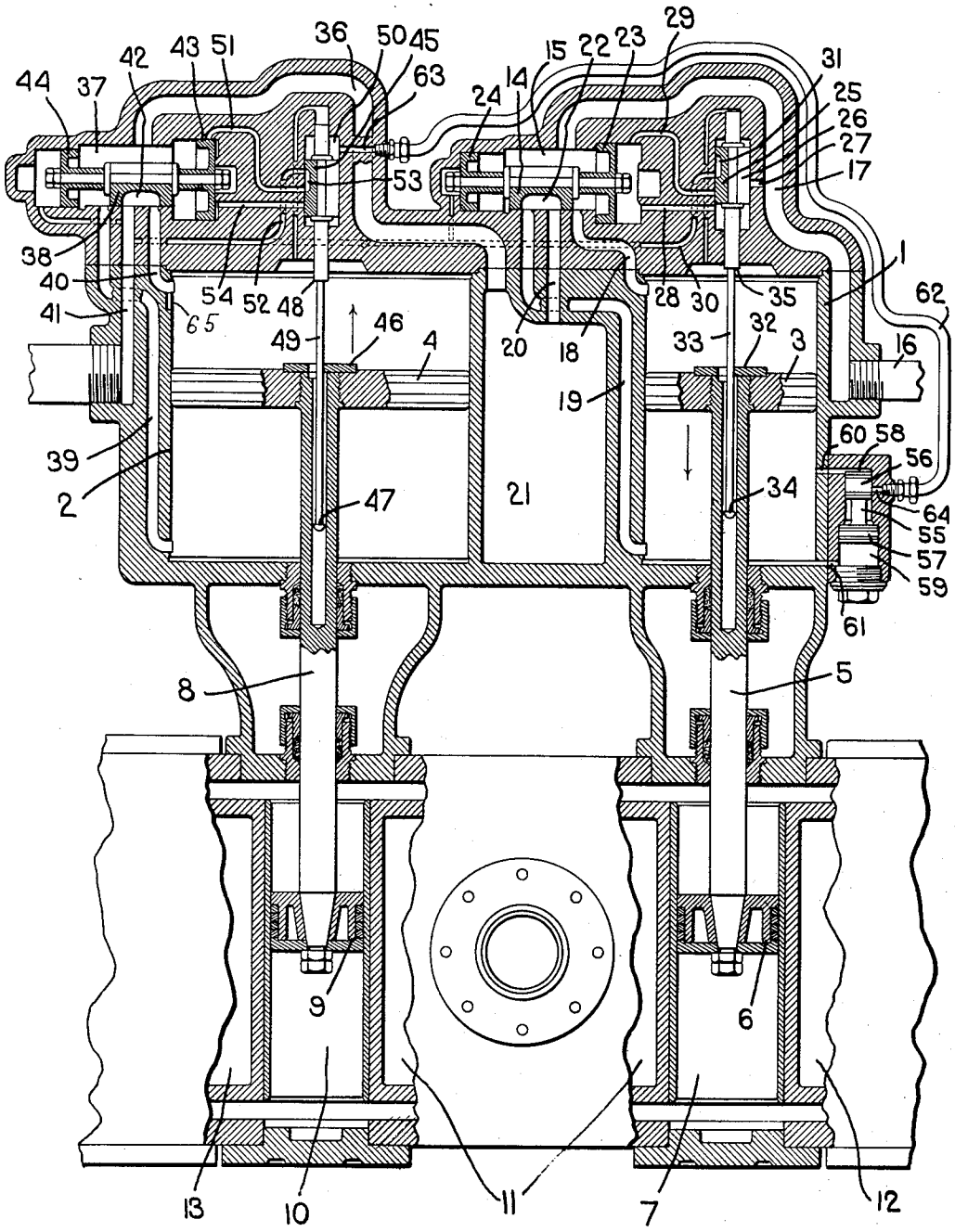
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COMPOUND STEAM ENGINE

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COMPOUND STEAM ENGINE

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This invention relates to a compound double-acting steam pump and has for one of its objects to provide a compound double-acting steam pump which is constructed to deliver a continuous flow of water. This is provided for by a novel construction by which the low pressure steam piston is caused to reverse just prior to the reversal of the high pressure steam piston so that the pistons operate slightly out of step with each other and each pump piston is, therefore, delivering water while the other pump is reversing.

