Dec. 2, 1941. R. L. FOSTER 2,264,518

VALVE OPERATING MEANS FOR DUPLEX DOUBLE-ACTING STEAM PUMPS

Filed Jan. 24, 1941 4 Sheets-Sheet 1

Fig. 1

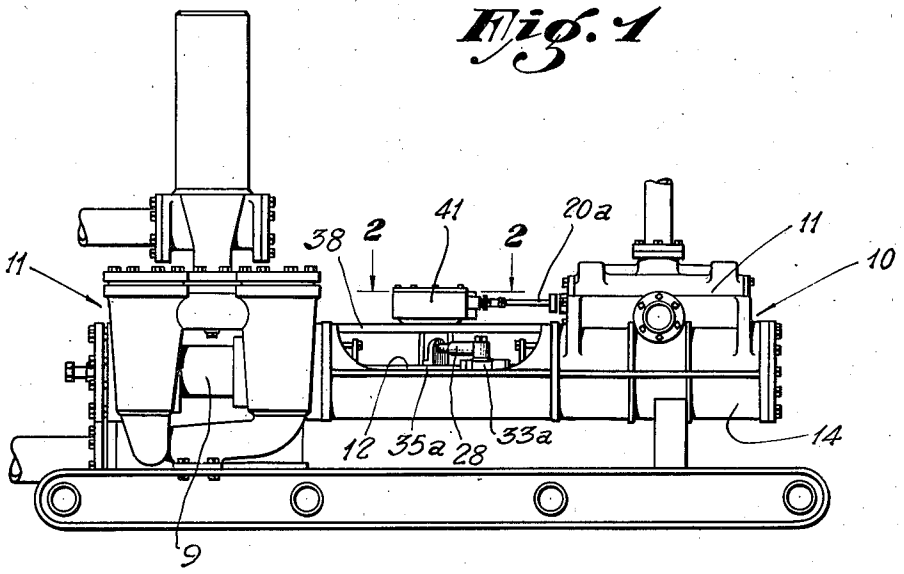


Fig. 4

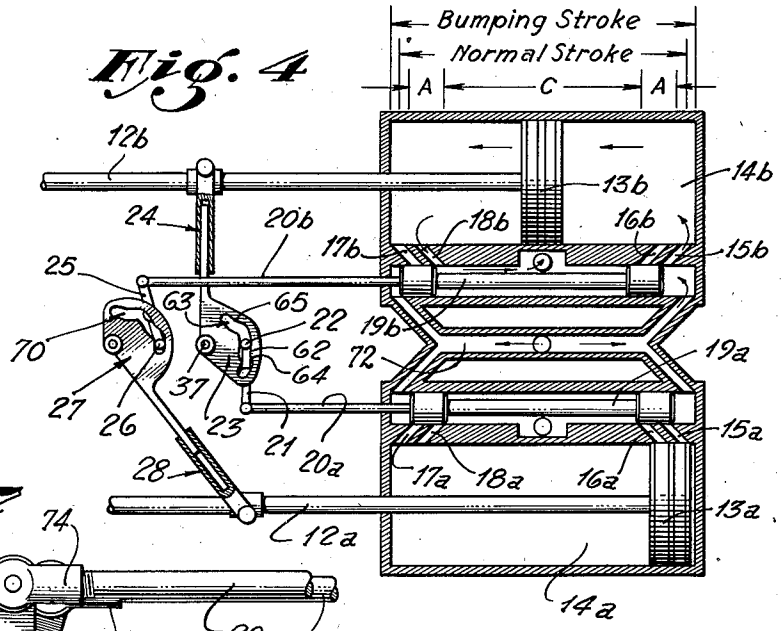
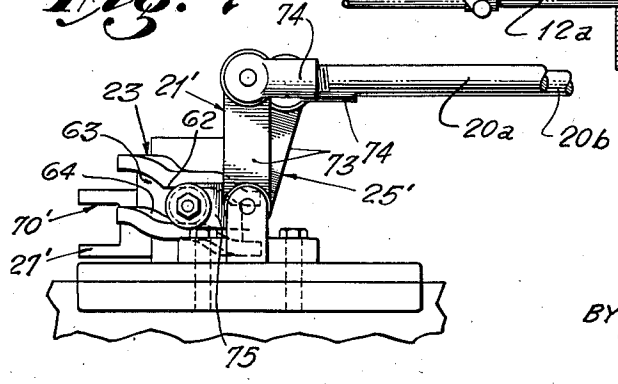


