No. 649,301. Patented May 8, 1900.

G. H. HARDIE & N. THOMPSON.

ENGINE.

(Application filed Sept. 8, 1899.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

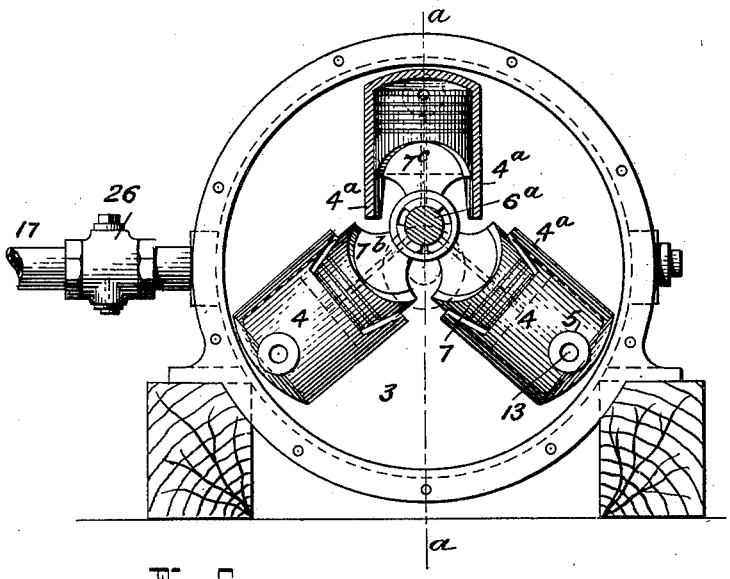

Fig. 5.

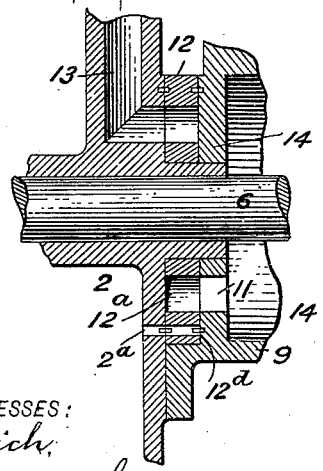

Fig. 6.

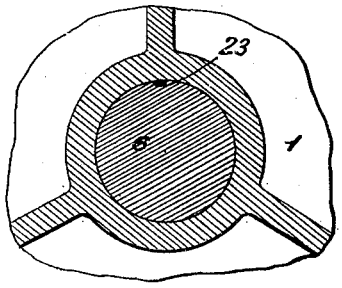

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Fig. 2.

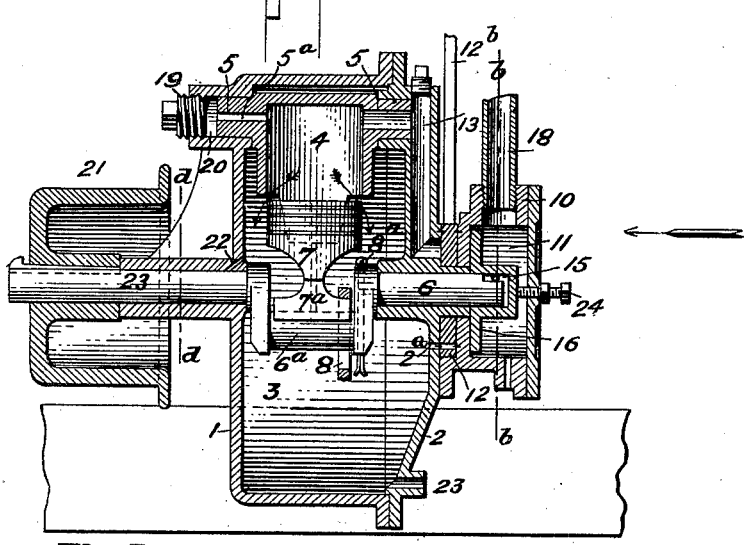


Fig. 3.