A further object of the invention is to provide a compound double-acting continuous flow steam pump which is so constructed that while the steam pistons are slightly out of step with each other thereby to produce the continuous flow, yet said pistons are so near in step that the low pressure steam piston receives for nearly its full stroke the benefit of the exhaust from the high pressure steam piston.

A further object of the invention is to provide a continuous flow double-acting steam pump in which the low pressure steam piston is capable of movement independently of the high pressure piston and which is constructed so that the low pressure steam piston will invariably make a full stroke in each direction before reversing.

Still a further object of the invention is to provide a compound double-acting steam pump which is constructed so that it will not become permanently stalled during operation and will invariably start when steam pressure is turned on, regardless of the position in which the steam pistons may be at the time of stopping.

Other objects of the invention are to improve generally compound double-acting steam pumps in the particulars hereinafter set forth.

In order to give an understanding of the invention I have illustrated in the drawing a selected embodiment thereof which will now be described after which the novel features will be pointed out in the appended claims.

The drawing shows a sectional diagrammatic view of a compound double-acting steam pump embodying my invention.

In the drawing the high pressure steam cylinder is indicated at 1 and the low pressure steam cylinder is indicated at 2. 3 indicates the high pressure steam piston operating in the high pressure cylinder 1, and 4 indicates the low pressure steam piston operating in the low pressure cylinder 2.

The high pressure steam piston 3 is connected by a piston rod 5 to a pump piston 6 operating in a pump cylinder 7 and the low pressure steam piston 4 is connected by a piston rod 8 with a second pump piston 9 operating in a pump cylinder 10. The pump pistons are double acting pistons and each piston is designed to deliver water into a common delivery chamber 11, the pump cylinder 7 taking its supply from a supply chamber 12 and the cylinder 10 taking its supply from a supply chamber 13. The inlet and the discharge valves of the two pumps are not shown herein and may have any suitable or usual construction.

The admission of steam to the high pressure steam cylinder 1 may be controlled by any suitable or usual valve mechanism. That herein shown comprises a valve 14 operating in a steam chest 15 to which live steam is delivered through the supply pipe 16 and the steam passage 17.

18 indicates a port connecting the valve chamber 15 with the upper end of the high pressure steam cylinder 1 and 19 indicates a port connecting said valve chamber with the lower end of said high pressure steam cylinder.

20 indicates an exhaust port leading to a receiving chamber 21 into which the steam is exhausted from the high pressure steam cylinder 1 and from which steam is supplied to the low pressure steam cylinder 2. When the valve 14 is in the position shown in the drawing the port 18 is open so that the live steam can be admitted to the upper end of the high pressure steam cylinder 1 and the port 19 will be connected to the exhaust port 20 through the valve port 22.

When the valve 14 is shifted to the right thereby to connect the ports 20 and 18, then live steam will be admitted to the lower end of the steam cylinder 1 and the upper end will be connected to the exhaust port 20.

The valve 14 is shifted by a differential piston structure comprising the connected pistons 23, 24, the piston 24 being smaller than the piston 23. This differential piston structure in turn is controlled by the reversing valve 25 which in turn is actuated by the high pressure steam piston 3 in a well known way. This reversing valve 25 operates in a steam chest 26 which is supplied with live steam through the port 27 communicating with the steam passage 17. The steam chest 26 is connected to the space at the right of the piston 23 through a port 28 and when the reversing valve 25 is in its raised position shown in the drawing live steam is admitted to the space at the right of the piston 23 with the result that the pressure on said piston 23 will be substantially balanced and the pressure against the piston 24 will hold the valve 14 in its position to the left.