Fig. 7



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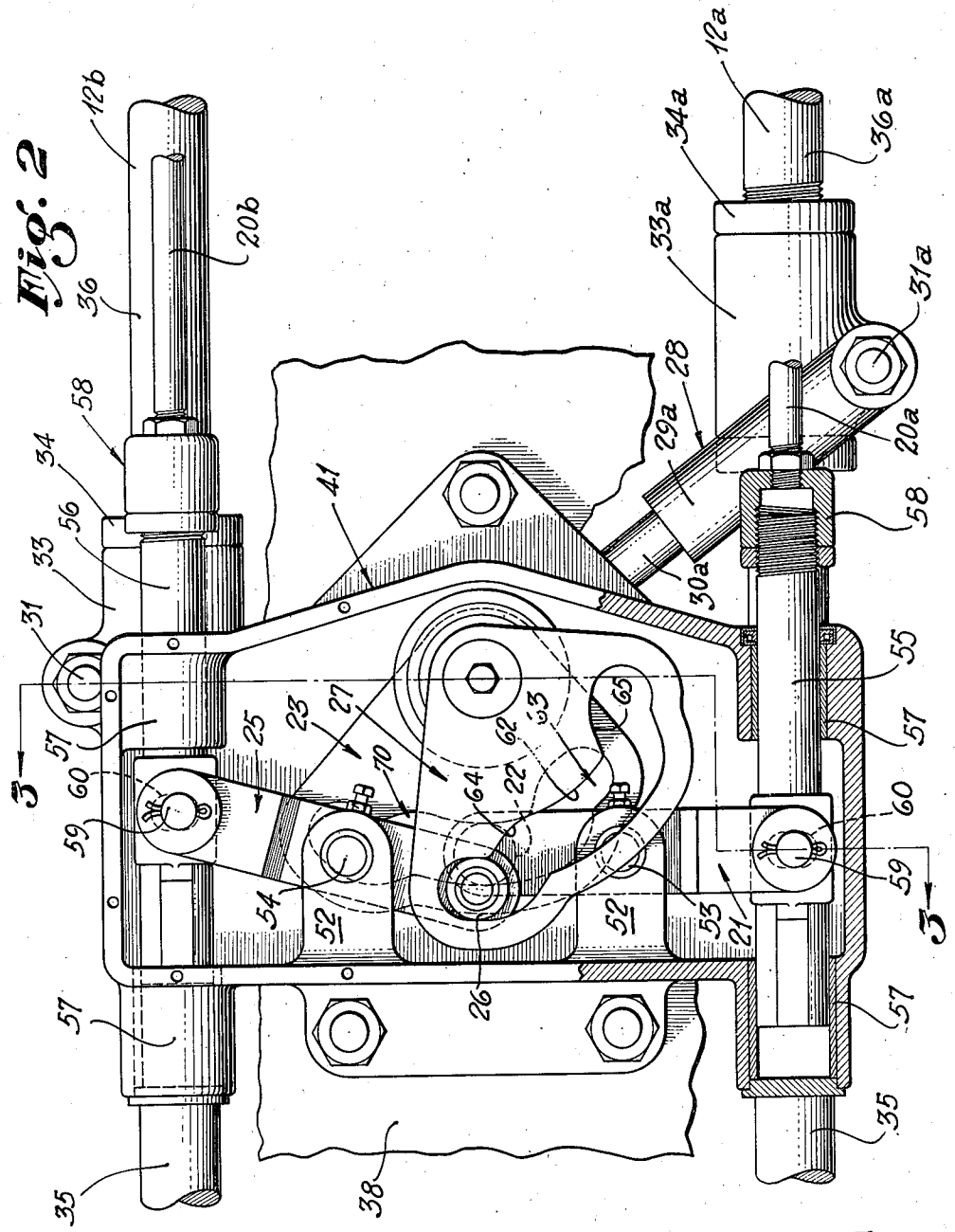
BY [signature]
ATTORNEY.