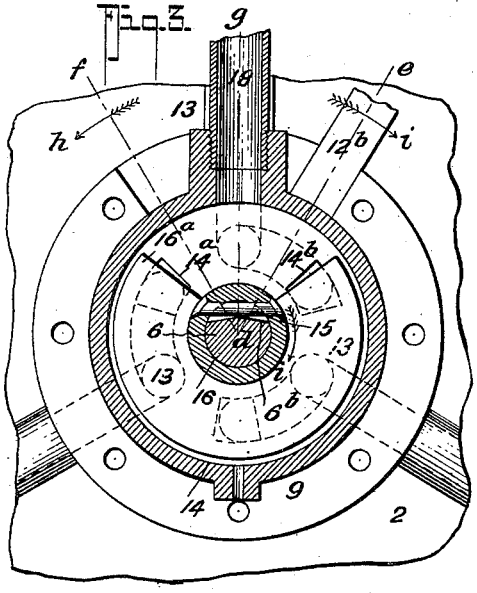
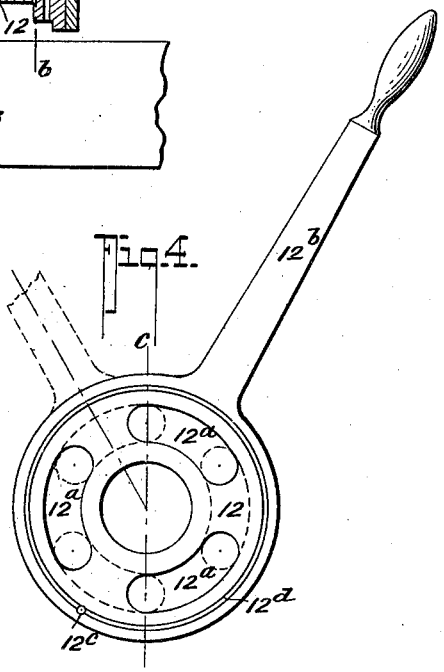


Fig. 4.



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UNITED STATES PATENT OFFICE.

GORDON H. HARDIE AND NICHOLAS THOMPSON, OF VANCOUVER, CANADA.

ENGINE.

SPECIFICATION forming part of Letters Patent No. 649,301, dated May 8, 1900.

Application filed September 8, 1899. Serial No. 729,862. (No model.)

To all whom it may concern:

Be it known that we, GORDON HENRY HARDIE and NICHOLAS THOMPSON, citizens of the Dominion of Canada, residing at Vancouver, in the Province of British Columbia, Canada, have invented a new and useful Engine, of which the following is a specification.

Our invention relates to improvements in single-acting three-cylinder engines in which the cylinders are pivotally arranged on trunnions within a case trihedrally around the drive-shaft, and ports connect from the main supply-chamber with the outer ends of these cylinders through their trunnions, which ports are operated by a valve rotating on the end of the drive-shaft; and our objects are to provide an engine of the above class that is cheap and simple of construction, and by reason of a movable valve-disk having elongated ports concentric with its center inserted in the passages of the ports and at the point of such insertion the ports being offset concentrically the engine may be started in either direction or reversed by the movement of said valve-disk, and also to provide a simple means for exhausting the fluid without taking it back through the inlet-ports.

We attain our objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is an end elevation of our engine with the cover containing the valves and ports removed. Fig. 2 is a section of the same through the center on the line *a a* in Fig. 1. Fig. 3 is an end view through the supply-chamber, taken on the line *b b* in Fig. 2 from the direction of the arrow. Fig. 4 shows the valve-disk removed, which is for starting, stopping, or reversing the engine independent of any other power-controlling devices. Fig. 5 shows a detail of the valve-disk and its means for making it comparatively steam-tight, and Fig. 6 is a sectional detail of the drive-shaft on the line *d d* in Fig. 2.

Similar numerals and letters refer to similar parts throughout the several views.

In the construction of our improved engine we provide castings 1 and 2, which are securely bolted together. The casting 1 is provided with a cylindrical recess which forms a chamber 3, in which are cylinders 4, pivotally mounted on trunnions 5, which lie in suitable recesses on the opposite sides of the recess or chamber 3 and in proximity with the periphery thereof.

Passing through a hub in the sections 1 and 2 is a shaft 6, having a crank 6^a arranged to turn within the chamber 3, and working within the cylinders 4, which are placed trihedrally around said shaft, are pistons 7, 7^b, and 7^c, whose inner or converging ends are provided with concaved shoes 7^a, which rest around the crank 6^a. These shoes 7^a are prevented from dropping from contact with the crank 6^a by a ring 8, embracing the same, (see Fig. 2,) and this ring 8 is held in place by a key 8^a, passing through the web of the crank, as shown.

Secured to the outer side of the casting 2, around the hub thereof, is an annular casting 9, which is provided with a cover 10, forming a closed chamber or chest 11.

Arranged between the sections 9 and 2 is an annular recess which encircles the hub of the said section 2, and a disk valve 12, having elongated ports 12^a, occupies all of the space within this recess or chamber, and a hand-lever 12^b is connected with said valve, which passes to the exterior through an opening in the upper side of the section 9. The said ports 12^a are each of a length one-sixth of the distance of the circumference of the disk at the radius they occupy, which is equal to the movement of the valve when turned by the lever 12^b, the object of which will appear presently.