When the reversing valve 25 is in its lowered position the port 28 is shut off and the port 29 will be connected to the exhaust port 30 through the port 31 of the valve 25 thereby exhausting the steam at the right of the differential piston 23. When this occurs the excess pressure on the left hand side of the piston 23 will move

the valve 14 to the right thereby reversing the high pressure steam piston 3. The reversing valve 25 is given its reversing movement by the high pressure piston 3, this being done by means of the usual reversing plate 32 carried by the piston 3 and a stem 33 depending from the reversing valve 25 and extending into an axial bore in the upper end of the piston rod 5, said stem 33 having shoulders 34 and 35 therein with which the reversing plate 32 engages near the ends of the piston stroke.

As the high pressure piston 3 reaches the bottom of its stroke the plate 32 engages the shoulder 34 and draws the valve 25 downwardly. This will cause the exhaustion of the live steam from the right hand side of the piston 23 so that the differential pressure on said piston will shift the valve 14 to the right and thus reverse the piston 3. Just before the piston 3 reaches the upper end of its stroke the reversing plate 32 engages the shoulder 35 and returns the reversing valve 25 to the full line position thereby again admitting live steam to the right of the piston 23 and causing the differential piston to shift into the position shown in the drawing thereby again reversing the high pressure steam piston 3.

This valve mechanism for reversing the high pressure steam piston is of known construction and is such as is commonly employed in certain types of steam engines.

As stated above the low pressure steam cylinder 2 takes its steam from the receiving chamber 21, for which purpose there is provided a steam passage 36 which communicates with the receiving chamber 21 and leads to a steam chest 37 in which operates a valve 38 similar to the valve 14 and which controls the admission of steam to the low pressure cylinder 2. The steam chest 37 is connected to the lower end of the low pressure steam cylinder 2 through a port 39 and is connected to the upper end of said cylinder through a port 40.

41 indicates an exhaust port through which steam is exhausted. When the valve 38 is in the position shown in the drawing the steam chest 37 has communication with the port 39 so that steam from the receiving chamber 21 will be delivered to the lower end of the low pressure steam cylinder 2, and the exhaust port 41 is connected to the port 40 through the valve port 42 so that steam is being exhausted from the upper end of said cylinder 2. When the valve 38 is shifted to the left the port 39 will be connected to the exhaust port 41 thereby allowing steam to be exhausted from the lower end of the cylinder 2 and at the same time the port 40 will be connected with the steam chest so that steam will be delivered to the upper end of said cylinder. The valve 38 is also actuated by a differential piston device similar to the differential piston 23, 24. Such differential piston comprises the large piston 43 and smaller piston 44 which are connected together and connected to the valve 38.

The actuation of the differential piston 43, 44 is controlled by a reversing valve 45 which in turn is actuated by the low pressure steam piston 4 in the same manner that the reversing valve 25 is actuated by the high pressure steam piston 3. The low pressure piston 4 has the reversing plate 46 adapted to engage shoulders 47, 48 on the stem 49 which depends from the valve 45 as the piston 4 approaches either end of its stroke.

The low pressure piston 4 is capable of movement independently of the high pressure piston 3 and as stated above one of the objects of the invention is to provide a novel construction wherein the pistons 3 and 4 will be caused to operate out of step with each other so that the reversal of each steam piston and its pump piston will take place while the other pump piston is delivering water, thereby providing for a continuous discharge of water.

In carrying out this object I provide means whereby the reversal of the low pressure steam piston 4 at one end of its stroke depends not only on the operation of the reversing valve 45 but also on the operation of the high pressure steam piston 3, so that the timing of the reversal of the low pressure steam piston is controlled by the position of the high pressure steam piston. In the drawing the low pressure steam piston 4 is shown as moving upwardly and the valve 38 is in the position to connect the port 40 with the exhaust port 41 while steam from the receiving chamber is being admitted to the lower end of the low pressure steam cylinder 2 through the port 39. The valve 38 is retained in this position by the differential pressure against the pistons 43, 44, pressure against the larger piston 43 being greater than that against the smaller piston 44.

It will be noted that the port 51 leading to the right hand end of the space in which the larger piston 43 operates is connected to an exhaust port 52 through the port 53 in the reversing valve 45.

