

Aug. 16, 1960

A. DOBLE

2,949,013

STEAM POWER SYSTEM

Original Filed April 7, 1952

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Fig. 1.

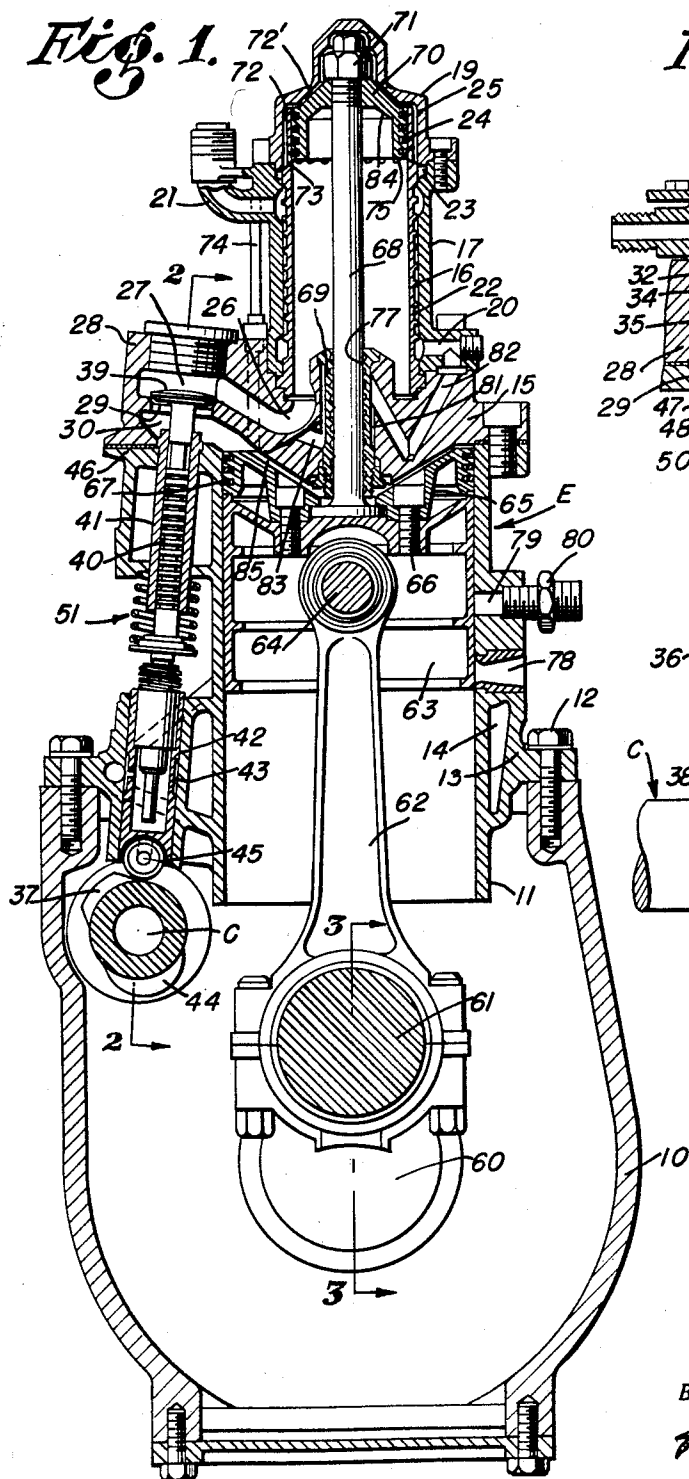
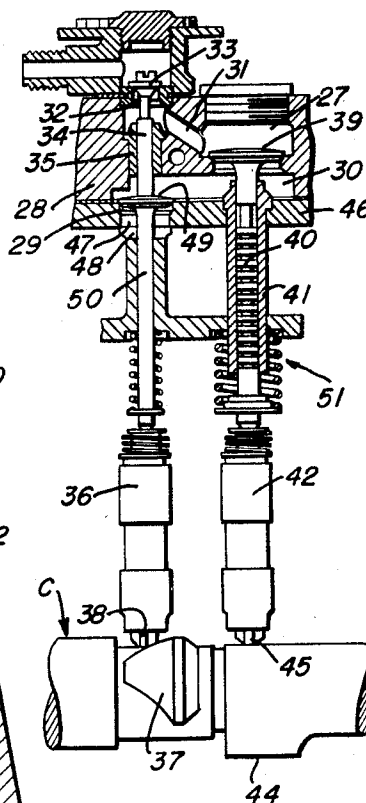


Fig. 2.



