7 of which are bolted to flanges 8 formed on the outer walls of the cylinders 9.

The shaft 2 is bored out from one end and through the bore 10 extend conduits 11, which lead from the fuel pump C and extend laterally out of the shaft and are connected respectively to the fuel injectors 12 of the several cylinders. The bore 10 is supplied with lubricating oil through a passage 13, which is discharged by centrifugal force through passages 14 opening into the bore and leading to connecting rod bearings.

Referring now to Figure 2 for the details of construction of the banks of cylinders, the cylinders 9 are arcuate in their extension and, secured to the rim 7 of the spider 6, rotate with the shaft 2.

Each of the cylinders is provided at its forward end with a combined exhaust and intake port 15, fitted with a pipe 16 open at both ends and controlled by a valve 17 normally closed by a spring 18 on the valve stem 22, which extends through the cylinder head. The valve 17 is adapted to be opened mechanically by a lever 19 pivotally mounted on a bracket 20 secured to the spider. One end of the lever 19 is provided with an adjustable tappet 21 adapted to contact the end of the valve stem, and its other

end is provided with a cam follower 23 adapted to follow the periphery of the cam plate 4, which is formed with cams 70 for the opening and closing of the valve at the proper times in the cycle to permit exhaust, intake, compression and combustion, as will be more fully described.

In each of the cylinders is a piston 24, to which is pivotally connected, by a piston pin, a connecting rod 26. The connecting rod 26 is in turn pivotally connected by a pin 25 to an end of an arm 27, the other end of which embraces the shaft 2 and is rotatable with respect to the shaft. Pivoted to the arm 27 and to the spider 6 are a pair of links 28, 29, the free ends of which are pivotally connected to a cam follower 30 adapted to follow a cam track 31 in the cam plate 4. It will be understood that, as shown in Figure 1, duplicate linkage and cam follower is provided with reference to the cam tracks 31' in cam plates 4, 4'.

The cam tracks 31 and 31', which are identical, are formed to control the pistons during the cycle of operation. Thus, when the cylinders fire the pistons are held relatively stationary, permitting the cylinders to move forward under the power stroke, the pistons are moved forward in the cylinders for the exhaust stroke, during which the valves 17 are opened by the peripheral cam surfaces of cam plate 4. Then the pistons are retracted in the cylinders for the intake stroke, during which the valves 17 remain open. Finally the valves 17 are closed and the pistons moved forward for the compression stroke.

The timing of the engine and the form of the cam tracks 31, 31' and of the peripheral cams 70 controlling the valves 17 is, for example, illustrated by Figure 2.

The cylinders 9 may be and usually are provided with cooling fins 71, as shown in Figure 1A.

Each of the cylinders is equipped with a fuel injection valve 12, to which, as has been described, is connected one of the fuel conduits 11, to which fuel is supplied by the fuel pump C.

The fuel pump C, as shown in Figure 3, comprises a number of cylinders 33, one for each cylinder of the engine, which are mounted on a casing or frame 34 for rotation about a fixed shaft 35 on ball bearings 36. The casing 34 is coupled to the main engine shaft 2 by means of bolts 37 passing through a flange 38 on the casing and threaded into the end of shaft 2. Between the end of shaft 2 and the casing 34 is interposed a plate 39 having passages for the reception of the ends of the fuel conduits 11 and aligning with passages 40 in the casing and to which in turn are connected fuel conduits 41 leading to the tops of the pump cylinders 33.

The passage 13, heretofore referred to for the supply of lubricating oil, extends through the plate 39 and through the fixed shaft 35, of the pump, to connection with a conduit 42 leading from a supply of lubricating oil.

Each of the pump cylinders 33 is provided with a piston 68 provided at its lower end with a cam follower 43 adapted to follow a cam 44 on the fixed shaft 35. The cam 44 will operate to raise the piston against the action of a spring 45.

At its upper end each of the cylinders 33 is provided with a discharge chamber 69, with which the fuel conduits 41 communicate and communication with which is controlled by a check valve 46; and with an inlet chamber 47 with which communicates a conduit 48 controlled by a check valve 49.