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VALVE OPERATING MEANS FOR DUPLEX DOUBLE-ACTING STEAM PUMPS

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Fig. 2



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VALVE OPERATING MEANS FOR DUPLEX DOUBLE-ACTING STEAM PUMPS

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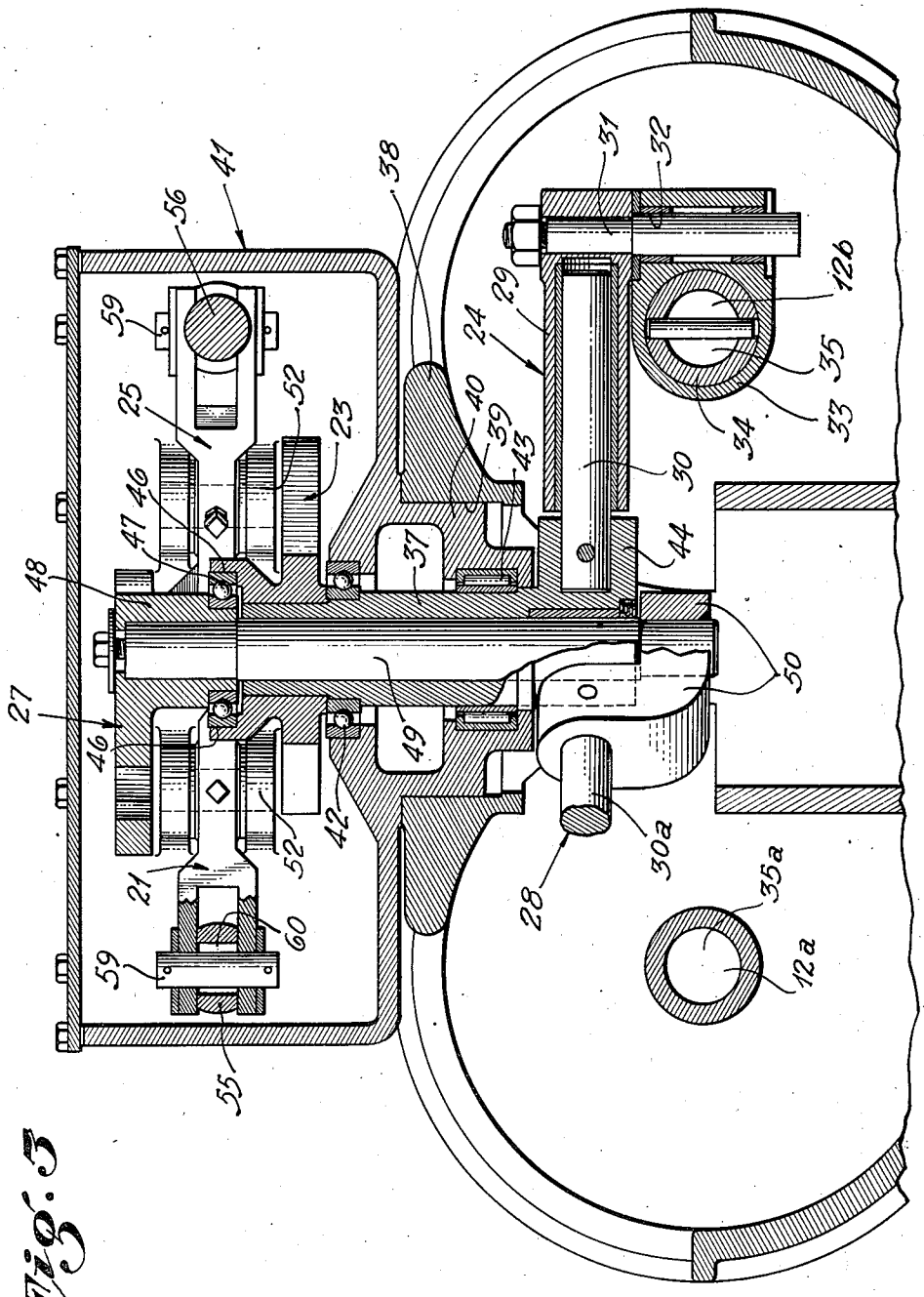