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Fig. 3.

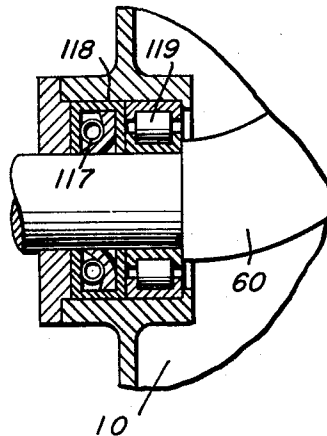
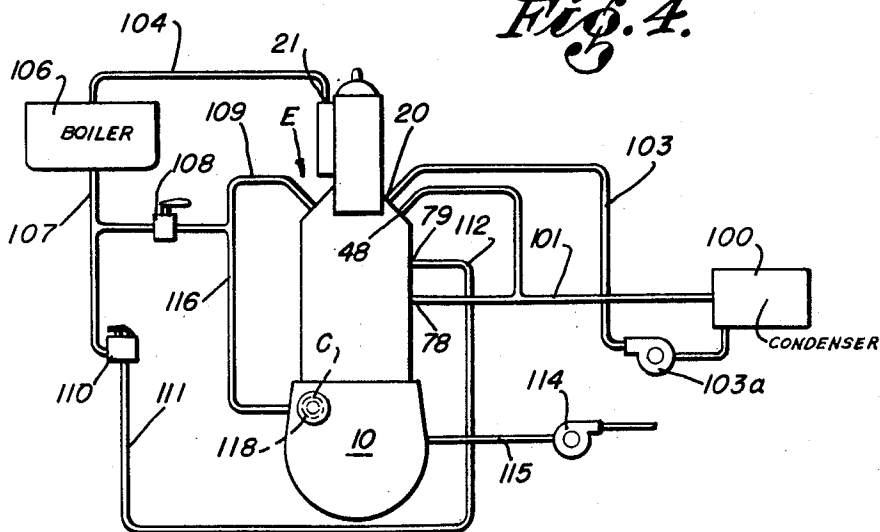


Fig. 4.



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STEAM POWER SYSTEM

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Continuation of application Ser. No. 280,978, Apr. 7, 1952, now Patent No. 2,730,996, dated Jan. 17, 1956. This application Mar. 14, 1955, Ser. No. 493,921

3 Claims. (Cl. 60—65)

This invention relates to fluid pressure engines of the Woolf type, and relates in particular to improvements in compound uniflow reversing steam engines having single acting high pressure and low pressure pistons inner-connected so that they act in unison, the high pressure piston being effective in one stroke direction and the low pressure piston being effective in the opposite stroke direction, thus giving double acting effects with single acting pistons.

This application is a continuation of my co-pending application, Serial No. 280,978, filed April 7, 1952, for Improvements in Fluid Pressure Engines, now Patent No. 2,730,996, issued January 17, 1956.

It is an object of the invention to provide a steam power system having a source of steam including a boiler, the inlet of which boiler is connected to the outlet of a condenser, a closed system being provided by connecting the boiler and the condenser respectively to the steam inlet and exhaust ports of an engine, the invention being characterized by having means for minimizing the contamination of the exhaust steam with oily vapors or lubricating oil from the engine.

It is a further object of the invention to provide a steam power system of the character described in the preceding paragraph having a sealed crankcase, suction means for conveying the exhaust steam from the cylinder to the condenser, and suction means for effecting in the crankcase a lowered pressure so as to minimize the flow of oily vapors from the crankcase along the internal cylinder walls and the interior of the cylinder to the exhaust port and the suction means which connects the exhaust port to the condenser.

A further object of the invention is to provide in this power system an engine cylinder having an exhaust port in the side wall thereof positioned so as to receive the exhaust steam when the piston approaches and reaches the end of its power stroke. The present invention provides a compound vapor engine, such as a steam engine wherein the crankcase is held at a pressure at least as low as the pressure in the condenser connected to the exhaust of the steam engine, by use of a separate suction pump to prevent or minimize passage of oily vapors from the crankcase into the vapor system.

Further objects and advantages of the invention may be brought out in the following part of the specification describing a preferred embodiment of the invention in detail for the purpose of making a complete disclosure without limiting the scope of the invention defined in the appended claims and without limitation of mechanical equivalents to which the claims may be entitled.