The conduits 48, communicating with the inlet chambers of the several cylinders 33, lead from a receiver 50 mounted for rotation on the shaft 35 and communicating with a passage 51 in the shaft, which is connected to a conduit 52 leading from a supply of fuel.

The discharge chamber in each of the cylinders 33 is connected to the inlet chamber by a passage 53, controlled at its discharge chamber end by a valve 54, normally maintained closed by a spring 55 and adapted to be opened by a cam 56 fixed on shaft 35, through the medium of a cam follower 57 on the stem of the valve.

The cam 44 is splined on the shaft 35 to slide longitudinally thereof and the shaft is slotted, as at 58, for the passage of a pin 59 connected to the cam and to a link 60, which extends through a bore 61 in the shaft and is in turn connected to a lever 62 fulcrumed in a bracket 63 mounted on a spider 64.

The hub of the spider 64 receives a square end 65 of shaft 35 and its arms are slotted at their ends, as shown at 66, Figure 4. The slotted ends of the spider are secured to the base 1' of the engine by means of bolts 67 and the spider hence operates to adjust the position of the cam 44 with respect to the pistons 68 and to prevent the shaft 35 from turning on the operation of the pump.

The operation of the engine in accordance with this invention will, in the light of the above description and of the accompanying drawings, be easily understood.

The engine, for efficient operation, will comprise at least the two banks of cylinders B, B', each bank comprising, as shown in Figure 2, four arcuate cylinders 9 with arcuate skirted pistons 24, connected for control by the cam tracks 31 and 31', as shown in Figure 2.

For proper supply of fuel to the cylinders 9, the cam 44 of the fuel pump will be adjusted by manipulation of lever 62, so that the stroke of the pistons 68 in the cylinders 33 will deliver the proper amount of oil through the conduits 41, passage 40 and conduits 11 to the fuel injectors 12 in the cylinders. The timing of the injection of the fuel will be adjusted through rotation of the shaft 35 to properly position the cams 44 for actuation of the piston 68 at the proper time by adjustment of the spider 64 with respect to the engine base plate 1'.

When the engine is started, which may be accomplished by any convenient well known means, or in any convenient manner, its cycle of operation will be, for example, as shown in Figure 2. Assuming, as shown in Figure 2, that one of the cylinders is at the firing point, i. e., fuel is injected, the cylinder will advance on its circular path while the piston will be held relatively stationary under control of the cam track. By way of example, the power stroke may extend through an arc of say 30°, when the valve 17 will be opened by the peripheral cam 70 and the piston, under control of the cam track, will advance in the cylinder on the exhaust stroke. The exhaust stroke may extend, for example, through an arc of 110°, during which the valve 17 will be open. Then the piston, under control of the cam track, will be retracted in the cylinder on the intake stroke, the valve 17 remaining open. The intake stroke may extend through an arc of say 110° when the valve 17 will close and the piston, under control of the cam track, will again advance in the cylinder on the compression stroke, which may extend through an arc of say 110°, when the cylinder will reach the firing point and the cycle will be repeated. The power developed by the

cylinders will be transmitted to the shaft 2 through the spider 6.

The cam track will desirably be so formed that the piston will come to rest in the travel of the cylinders through an arc say 10° at the end of the exhaust and beginning of the intake strokes and at the end of the intake and beginning of the compression strokes, as indicated in dotted lines Figure 2.

Fuel under pressure will be supplied to the fuel injectors in the cylinders by the pumps comprising cylinders 33 and pistons 38, supplied with fuel through inlet chambers 47 and discharging fuel through the discharge chambers 69.

In order that excess fuel be not supplied to the fuel injectors with resultant smoking, i. e., in order that the injection of fuel may terminate sharply, the valves 54, operated by cam 66, will open at the end of the injection and release pressure in the discharge chamber 69, with bypassage of oil back to the inlet chamber 47.