To reverse the valve 38 requires that the port 51 should be closed and sufficient steam pressure be applied to the right hand side of the piston 43 to overcome the differential pressure on said pistons 43, 44 and force said differential piston and valve 38 toward the left. The application of such steam pressure is accomplished partly through the reversing of the position of the reversing valve 45 and partly through the operation of the high pressure steam piston 3.

Provision is made whereby the steam that supplies the pressure to the right hand side of the larger piston 43 to shift the valve 38 to the left is live steam admitted to the steam chest 50 in which the reversing valve 45 operates and the admission of the live steam to said steam chest is controlled by the operation of the high pressure steam piston 3.

When the low pressure steam piston 4 approaches the upper end of its stroke the reversing plate 46 will engage the shoulder 48 and raise the reversing valve 45. This will close the port 51 and open the inlet port 54. The raising of the reversing valve 45, however, does not of itself cause a reversal of the valve 38. To accomplish this it is necessary also to admit to the steam chest 50 and the port 54 steam under sufficient pressure to cause the differential pistons 43, 44 to move towards the left. Such admission of steam is controlled by the movement of the high pressure steam piston 3 and occurs during but before it reaches the end of its down stroke. For this purpose means are provided whereby during the downward travel of the high pressure steam piston 3 live steam will be admitted to the steam chest 50 thereby causing a reversal of the valve 38 and a consequent reversal of the low pressure steam piston 4, such reversal occuring before the high pressure steam piston has reached the lower end of its stroke.

The means provided for thus controlling the

admission of live steam to the steam chest 50 comprises a differential piston valve 55 having the two connected pistons 56, 57, the piston 56 being smaller than the piston 57 and operating in a cylindrical chamber 58, while the larger piston 57 operates in a cylindrical chamber 59. The upper end of the smaller chamber 58 is connected to the high pressure cylinder 1 through a port 60 and the lower end of the larger chamber 59 is similarly connected to the high pressure steam cylinder 1 through a port 61.

The cylindrical chamber 58 has communication with a pipe 62 through a port 64 and the other end of said pipe communicates through a port 63 with the steam chest 50.

So long as the same pressure, no matter how great, is admitted to the two cylindrical chambers 58, 59 the differential valve will be held in its raised position shown in the drawing because of the excess pressure on the larger piston 57. When the differential valve is thus in its raised position the piston 56 closes the port 64.

The port 60 is so positioned that the high pressure steam piston 3 will overrun the port during its downward stroke. When the parts are in the position shown in the drawing both ports 60 and 61 have the same pressure, this being the back pressure on the high pressure steam piston 3. As soon as the piston 3 has overrun the port 60 then the upper end of the differential valve will be subjected to the live steam pressure while the lower end of said valve will still be subjected to the back pressure. The difference in pressure between the live steam and the back pressure is sufficient to move the differential valve 55 downwardly thereby uncovering the port 64 and allowing live steam to be admitted to the steam chest 50. The admission of live steam to the steam chest 50 will cause sufficient pressure to be applied to the right hand end of the piston 43 to shift the valve 38 into the position to reverse the low pressure steam piston 4. Such reversal, therefore, will occur immediately after the high pressure piston 3 has passed the port 60 and while said piston is still moving downwardly, assuming that the low pressure steam piston 4 has reached the upper end of its stroke and raised the reversing valve 45.

After the low pressure steam piston 4 has been reversed it continues to move downwardly to the lower end of its stroke at which time it automatically pulls down the reversing valve 45 thereby bringing it into the position shown in the drawing. Such reversal of the valve 45 will bring the ports 51, 52 into communication so that steam will be exhausted from the right hand end of the piston 43 and as this occurs the differential pressure on the pistons 43, 44 will move the valve 38 to the right shifting it into the position shown in the drawing thereby causing a reversal of the low pressure steam piston. When the low pressure steam piston again reaches the upper end of its stroke it will raise the valve 45 but this will have no effect on the valve 38 until during the next downward descent of the high pressure piston 3 said piston uncovers the port 60.