Fig. 1 is a cross-sectional view through one of the cylinder sections of a vapor engine embodying the invention;

Fig. 2 is a fragmentary sectional view taken substantially as indicated on the line 2—2 of Fig. 1 to show the valves for controlling the flow of vapors to and from the cylinders of a vapor engine;

Fig. 3 is a fragmentary sectional view showing crankcase sealing means; and

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Fig. 4 is a diagram of the power plant which includes the steam engine illustrated in the foregoing figures.

The steam power system employs an engine E which includes a crankcase 10 to which a low pressure cylinder 11 is secured by bolts 12. On the lower portion of the cylinder 11 there is a jacket 13 forming a chamber 14. A low pressure cylinder head 15 is secured to the upper end of the cylinder 11, and a high pressure cylinder liner 16 is supported coaxially of the low pressure cylinder 11 by the high pressure cylinder 17 and high pressure cylinder head 19. The high pressure cylinder 17 has an inlet port 20 near its lower end and an outlet port 21 near its upper end, these ports being connected by a helical passage 22 formed between the high pressure cylinder liner 16 and the high pressure cylinder 17 by cutting a helical groove in the external surface of the high pressure cylinder liner 16. A seal 23 is disposed around the upper portion of the high pressure cylinder liner 16 and the high pressure cylinder head 19 is so formed with relation to the upper extremity 24 of the cylinder liner 16 as to provide an annular space or passage 25 between the parts 19 and 24, the purpose of which will be explained in the following.

The low pressure cylinder head 15 has therein a passage 26 which connects the lower end of the high pressure cylinder 16 with a valve chamber 27 formed in a laterally extending portion 28 of the cylinder head 15. The valve chamber 27 communicates through a transfer valve port 29 with a passage 30 leading into the upper end of the low pressure cylinder 11. The valve chamber 27 also communicates through a passage 31 with a high pressure inlet valve port 32, Fig. 2, arranged to be closed and opened by a high pressure inlet valve poppet 33 having a stem 34 which projects down through a valve guide 35 in alignment with a valve lifter 36 arranged to be actuated by cam shaft C having a cam 37 which engages a roller 38 disposed at the lower end of the lifter 36.

A transfer poppet valve 39 is arranged to control flow through the valve port 29. This poppet valve 39 has a downwardly projecting stem 40 which slides in a valve guide 41 and is arranged to be periodically lifted by a valve lifter 42 which is slidable in a guide 43 and is arranged to be actuated by a cam 44 which engages a roller 45 supported at the lower end of the lifter 42. In Figs. 1 and 2 is shown the manner in which the passage 30 is formed between the extension 28 of the cylinder head 15 and a lateral extension 46 of the upper portion of the low pressure cylinder 11. In the extension 46 there is an auxiliary valve port 47, Fig. 2, substantially aligned with the valve port 32, which communicates through a passage 48 with the vapor return line 101 (Fig. 4), leading to the condenser 100 to which the engine is connected or to other vapor disposal. An auxiliary exhaust valve 49, of poppet type, is arranged to control flow of fluid through the port 47. This valve 49 has a stem 50 guided in substantial alignment with the stem 34 of the poppet valve 33, and the valve 49 and its stem are disposed between the lower end of the valve stem 34 and the valve lifter 36 so that the cam 37 acts, in addition to its opening of the valve 33, to open the auxiliary exhaust valve 49 and thereby exhaust steam which may leak into the upper portion of the low pressure cylinder 11 during the time high pressure steam is being fed into the high pressure cylinder 17.

A crankshaft 60, supported for rotation in the crankcase 10 provides a crank 61 from which a connecting rod 62 extends upwardly into the low pressure cylinder 11. A cross head 63 is connected to the upper end of the connecting rod 62 by a wrist pin 64 and a low pressure piston 65 is directly secured to the upper end of the cross head 63 by screws 66, this piston 65 carrying a plurality

of piston rings 67 for sealing engagement with the inner surface of the cylinder 11.