Fig. 5

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VALVE OPERATING MEANS FOR DUPLEX DOUBLE-ACTING STEAM PUMPS

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Fig. 5

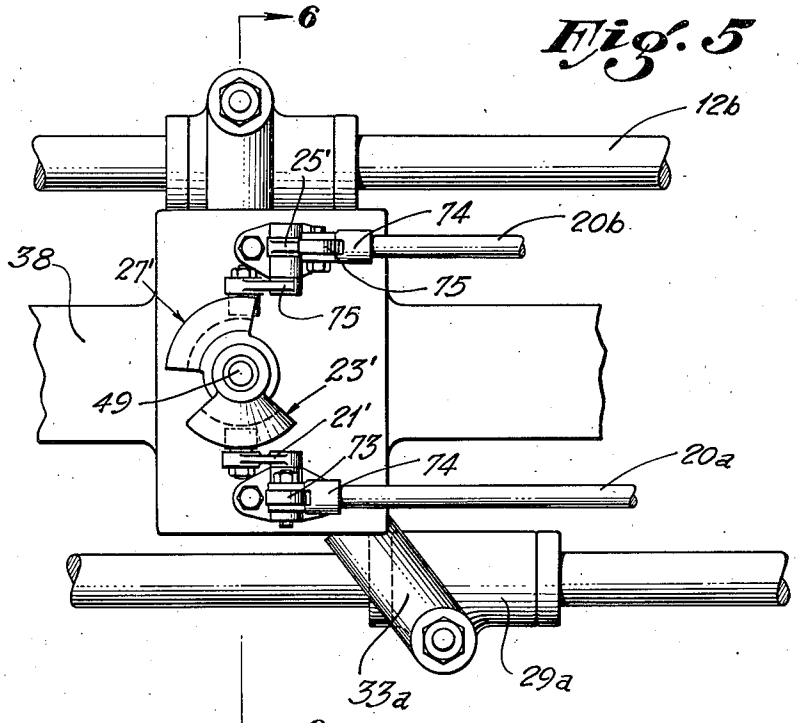
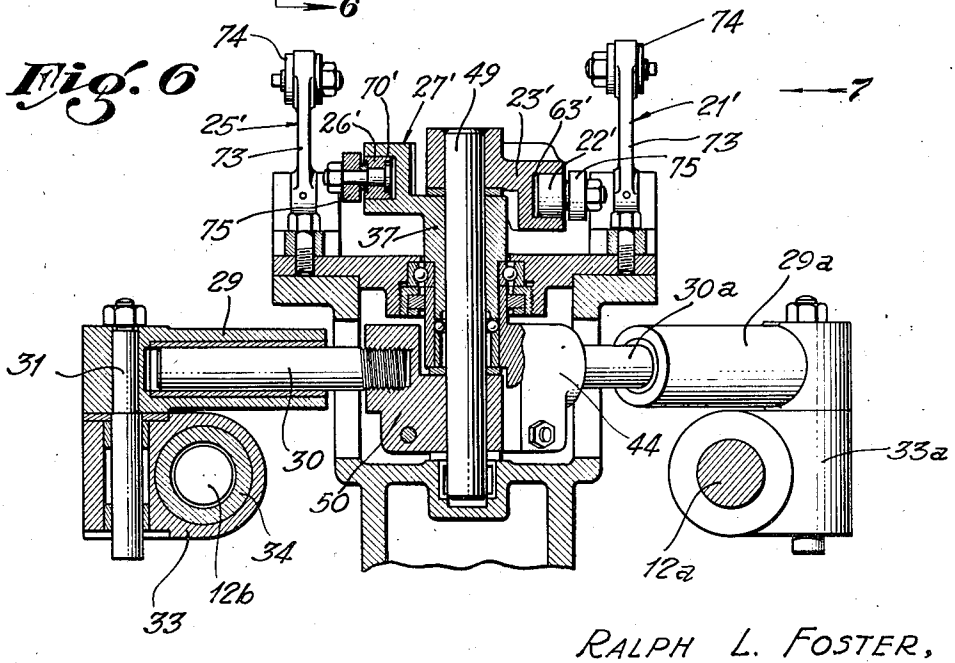