Although the high pressure and low pressure pistons are not mechanically connected together yet they are maintained in their out-of-step relation by the operation of the differential valve 55, which ensures that the low pressure steam piston 4 will always be reversed before the high pressure steam piston 3 reaches the lower end of its stroke.

Another important feature of this invention is that the low pressure steam piston 4 will always make a full stroke before reversing thus obviating the possibility of short stroke operation. The reversal at the lower end of the stroke results from the pulling down of the reversing valve 45 by the downward movement of the piston 4 so that said piston 4 cannot reverse until it has shifted the position of the reversing valve 45.

In order to reverse the piston 4 at the upper end stroke it is necessary not only that the reversing valve 45 should be raised by the piston (and this can only occur when the piston 4 has completed its up stroke) but it is also necessary that the differential valve 55 should be actuated by the operation of the high pressure piston 3 overrunning the port 60. The mere overrunning of the port 60 while the reversing valve 45 is in the position shown in the drawing will not cause a reversal of the low pressure steam piston 4 unless the valve 45 is in the raised position, and in order thus to reverse the valve 45 it is necessary that the low pressure piston 4 should make its complete up stroke.

Another advantage resulting from the construction herein shown is that the pump will never become permanently stalled and will always start whenever live steam is admitted to the supply pipe 16 regardless of the positions which the pistons 3 and 4 may have when the pump stops. If, for instance, the pump stops with the high pressure steam piston 3 moving down and the low pressure steam piston 4 moving up and with the valves 14 and 38 in the position shown in the drawing. After the pump has stopped the valve 25 will gradually gravitate into its lowest position and the steam at the right hand end of the high pressure differential piston 23, 24 will either leak away or become exhausted.

The shutting off of the steam to stop the pump will, of course, cut off the pressure from the steam chest 15 and the high pressure differential piston 23, 24 with its valve 14 will thus remain in the position shown in the drawing, even after the steam has been exhausted from the space at the right hand end of the differential piston. When the pump throttle is opened to admit steam to the steam passage 17 and valve chest 15, the differential pressure on the differential high pressure piston will move it to the right thus opening the port 19 so that steam will be admitted beneath the high pressure steam piston 3 and the latter will move upwardly.

When the high pressure steam piston 3 reaches the upper end of its stroke it will reverse, as will be obvious, and during its down stroke it will exhaust into the receiving chamber 21.

The steam in the receiving chamber 21 is admitted to the lower end of the low pressure cylinder 2 so that the low pressure steam piston 4 will start in an upward direction and as soon as the two pistons begin operation they will automatically assume their out-of-step relation by the operation of the differential valve 55 as above described.

If, when the steam is shut off, the pump comes to rest with the high pressure piston 3 moving upwardly, the corresponding positions of the reversing valve 25 and valve 14 are such that when the pump throttle is opened to start the pump in operation the steam will be admitted to the cylinder 1 beneath the piston 3 so that it will continue its upward movement and as soon as suitable pressure has been built up in the re-

ceiving chamber 21 the steam pressure in the steam chest 37 acting on the differential piston 43, 44 will move the valve 38 into the position shown in the drawing so that steam will be admitted at the lower end of the low pressure cylinder 2 and the low pressure piston 4 will start in an upward direction. When the low pressure piston 4 reaches the upper end of its stroke, however, it will not reverse until the high pressure steam piston is approaching the lower end of its stroke and has moved downwardly past the port 60.

In order to prevent the building up of a pressure in the receiving chamber 21 sufficient to stall the high pressure steam piston 3, I have provided a leakage groove 65 at the upper end of the low pressure cylinder 2 which is constructed so that when the low pressure piston 4 is at the upper end of its stroke there is an opportunity for the steam beneath said low pressure piston to leak to the exhaust through said groove. If, therefore, sufficient back pressure is developed in the receiving chamber 21 to stall temporarily the high pressure steam piston before it overtravels the port 60 the leakage which occurs through the leakage groove 65 will relieve this back pressure sufficiently to prevent the high pressure piston from becoming permanently stalled.