A high pressure piston rod 68 is held in transversely-slidable engagement with the upper end of the cross head 63 by low pressure piston 65. This piston rod 68 projects upwardly through a gland 69, which is supported in axial position by the low pressure cylinder head 15, into the high pressure cylinder 17. A high pressure piston 70 is screwed onto the upper end of the piston rod 68 and is fixed thereon by lock screw means 71. The high pressure cylinder head 19 is so formed with relation to the upper portion of the high pressure piston 70 and the lock screw means 71 as to provide a very narrow space or chamber 72 between the cap 19 and the back face of the piston 70, which may be regarded as including its locking means 71, when the piston 70 is at the extreme end of its power stroke, or in other words is raised to the position in which it is shown in full lines in Fig. 1. The chamber 72 extends down around the exterior of the upper end of the liner 15 to the shoulder 73 and is connected to the upper end of the low pressure cylinder 11 by a duct 74. A plurality of terminal ports 75 connect the space 72 with the upper portion of the high pressure cylinder 16. These ports 75 are positioned so that they will be uncovered when the piston 70 reaches the end of its power stroke, as shown in Fig. 1.

The gland or guide 69 through which the piston rod 68 moves has a plurality of annular grooves 77 therein so as to provide a labyrinth seal around the rod 68 between the low pressure cylinder 11 and high pressure cylinder liner 16. In the side wall of the low pressure cylinder 11 there is a terminal exhaust port 78 adapted to be connected to the condenser 100. Above the terminal exhaust port 78, the side wall has a braking fluid inlet port 79 arranged to be connected to a source of vapor under pressure by duct means as shown in part at 80. The cylinder head 15 is formed so as to provide a space for cooling water around the gland 69, and this space 81 is connected with the inlet port 20 by a duct 82, and a duct 83 is formed in the cylinder head 15 so as to carry the cooling liquid away from the space 81.

In Fig. 1 the high pressure piston 70 is shown at the end of its power stroke, having uncovered ports 75, just prior to the opening of the transfer valve 39. It will be understood that the piston has moved upwardly into the position in which it is shown in Fig. 1 from a position at the lower end of the cylinder line 16 under pressure of the steam which has been admitted to the front face 84 of the high pressure piston 70 by the opening of the high pressure inlet valve 33 for a period of time determined by the conditions of operation of the engine. That is to say, in keeping with steam engine practices high pressure steam is admitted to the high pressure cylinder 17 during a part of the piston stroke, whereupon the steam inlet valve 33 is closed, permitting expansion of the steam to act upon the front face 84 of the piston 70 during the remainder of its power stroke. The opening of the ports 75 by the piston 70 as it moves into the extreme position in which it is shown, results in a blast of steam outward into the lower part of the chamber 72 and down through the duct 74 into the upper end of the cylinder 11 so that vapor pressure will be built up against the front face 85 of the low pressure piston 65 and also in the passage 30 where this pressure will act upwardly against the exposed lower face of the poppet valve 39, reducing to a material extent the force which must be exerted by the cam 44 to lift the valve 39 so that steam may flow from the lower end of the high pressure cylinder 17 through the passage 26, the valve port 29 and the passage 30 into the upper end of the low pressure cylinder 11 where the steam may then expand so as to force the piston 65 downward through the power stroke thereof. During this time the pressure in the space 72 against the back face 72' of the piston 70 will be substantially the

same as the pressure in the cylinder 17 below the piston 70, and when the piston 70 passes downwardly below the ports 75 transfer valve 39 will be open and the pressure in the space above the low pressure piston will be transmitted through the passage 74 so that the pressures on opposite ends of the high pressure piston are substantially balanced during the power stroke of the low pressure piston 65. Expansion of the steam within the low pressure cylinder 11 continues until the upper end of the piston 65 uncovers the mouth of the terminal exhaust port 78 whereupon the steam at low pressure is exhausted to the conduit 101 leading to the condenser. The ending of the operating cycle includes the closing of the transfer valve 39, at a time prior to the uncovering of terminal port 78 and the opening of the high pressure inlet valve 32 at the start of the succeeding cycle.

Braking of the engine is accomplished by admitting vapor, such as steam through the inlet port 79 when the piston 65 is moving upwardly with its upper end positioned below the port 79. The admitted steam is compressed within the cylinder 11 and also travels through the duct 74 into the upper end of the cylinder 17, where it is compressed also by piston 70 so that the admitted braking steam then reacts downwardly against the front face or end of the low pressure piston 65 and against the back end of the high pressure piston 70.