Lubricating oil will be supplied to the hollow interior of the main shaft 2 through passage 13 and conduit 42, leading from a supply of lubricating oil. Oil within the shaft will be thrown out through conduits 14, which include a flexible section, in view of the relative movement of the arms 27 and spider 6, to connecting rod pins 25, and from thence through the connecting rod 26 to the piston pins and from thence to the cylinder walls. The various pins, such as those connecting the links 28 and 29 to the arms 27 and spider 6 may be lubricated by the provision of grease cups.

It will be appreciated, of course, that the banks of cylinders B, B' are arranged in staggered relation to the end that the application of power may be made evenly.

It will be appreciated that additional banks of cylinders may be provided, identical with those described, where it is desired to increase the power of the engine.

It will be appreciated that it is not intended that this invention shall be limited to the details included in the above description given for illustrative purposes, it being contemplated that various modifications in detail may be made without departing from the scope of the invention as defined in the appended claims.

What I claim and desire to protect by Letters Patent is:

1. In a rotary Diesel engine, in combination, a rotatable shaft, a plurality of arcuate cylinders radially spaced from the shaft, means fixedly connecting said cylinders to said shaft for rotation therewith, pistons in said cylinders, connecting rods connected to said pistons, arms turnable on said shaft and respectively connected to said connecting rods respectively, a fixed cam track, a linkage connecting each of said arms with a cylinder and a cam follower connected to each of said linkages and positioned to follow said cam track, said cam track being designed to control the movements of said pistons in the cylinders in the rotation of the cylinders and shaft.

2. In a rotary Diesel engine, in combination, a rotatable shaft, a plurality of arcuate cylinders radially spaced from the shaft, means fixedly connecting said cylinders to said shaft for rotation therewith, a port in the head of each of said cylinders, a valve controlling each of said ports, and means including fixed cams adapted to open said valves for exhaust from and intake into said cylinders.

3. In a rotary Diesel engine, in combination, a rotatable shaft hollow from one end, a plurality of cylinders radially spaced from the shaft, means fixedly connecting said cylinders to said shaft for rotation therewith, a fixed shaft in line with said shaft to which said cylinders are connected, fuel injection nozzles in said cylinders, conduits leading from said nozzles into and through said shaft, a plurality of fuel pumps connected to said cylinders and rotatable therewith with respect to said fixed shaft, and conduits connecting the discharge from said fuel pumps with said first mentioned conduits.

4. In a rotary Diesel engine, in combination, a rotatable shaft hollow from one end, a plurality of cylinders radially spaced from the shaft, means fixedly connecting said cylinders to said shaft for rotation therewith, a fixed shaft in line with said shaft to which said cylinders are connected, fuel injection nozzles in said cylinders, conduits leading from said nozzles into and through said shaft, a plurality of fuel pumps connected to said cylinders and rotatable therewith with respect to said fixed shaft, conduits connecting the discharge from said fuel pumps with said first mentioned conduits, a receiver rotatable about said fixed pump shaft, a fuel supply conduit extending within said fixed shaft and opening into said receiver and conduits leading from said receiver to the inlets of said fuel pumps respectively.

5. In a rotary Diesel engine, in combination, a rotatable shaft hollow from one end, a plurality of cylinders radially spaced from the shaft, means fixedly connecting said cylinders to said shaft for rotation therewith, pistons in said cylinders, connecting rods attached to said pistons, conduits including a flexible section leading from the interior of said shaft to said connecting rods, means to close the open end of said shaft and means for the supply of lubricating oil to the interior of said shaft.

6. In a rotary Diesel engine, in combination, a rotatable shaft, a plurality of arcuate cylinders radially spaced from the shaft, means fixedly connecting said cylinders to said shaft for rotation therewith, a port in the head of each of said cylinders, a valve controlling each of said ports, pistons in said cylinders, means including a fixed cam track for operating said valves in the rotation of said cylinders about said shaft, said cam track having a contour such that said valves will be maintained open continuously throughout the exhaust and intake strokes of the pistons in said cylinders respectively.

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