Communicating between the elongated ports 12^a in the disk valve and with the cylinders 4 through the trunnions pivoted in the casting 2 are ports 13, which are opened and closed by the forward or back movement of the lever 12^b.

Arranged trihedrally around the shell of the casting 9, which lies against the disk valve 12, are ports 14, 14^a, and 14^b, and, as better shown in Fig. 3, these ports are placed midway between the ports 13, just the distance from alinement with same that corresponds with the length of the elongated ports 12^a in the disk valve.

From the foregoing and as illustrated on Fig. 3 when the lever 12^b is thrown over on the line *d e* the engine will rotate in the direction of the arrow, and when said lever is

pushed over on the line *d f* it will travel in the direction of the arrow marked *h;* but when said lever is brought to a vertical position on the line *d g* all the ports will be closed by the webs between the ports 12^a lying thereover.

Secured by a pin 15 to the end of the shaft 6 within the chamber 11 is a rotating valve 16. This valve consists of a disk having a segment removed, as 16^a, so that there is only one port fully exposed at once, and as the shaft rotates each port is given its required exposure to allow the steam or pressure to engage one of the pistons, the relation of the crank 6^a and the opening 16^a being such that when the communication is made with one of the cylinders the piston is pushed back within the same, so that it is a continuous push on each piston as each port is reached. The pin 15 is passed through and riveted or otherwise fastened in the hub of the valve 16 and lies in a flattened portion 6^b on the end of the shaft 6. This flattened portion is made so that the valve is allowed to lag, and consequently gives steam to the exposed port to push the crank over the dead-center. For instance, Figs. 1 and 3 are showing the shaft 6 traveling in the direction of the arrow marked *i*. The piston 7^b will be pushing until the crank has passed beyond the dead-center of the piston 7^c, when the load will be taken up by such piston by reason of the port 14^a being closed and the port 14^b opened. (See Fig. 3.) When each piston is thrown out to its full stroke, (see Fig. 2,) its inner end comes beyond the orifice of the cylinder 4. This allows the steam to exhaust freely into the chamber 3, whence it escapes by the pipe 17; but the piston is held in proper alining contact with the cylinder by projected lips 4^a on each side of the mouth of the same.

The steam or other expansive fluid is introduced to the chamber or chest 11 by the pipe 18, (see Fig. 2,) and as the pressure is taken into the port 14^a or 14^b, according to the position of the opening 16^a in the valve, it passes to one of the cylinders 4 by one of the ports 13, the particular port being opened by the disk valve 12 and this being consequent upon the direction the engine is required to be driven.

To prevent leakages between the disk valve 12 where the lever passes between the sections 2 and 9, we provide an annular tongue-shaped groove 12^d around the opposite sides thereof, which allows the water and oil to gather and act as a packing, and this water and oil is passed from one groove to the other by a small aperture 12^c, whence it may escape by a small opening 2^a to the chamber 3.

To equalize the pressure on the ends of the oppositely-disposed trunnions 5, a small aperture 5^a is made through each of the trunnions opposite to the ones carrying the ports 13, and the orifices in which these trunnions having the small orifice 5^a lie are stopped by plugs 19 or otherwise some slight distance from the ends of such trunnions, which form small chambers 20 between the plugs 19 and said trunnions. This is a very important feature, as otherwise it would be necessary to have some packing devices around the trunnions 5, carrying the ports, as the pressure would tend to force the shoulders of said trunnions against the bosses in the casting 1 and cause a direct and serious leak to the chamber 3 around the trunnions having the ports 13, whereas by reason of the greater exposed surface of the trunnions on the opposite side owing to the difference between the diameter of the aperture 5^a and the ports 13 the trunnions carrying said ports will be normally held against the bosses in the casting 2, which is the weak point to be guarded against. The lubricant is communicated with the inlet-pipe 18 and is blown through the different parts of the machine by the pressure. For instance, the pressure at the opposite ends of the trunnions will force the lubricant around the same to the chamber 3. The crank of the shaft, as 6^a, will be lubricated by the oil or lubricant passing down small apertures through the center of the pistons. This will deposit the lubricant between the shoes of the pistons 7^a and the crank 6^a, and the end of the shaft 6, carrying a belt-pulley 21, is lubricated by a small vent 22, communicating from the chamber 3 with the groove 23 in the shaft along the portion received in the hub of the section 1. To insure the operation of this when the engine is running at a low speed without a load, we place a check-valve 26 in the waste-pipe 17, which may be regulated so that a slight pressure will be generated within the chamber 3, which will have the effect of blowing the required lubricant into the groove 23. This artificial pressure, however, in the chamber 5 is not necessary when the engine is turning at a high speed or working under pressure. The inclosed end of the shaft 6 is also provided with a small groove similar to the groove 23. This serves a double purpose. It prevents the pressure from getting under the valve 16 and perhaps holding it from properly covering the ports by allowing such pressure to escape to the chamber 3, and such escape will carry the lubricant forward and lubricate that portion of the shaft.

