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STEAM PUMP.  
APPLICATION FILED DEC. 16, 1908.

2 SHEETS--SHEET 1.

Fig. 1.

A side view of a mechanical device, likely a pump or engine component, showing various parts labeled with numbers 1 through 40. The device features a large cylindrical body on the left, a central horizontal shaft with multiple gears and pulleys, and a vertical assembly on the right. The drawing is a technical illustration with detailed mechanical components and numbered callouts.

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2 SHEETS--SHEET 2.

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# UNITED STATES PATENT OFFICE.

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## STEAM-PUMP.

999,711.

Specification of Letters Patent.

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*To all whom it may concern:*

Be it known that I, BURT O. GAGE, a citizen of the United States, residing in Warren, in the county of Worcester and State of Massachusetts, have invented an Improvement in Steam-Pumps, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to steam pumps, and consists in a novel construction of the valve mechanism having for its object to render the operation of the pump less violent by gradually cutting off the admission of steam to the cylinder as the piston approaches the end of its stroke.

The invention is embodied in a pump of the kind known as a direct acting steam pump in which the main valve controlling admission and exhaust of steam with relation to the main cylinder is itself steam actuated, being operated by a piston, the movement of which is controlled by an auxiliary or controlling valve which is mechanically actuated by the main engine piston, or some part connected therewith.

In the construction forming the subject of the present invention, the main valve is actuated or moved in part by mechanical connections from the main engine piston, and has its movement completed by steam actuation under control of the controlling valve, and the mechanical valve operating connections from the main piston cooperate with a rod or stem connected with the main valve or its piston, and also with the rod or stem of the controlling valve, the construction and arrangement being such that at the proper point in the stroke of the main piston, say, about as it passes mid-stroke position, it operates upon the controlling valve which, in the first part of the movement thereof, acts upon the controlling ports of the valve driving engine, so as to balance the steam pressures on the piston thereof, while, in the final part of its movement, as the main piston arrives at the end of its stroke, the said controlling valve reverses the steam connections, and causes the valve actuating piston to be steam actuated to shift the main valve. During the latter part of the stroke of the main piston, however, after the controlling valve has been moved to balance the steam pressures on the valve

actuating piston, as has just been mentioned, the mechanical valve actuating appliances act upon the rod of the main valve and move the same in the direction to close the port through which steam is being admitted, this movement taking place in the latter part of the stroke of the main piston, and thus gradually cutting off the admission of steam that is driving the main piston. At or before the time, in the movement above mentioned, that the main piston has, by the mechanical connections, shifted the main valve far enough to cut off the admission of steam to the main cylinder, the shifting movement of the controlling valve has been completed and thus causes the main valve to be steam actuated to complete its movement by which the end of the main cylinder which last receives steam is connected with the exhaust, and steam is admitted to the other end of said cylinder through the port which has been fully opened by the completion of the movement of the main valve.

The main valve is mechanically moved to close or substantially close the exhaust port of the steam cylinder so as to cushion the piston therein at the end of its stroke in opposite directions, and provision is made as will be described for cushioning the valve-actuating piston at the end of its stroke in opposite directions, whereby a smooth and noiselessly operating pump is obtained.

Figure 1 is a side elevation of a steam pump embodying this invention; Fig. 2 is a longitudinal section of the steam cylinder and associated parts showing the mechanical valve actuating appliances in elevation; Fig. 3 is a sectional plan on line  $x^3$ , Fig. 2, on a larger scale showing the controlling valve and parts controlled thereby; and Fig. 4 is a transverse sectional elevation at line  $x^4$ , Figs. 2 and 3.

The general construction and arrangement of the working parts of the pump may be such as are commonly adopted, said pump comprising the steam cylinder 2 by which the pump is actuated, and the pump proper 3 which may be of any suitable or usual construction, the steam piston 4 (see Fig. 2) being directly connected by a rod 5 with the piston or plunger of the pump so as to give the said pump piston or plunger a positive reciprocatory movement in unison with the steam piston.

Steam is admitted to and exhausted from



the ends of the steam cylinder 2 through ports 6 and 7 controlled by a main valve 8 shown as of the usual D valve construction, which, when moved to the end of its stroke in one direction (say to the left, as shown in Fig. 2) admits steam through the port 7 to the opposite end of the cylinder, and permits the steam to exhaust through the port 6 and the cavity in the main valve 8 to the exhaust port 9 which has its opening in the main valve seat between the openings of the steam ports 6 and 7. Said main valve 8 is actuated by a piston 10 working in a cylinder 12, said piston being double ended with the space between its heads in communication with and forming a part of the steam chest, from which steam passes under control of the main valve 8 to the main cylinder.