The steam power system is shown in Fig. 4. The system includes a condenser 100 which is connected to the terminal exhaust port 78 and also to the exhaust passage 48 by exhaust piping 101. Feed water from the condenser 100 is pumped through conduit 103 by means of a pump 103a which creates a suction in the exhaust piping 101 to the inlet port 20 of the cooling system of the engine E. In passing through the cooling spaces 81 and 22 of the engine, the feed water is heated as a part of its function of keeping the frictionally operating walls 16 and 69 at a temperature sufficiently low to enable lubrication thereof. Accordingly, the heat thus extracted is returned into the system. The outlet port 21 of the cooling system is connected through piping 104 with a steam boiler 106 having a steam delivery pipe 107 leading therefrom. A throttle valve 108 connects this pipe 107 through a pipe 109 with the high pressure steam inlet of the engine E, and a brake valve 110 is connected to the steam delivery pipe 107 and to the braking inlet 79 by duct 111. Some of the heat of the steam employed for braking purposes in the engine is returned into the system. As the pistons 65 and 70 move upwardly after the admission of steam through the inlet 79, the steam thus admitted is compressed so that the temperature thereof is raised. Some of the heat from this compressed steam is transmitted through some of the engine walls to the feed water which is moving through the cooling spaces of the engine.

The power system also includes a suction pump 114 which is connected to the interior of the crankcase 10 by duct means 115. This pump 114 creates a partial vacuum within the crankcase 10 which is greater than the suction in the piping 101 and continuously draws off air and oily vapors which would otherwise find their way into exhaust port 78, thereby minimizing contamination of the exhaust steam with air and oil vapors. In order that this low pressure or partial vacuum may be maintained in the crankcase, a seal 117, Fig. 3, is disposed around the portion of the crankshaft 60 which passes through the crankcase opening 118 to the exterior of the crankcase, adjacent the crankshaft bearing 119. If the opposite end of the crankshaft also passes to the exterior of the crankcase another similar seal 117 will be provided around the other end of the crankshaft. It will be noted that the seal 117 is faced outwardly, or leftwardly, so as to resist entry of fluid from the exterior through the opening 118 into the interior of the crankcase.

I claim:

1. In a steam power system: a cylinder including walls forming a water receiving space contiguous to said cylinder; a piston operative in said cylinder through consecutive power and exhaust strokes; a crankcase connected to the cylinder having a crankshaft opening; a crankshaft in said crankcase connected to said piston and having a portion which extends out through said opening; means for sealing around said crankshaft where it passes through said opening so as to prevent entry of fluid through said opening into said crankcase; steam supply means including a boiler having an inlet connected to said water-receiving space of said cylinder and a condenser having its outlet connected to said water receiving space which is in turn connected to said boiler; inlet steam valve means for connecting said boiler to said cylinder; means forming an exhaust port for said cylinder; means for conducting exhaust steam from said exhaust port to said condenser; and suction pump means connected to said crankcase for producing a sub-atmospheric pressure in said crankcase at least during the exhaust strokes of said piston and minimizing flow of oily vapors from the crankcase past the piston into the cylinder.

2. In a steam power system: a steam engine having cylinder means connected to a crankcase having a crank opening, walls forming water spaces contiguous to said cylinder means, piston means operative in said cylinder means, a crank in said crankcase connected to said piston means for operation thereby, said crank means having a portion which passes out through said opening of said crankcase, and means sealing around said crank where it passes out through said opening to resist entry of fluid into the crankcase through said opening; a steam boiler connected through control valve means with said engine; a condenser connected to the exhaust of said engine to receive the exhaust steam therefrom; a suction pump connected so as to apply suction to said cylinder means so as to exhaust steam therefrom; duct means connecting said condenser, said water spaces of said engine and said boiler in series so that water from said condenser will cool said cylinder means and be

heated by heat therefrom; and a suction pump connected to the interior of said crankcase and being operative to maintain in said crankcase a pressure below the pressure effected in said cylinder means by said suction pump to minimize passage of oily vapors from the crankcase through the exhaust of the engine.

3. In a steam power system: a steam engine having cylinder means connected to a crankcase having a crank opening, walls forming water spaces contiguous to said cylinder means, piston means operative in said cylinder means, a crank in said crank case connected to said piston means for operation thereby, said crank means having a portion which passes out through said opening of said crankcase, and means sealing around said crank where it passes out through said opening to resist entry of fluid into the crankcase through said opening; a steam boiler connected through control valve means with said engine; a condenser connected to the exhaust of said engine to receive the exhaust steam therefrom; duct means connecting said condenser, said water spaces of said engine and said boiler in series so that water from said condenser will cool said cylinder means and be heated by heat therefrom; and a suction pump connected to the interior of said crankcase and being operative to maintain subatmospheric pressure therein to minimize passage of oily vapors from the crankcase through the exhaust of the engine.

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