Our engine may be worked vertical, horizontal, or at any angle desired, and in case it is run vertical the valve 16 is prevented from dropping from contact with the ports by a set-screw 24, passing over the cover 10 and adjusted the proper distance from the hub of the same to allow it play sufficient to lag on shaft when reversed or turned, as before mentioned.

As shown by the illustration Fig. 1, the waste-pipe 17 is placed about the center of the casting with respect to vertical position when the engine is run horizontally. This allows the water caused by the condensed steam (when steam is the power used) to form in the lower part of the chamber, and as the

oil floats on top of this the action of the cylinders, pistons, and crank 6^a will keep continually splashing the oil over the parts, and consequently the internal parts are continually lubricated. The water and oil may be drawn off when required through the discharge-orifice 25, placed at the lowest point of the casting 2, as best shown in Fig. 2, which opening when the machine is running is closed in any suitable manner.

We are aware that multiple engines have been in use before our invention; but so far as we know none have been in use having our particular arrangement of the cylinders in conjunction with the reversing mechanism and rotating valve-gear. Therefore

What we claim as new, and desire to secure to ourselves by Letters Patent, is—

1. In a three-cylinder engine having the cylinders pivotally arranged trihedrally around the crank-shaft within a casing formed by the sections 1 and 2, in combination with ports leading off from said cylinders to a common supply-chamber, a disk valve 12 having elongated ports therein interposed between the supply-chamber and the cylinders, offsets in the ports at the point of contact with the disk valve, such offsets corresponding with the length of the elongated ports in the said disk valve, and a rotating valve 16 loosely fixed on the end of the crank-shaft within the common supply-chamber, as specified.

2. In an engine having a closed chamber 3 for receiving the waste and exhaust, in combination with a crank-shaft arranged to turn in said chamber, and pistons arranged trihedrally around the crank of the shaft working in cylinders pivoted on oppositely-disposed trunnions journaled in bosses in opposite sides of the chamber 3, pressure communications through the trunnions on one side of the cylinder, and apertures through the oppositely-disposed trunnions to chambers 20, as and for the purposes specified.

3. In combination with cylinders trihedrally placed and pivoted on trunnions with pistons working therein and engaging a crank-shaft with their converging ends, ports communicating with the cylinders through the trunnions and with a common supply-chamber 11, offsets in said ports at a point near the chamber 11, a disk valve 12 interposed in the ports at a point where the offsets occur, elongated ports 12^a in the disk valve whereby the communication may be changed from one port to another, and a rotating valve 16 loosely fixed to the end of the crank-shaft.

4. In combination with cylinders trihedrally arranged from each other and pivoted on trunnions with pistons working therein, and a crank-shaft arranged to turn between the said pistons, a common supply-chamber 11, ports communicating between the pistons, through the trunnions, and the supply-chamber 11, offsets or jogs in the ports near the supply-chamber, of a disk valve 12 having annular tongue-shaped grooves therearound, in the path of the ports at the point where the offsets take place, elongated ports 12^a in said disk valve, of a valve loosely fixed to the end of the crank-shaft within the closed chamber, said valve consisting of a disk 16 with a segment 16^a removed from one side to expose one port at once as the same is rotated by the said shaft.

5. In an engine of the class described, a disk valve 12 having the elongated ports therein for reversing the machine, and being provided with a groove 12^d on its opposite sides and an orifice 12^c communicating between the grooves, for the purposes specified.

6. In a multiple single-acting engine having the cylinders arranged within an exhaust-chamber 3 formed by castings 1 and 2, and pivotally mounted on trunnions 5 through which the pressure is introduced to the pistons and a crank-shaft passing through the center of said chamber; in combination with a chamber or chest 11, consisting of an annular casting 9 with a cover 10, said castings 9 being securely fixed to the casting 2 and embracing the hub thereof and the end of the crank-shaft, an annular chamber between the sections 2 and 9 and a disk valve arranged to fit therein and susceptible of being turned one-sixth of a revolution, elongated ports 12^a in the disk valves, ports 13 communicating with one end of the elongated ports 12^a and the ports 14, 14^a, and 14^b communicating between the opposite ends of the said elongated ports and the chamber 11, and a valve 16 loosely fixed on the inclosed end of the shaft, such valve having a recess therein so that as it rotates with the shaft but one port in the section 9 will be exposed at once.

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