Fig. 6



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UNITED STATES PATENT OFFICE

2,264,518

VALVE OPERATING MEANS FOR DUPLEX DOUBLE-ACTING STEAM PUMPS

Ralph L. Foster, Houston, Tex., assignor to Emsco Derrick & Equipment Company, Los Angeles, Calif., a corporation of California

Application January 24, 1941, Serial No. 375,758

9 Claims. (Cl. 121—114)

My present invention relates to an improvement in valve operating means for duplex double-acting steam pump whereby increased operating efficiency is attained by reducing the steam consumption of such pump.

It is an object of the invention to provide for a duplex double-acting steam pump a valve gear which will control the delivery of steam to the ends of the cylinders of the steam pump in such a manner that a number of improved results are accomplished. It is an object of the invention to produce in a steam pump of the character described such timing of the steam inlet and steam cut-off as to increase the efficiency of the pump, to minimize short stroking, and to avoid over stroking of the pistons which results in the pistons' bumping the cylinder heads, these results being accomplished without the use of auxiliary ports in the ends of the cylinders, the result being that short stroking and over stroking of the piston are substantially effected without steam losses which result from the use of auxiliary ports.

It is an object of the invention to provide a valve gear for a steam pump of the character described wherein the character of the flow of steam is such that inefficiency resulting from the expansion of steam through a relatively small orifice into a relatively large chamber is avoided.

A further object of the invention is to minimize loss of efficiency due to condensation of steam in the steam cylinders of the pump by reducing to a minimum the pause or inactive period of each piston at the ends of its stroke. Pumps operating by use of the standard linkage inherently developed a piston pause at each end of the stroke, this pause being sufficient to allow the opposite piston to arrive at a point in a stroke approximately five eighths ahead of a stroke of a stationary piston. The actual pause amounts to the time it takes for a piston to travel one quarter of its stroke, and this pause occurs at each end of the stroke for each piston. During this cycle of pauses, or inaction, a full head of steam is back of the piston, forcing the piston against the end trapped steam cushion. At this time the steam is producing no useful work and condensation occurs in the cylinder, this condensation being made up by steam from the boiler so that there is a use of steam without performance of useful work. With the present valve gear, a rapid valve action is achieved and all of the ports are simultaneously closed as the steam piston reaches the end of its stroke. Also the pump piston consistently makes a full stroke, since the steam cushion at the end of the stroke is at a minimum and is only retained for protection and not for the purpose of stopping the piston while in normal operation.

Further objects and advantages of the invention will be brought out in the following part of the specification.

Referring to the drawings, which are for illustrative purposes only:

Fig. 1 is a side elevation of a steam pump having a preferred embodiment of my invention.

Fig. 2 is an enlarged fragmentary plan view, looking down from the plane 2—2, of Fig. 1, showing the cover of the cam housing removed so that the cams are brought to view.

Fig. 3 is a cross section taken as indicated by the line 3—3 of Fig. 2.

Fig. 4 is a schematic view showing the steam cylinders, steam valves, and valve gear, for explanation of the operation thereof.