The parts thus far considered may be of any suitable or usual construction.

The valve actuating piston 10 is provided with a rod or stem 13 extending out through a stuffing box in the head of the cylinder, and having pivotally connected therewith a tappet rod 14 provided with tappet projections 15. The admission and exhaust of steam to the ends of the cylinder 12 for the purpose of actuating the piston 10 is governed by a controlling valve 16, shown as of the D valve construction having a cavity 17 which controls the exhaust port connections, as will be explained. Said controlling valve 16 works in a steam chest 18, shown as cylindrical in form and communicating through passage 19 with the main steam chest so that steam is at all times admitted to said steam chest 18 and surrounds the valve 16 therein when steam is admitted to the main steam chest to drive the engine. The said controlling valve 16 is provided with a rod or stem 20 which preferably extends through both ends of the steam chest 18, in order to balance the action of the steam on the controlling valve 16, and said stem 20 is pivotally connected with a tappet rod 22 having tappet projections 23 thereon. As shown in Fig. 3, there are steam ports 25, 26 leading from the seat of the controlling valve 16 to the opposite ends of the cylinder 12, and other ports 27, 28 having openings in the valve seat out of alinement with the openings of the ports 25, 26 also leading to the ends of the cylinder, and having their port openings in the steam chest in alinement with the opening of an exhaust port 29 which communicates with the exhaust passage 9 of the main engine.

The openings of the ports 27, 28, 29 are so located and spaced that when the controlling valve 16 is at one extremity of its movement, its cavity 17 connects one of said ports 27 or 28 with the intermediate exhaust port 29, while the ports at the other end of said valve leading to the end of the cylinder are open or uncovered, the said valve, when in its left hand position, for example, cov-

ering and closing the steam port 25 leading to the left hand end of the cylinder and connecting the port 27 leading from the left hand end with the exhaust port 29, and at the same time leaving both ports 26, 28 leading to the right hand end of the cylinder uncovered, so that steam is admitted to the right hand end of the cylinder 12 and exhausted from the left hand end thereof, and the valve actuating piston 10 is thus forced to the left hand end of the cylinder 12 leaving the right hand main steam port 7 fully opened, and the left hand steam port 6 fully connected with the exhaust 9, so that the main piston 4 makes its stroke from right to left, all as shown in Fig. 2.

The ports governed by the controlling valve are also so located that when the said controlling valve begins its movement from the extreme position, say, at the left hand, as just explained, it first moves the cavity 17 far enough to disconnect port 27 from the exhaust port 29 and to close the said port 27, but before it moves far enough to connect the right hand port 28 with the exhaust port 29, it uncovers the port 25 leading to the left hand end of the cylinder, but has not yet covered the steam port 26 leading to the right hand end of the cylinder, so that in the first part of the movement of the auxiliary valve (approximately one half of its stroke) both ends of the cylinder 12 are disconnected from the exhaust, but steam is admitted to both ends, so that the piston 10 is balanced and makes no movement in response to steam pressure, but is free to be moved by any extraneous mechanical force.

By reference to Figs. 2 and 4, it will be observed that the steam inlet ports 25, 26, for the cylinder 19 are located in close proximity to the opposite end walls of said cylinder, whereas the exhaust ports 27, 28 are removed from the said end walls so as to leave spaces between the end walls of the cylinder 19 and the ends of the piston 10 when the latter covers the exhaust ports 27, 28, which spaces are filled with steam and form steam cushions for the piston 10 at the end of its movement in opposite directions.

The mechanical connections from the main piston to the main and controlling valves are as follows: The rod 5 of the main piston is provided with a stud 35 which engages a fork in the end of a valve operating lever 36 fulcrumed at 37 on a suitable portion of the main frame work, and pivotally connected at 38 with a tappet 39 mounted to slide upon the tappet rods 14 and 22, before mentioned, that are pivotally connected with the main and controlling valve stems 13, 20, respectively. The pivotal connection of the tappet rods 14, 22, with the valve stems accommodates the movement of the pivotal connection at 38 between the lever 36 and the tappet 39 in