It is desirable that the reversing valve 45 should be so made that it will not gravitate downwardly from its upper position when the steam pressure is cut off from the steam chest 50. This can be provided for in any suitable way such as employing appropriate means for applying to said valve spring pressure which will produce a sufficient frictional engagement to prevent the valve from gravitating downwardly.

I claim:

1. A compound steam pump having a high pressure steam cylinder, a high pressure double-acting piston therein, a low pressure steam cylinder, a low pressure double-acting piston therein capable of movement independently from the high pressure piston, means actuated by the low pressure steam piston to cause its reversal at one end of its stroke, and a second means controlled by the high pressure steam piston as it approaches one end of its stroke co-operating with said first-named means to cause a reversal of the low pressure piston at the other end of its stroke.

2. A compound steam pump having a high pressure steam cylinder, a high pressure piston therein, a low pressure steam cylinder, a low pressure piston therein capable of movement independently from the high pressure piston, and steam-actuated means rendered operative by the movement of the high pressure piston as it approaches but before it reaches one end of its stroke to reverse the low pressure piston at one end of its stroke.

3. A compound steam pump having a high pressure steam cylinder, a high pressure piston therein, a low pressure steam cylinder, a low pressure piston therein, a valve for reversing the low pressure piston, means rendered operative by the low pressure piston as it reaches one end of its stroke to actuate said valve, and means rendered operative jointly by the low pressure piston when it reaches the other end of its stroke and by the movement of the high pressure piston before it reaches the end of its stroke to operate said valve.

4. A compound steam pump having a high pressure steam cylinder, a high pressure piston therein, a low pressure steam cylinder, a low pressure steam piston therein, a steam valve controlling the admission of steam to and the exhaust from the low pressure cylinder, a differential piston for operating the steam valve, a reversing valve for controlling movement of the differential position, a valve chest in which said reversing valve operates, means to reverse said valve by the movement of the low pressure piston, and means controlled by the movement of the high pressure piston to admit to the valve chest steam under pressure to actuate the differential piston after the reversing valve has been reversed.

5. A compound steam pump having a high pressure steam cylinder, a high pressure piston therein, a low pressure steam cylinder, a low pressure steam piston therein, a receiving chamber to receive the exhaust from the high pressure cylinder and from which steam is supplied to the low pressure cylinder, a steam valve for controlling the admission of steam to and exhaust from the low pressure cylinder, a differential piston for operating said valve, said piston being subjected continuously to the pressure in the receiving chamber, and means rendered operative by the movement of the high pressure piston in one direction to subject said differential valve to the action of live steam thereby reversing the steam valve.

6. A compond steam pump having a high pressure steam cylinder, a high pressure piston therein, a low pressure steam cylinder, a low pressure steam piston therein capable of movement independently from the high pressure piston, means actuated by the low pressure piston to cause a reversal at one end of its stroke, and a second means subject to opposing pressures on opposite sides of the high pressure piston co-operating with said first-named means to cause a reversal of the low pressure piston at the other end of its stroke.

7. A compound steam pump having a high pressure steam cylinder, a high pressure piston therein, a low pressure steam cylinder, a low pressure steam piston therein capable of movement independently from the high pressure piston, and means independent of what ever back pressure may be acting on the high pressure piston co-operating with means actuated by the low pressure piston itself to cause a reversal of the low pressure piston at one end of its stroke.

8. A compound steam pump having a high pressure steam cylinder, a high pressure piston therein, a low pressure steam cylinder, a low pressure steam piston therein, a valve for reversing the low pressure piston, valve-operating means rendered operative jointly by the low pressure piston when it reaches the end of its stroke and by the movement of the high pressure piston before it reaches the end of its stroke.

9. A compound steam pump having a high pressure steam cylinder, a high pressure piston therein, a low pressure steam cylinder, a low pressure steam piston therein, a valve for revessing the low pressure piston, and means independent of whatever back pressure may be acting on the high pressure piston and co-operating with means actuated by the low pressure piston itself to actuate said valve.

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