Fig. 5 is a fragmentary plan view of the intermediate section of the pump disclosed in Fig. 1, with an alternative form of my valve gear in operative position.

Fig. 6 is a cross section taken as indicated by the line 6—6 of Fig. 5.

Fig. 7 is an elevational view to reduced scale taken as indicated by the arrow 7 in Fig. 6.

The steam pump shown in Fig. 1 comprises a power end 10 and a pump end 11 arranged in the customary manner employed in duplex double-acting steam pumps, wherein a pair of double-acting pumps 9 are disposed in side by side relation and are operated through the use of piston rods 12 respectively indicated as 12*a* and 12*b*, which are connected to pistons respectively designated as pistons 13*a* and 13*b*. These pistons operate in cylinders 14, respectively indicated as 14*a* and 14*b*, of the double-acting type. At the rightward end of the cylinder 14*a* there is an inlet port 15*a* and an exhaust port 16*a*, and at the rightward end of the cylinder 14*b* there is an inlet port 15*b* and an exhaust port 16*b*. In a like manner, the leftward ends of the cylinders 14*a* and 14*b* have inlet ports 17*a* and 17*b* and exhaust ports 18*a* and 18*b*. These ports are controlled by piston valves 19*a* and 19*b* as will be hereinafter described, there being valve operating rods 20*a* and 20*b* extending from the valve members 19*a* and 19*b* as shown in Fig. 4.

The valve rod 20*a* is connected to one end of a lever 21, having a follower 22 which engages a cam 23 having a lever means 24 engaging the piston rod 12*b*, whereby movement of the valve 19*a* is accomplished by movement of the piston 13*b* through the cam 23 and the follower 22. The valve rod 20*b* is connected to a fulcrum lever 25,

having on the other end thereof a follower 26 which engages a cam 27 adapted to be swung through lever means 28 having connection with the piston rod 12a. Accordingly, movement of the valve 19b is accomplished by movement of the piston 13a through the cam 27 and the follower 26.

As shown in the Fig. 3, the lever means 24 associated with the cam 23, may be made telescopic in character and include a sleeve 29 in which a rod 30 is slidable. The outer end of the sleeve 29 carries a vertical pin 31 which projects downwardly into an opening 32 formed in a sleeve 33, which is rotatable on a sleeve 34 which forms a part of the piston rod 12b. In ordinary practice, the sleeve 34 is threaded so that the rod sections 35 and 36 screw thereinto. In the form of the invention shown in Figs. 1 to 4 inclusive, the lever means 24 swings in a horizontal plane around a vertical axis defined by a hollow shaft 37, as the piston rod 12b reciprocates. The bridge 38 between the power end 10 and the pump end 11 of the steam pump has a vertical bore 39 to receive a downwardly projecting boss 40 on the lower wall of a cam housing 41. This boss 40 carries bearings 42 and 43 which support the hollow shaft 37. The hollow shaft 37 has, at the lower end thereof, a laterally projecting boss 44 to receive an end of the rod 30, whereby the rod 30 is connected to the sleeve 37 so as to impart oscillation thereto. The cam 23, which is secured to the upper end of the hollow shaft 37, has a counterbore 46 to receive a bearing 47 which in turn supports the lower portion of a boss 48 which projects downward from the cam 27. From the boss 48 of the cam 27 a vertical shaft 49 extends downward through the hollow shaft 37, and has on the lower end thereof a bracket 50 to which is connected the rod 30a of the lever means 28 associated with the cam 27. The lever means 28 is connected to the connecting rod 12a, and includes parts which are identical to the parts described relative to the lever means 24, such parts being designated by the same numeral with the letter a affixed thereto.

The cams 23 and 27 are disposed within the cam housing 41 which has projecting brackets 52 carrying vertical pins 53 and 54 on which the levers 21 and 25 are respectively fulcrumed. At the opposite sides of the cam housing 41 slide rods 55 and 56 are mounted in horizontal guides 57. The slide bars 55 and 56 have threaded attachment means 58 at the rightward end thereof for connection to the valve rods 20a and 20b, to the ends of the levers 21 and 25 which carry pins 59 to engage lateral slots 60 in the slide bars 55 and 56.