an arc around the fulcrum 37 of the lever, so that the tappet 39 has in effect a sliding movement on the rods 14, 22, and has separate tappet portions to coöperate with the  
 5 tappet projections 15 on the main valve rod and the tappet projections 23 on the controlling valve rod. The tappet projections should be so adjusted that, in the movement of the tappet produced by the main piston  
 10 4, the tappet projections 23 connected with the controlling valve rod will be first engaged, and will be moved far enough to shift the controlling valve far enough to balance the steam pressures on the main  
 15 valve actuating piston 10 as before described, by the time that the tappet 39 engages the proper tappet projection 15 on the main valve rod 14, and in the further movement of the main piston the tappet 39 will  
 20 carry both valves mechanically, and about as the main piston completes its stroke the main valve will have been carried about to mid-position, having thus gradually cut off the admission of steam to the end of the  
 25 cylinder behind the piston during the latter part of the stroke of the piston. Before the main piston has thus moved the main valve far enough completely to close the port leading to the end of the cylinder, the  
 30 controlling valve will have been moved far enough to close the admission of steam to and open the exhaust from the end of the cylinder 12 toward which the valve actuating piston 10 is being mechanically moved  
 35 by the main piston, as has just been described, and steam will remain admitted to the other end of the said cylinder 12, so that the valve actuating piston 10 will now be moved promptly by the steam pressure on  
 40 piston 10 to shift the main valve and fully open the exhaust from the end of the main cylinder that has previously taken steam, and fully open the port from the steam chest to the  
 45 other end of the said cylinder so as to cause the main piston to be driven effectively on its next stroke.

It is not essential that the balance of the main valve actuating piston 10 should be effected by admitting steam to both ends of  
 50 the cylinder while both ends are cut off from the exhaust, as an effective balance might be produced by having steam cut off from both ends of said cylinder while both ends are placed in communication with the ex-  
 55 haust.

The important matter in the construction and arrangement of the controlling valve is that shortly after the beginning of its movement it causes the steam pressures on  
 60 the main valve actuating piston 10 to be balanced and to remain so during a determinate further portion of the movement of the controlling valve, the final part of which movement causes the steam connections to  
 65 be shifted or reversed from the condition

in which they were when the movement or stroke of the controlling valve began.

By the herein described construction, the engine valves will be operated with certainty and without danger of remaining closed or  
 70 partially shifted when the main piston completes its movement, but the admission of steam to actuate the main piston is gradually cut off as the piston completes its  
 75 stroke, instead of following through the full area of the admission port to the end of the stroke of the piston, as would be the case if the main valve were shifted only by the  
 80 actuation of the steam under control of the controlling or auxiliary valve, and as a result the main piston 4 is provided with a steam cushion at the end of its stroke in  
 85 opposite directions. Furthermore, by means of the exhaust ports 27, 28, for the cylinder 19 being removed from the end  
 90 walls of the said cylinder and closed by the piston 10 therein, steam cushions are provided for the piston 10 at the end of its stroke in opposite directions, with the result  
 95 that a smooth and noiselessly running pump is obtained.

#### Claims.

1. The combination with the main valve of a steam pump, of a piston connected with  
 95 said valve to move it, a cylinder in which said piston is located having separate inlet and exhaust ports leading to the opposite ends of said cylinder, said exhaust ports being located a greater distance from the ends  
 100 of said cylinder than said inlet ports and co-operating with the said piston to form steam cushions for the latter, means for mechanically moving said main valve for a portion of its travel to substantially close the ex-  
 105 haust port of the steam cylinder of the pump before the piston of the steam cylinder reaches the end of its stroke and thereby form a steam cushion for the piston of the  
 110 steam cylinder at the end of its stroke in opposite directions, and a mechanically operated auxiliary valve controlling the ports to the cylinder of the valve-actuating-piston and coöperating with the latter to balance  
 115 the said actuating piston during a portion of its stroke and to unbalance the same at or about the time the main valve closes the ex-  
 120 haust port of the steam cylinder and thereby complete the movement of the main valve independently of the means which mechanically move said main valve, substantially as  
 125 described.

2. The combination with the main valve of a steam pump, of a piston connected with  
 125 said valve to move it, a cylinder in which said piston is located having separate inlet and exhaust ports leading to the opposite ends of said cylinder, said exhaust ports being located away from the ends of the said  
 130 cylinder and coöperating with the said piston to form steam cushions for the latter, means



for mechanically moving said main valve  
for a portion of its travel to substantially  
close the exhaust port of the steam cylinder  
of the pump before the piston of the steam  
5 cylinder reaches the end of its stroke and  
thereby form a steam cushion for the piston  
of the steam cylinder at the end of its  
stroke in opposite directions, and a me-  
chanically operated auxiliary valve con-  
10 trolling the ports to the cylinder of the  
valve-actuating-piston and coöperating with  
the latter to balance the said actuating pis-  
ton during a portion of its stroke and to un-

balance the same at or about the time the  
main valve closes the exhaust port of the 15  
steam cylinder and thereby complete the  
movement of the main valve independently  
of the means which mechanically move said  
main valve, substantially as described.

In testimony whereof, I have signed my 20  
name to this specification in the presence of  
two subscribing witnesses.

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Witnesses:

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents,  
Washington, D. C."

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