It will be noted that when either valve 19, as illustrated by valve 19a in Fig. 4, is in intermediate position, all of the ports, 15a, 16a, 17a and 18a will be closed. At this time the cam follower 22 will be in the intermediate section 62 of the cam slot 63 of the cam 23. This intermediate or middle section of the slot 63 is formed concentric to the axis of the shaft 37 on which the cam 23 oscillates. Also, the length of the middle section 62 of the cam slot 63 is at least one half the total effective length of the slot 63, and at the ends of the middle section 62, the slot has end sections 64 and 65 arranged to move the follower 22 in opposite directions so that the valve 19a will be moved in opposite direction from the intermediate position thereof shown in Fig. 4. The slot 70 in the cam 27 is formed in a manner similar to the formation of the slot 63 of cam 23. In the upper right hand corner of Fig. 4 I have indicated the bumping stroke and the normal stroke of the pistons, and likewise have indicated the length of stroke C during which the valve associated with the opposite cylinder will remain closed, and by the letters A the active periods during which valve action will take place. The valve 19b is shown in a position to open an inlet port 15b which is connected with the steam inlet passages 72 of the pump, and to open the exhaust port 18b on the opposite side of the piston 13b, the result being that the piston 13b is in movement toward the left end of the cylinder 14b. The cam slot 63 is so formed that when the piston 13b reaches the leftward extremity of the dimension C, the end portion 64 of the cam slot 63 will actuate the valve 19a in leftward direction so as to open the inlet port 15a and the exhaust port 18a, with the result that steam will be fed into the rightward end of the cylinder 14a and leftward movement of the piston 13a will be started as the piston 13b is completing its movement in leftward direction. As the piston 13b reaches the end of its normal stroke in leftward direction, the leftward movement of the piston 13a will be such as to move the cam 27 through such distance that the middle section of the cam slot 70 thereof will be brought into engagement with the follower 26 and the valve 19b will be moved into intermediate position, thereby closing all of the ports associated with the cylinder 14b, and the action of the middle section of the cam slot 70 will be to maintain the valve 19b in closed position until the piston 13a reaches a point relatively near to the leftward end of its travel, whereupon there will be a rapid movement of the valve 19b in rightward direction to open the inlet port 17b and the exhaust port 16b. The piston 13a may be referred to as the left hand piston and the piston 13b may be referred to as the right hand piston. It will be noted that the movement of one piston controls the movement of the opposite hand valve. For example, movement of piston 13a, referred to as the left hand piston, controls the movement of the right hand valve 19b, and therefore the feeding of steam into the ends of the right hand cylinder 14b is controlled by the movement of the left hand piston 13a.

In Figs. 5 and 6, I show an alternative form of the invention to indicate the manner in which different types of cam actions may be employed. In these Figs. 5 and 6, many of the parts described relative to Figs. 2 and 3 are shown, and accordingly those parts in Figs. 5 and 6 having similar function to parts shown in Figs. 2 and 3 have had applied thereto numerals previously employed to indicate the same. In these Figs. 5 and 6 I show cams 23' and 27' respectively connected to the shaft members 49 and 37 so as to operate therewith in response to reciprocation of the connecting rods 12b and 12a. These cams have peripheral cam slots 63' and 70' which produce movement of cam followers 22' and 26' in the general direction of the axes of the shaft members 49 and 37 instead of radially with respect thereto. Lever means 21' and 25', in this form of the invention, consist of bell cranks, each having, as shown in Fig. 7, an upright arm 73 connected either to a valve rod 20a or 20b by means of a clevis 74, and having a laterally extending lever or arm 75 to carry a cam follower 22' or 26'.

In Figs. 5 and 6 the connection of the parts may be traced whereby it will be perceived that

movement of the piston rod 12a will result in oscillation of the cam 27', whereby such cam 27' will transmit movement through the bell crank 25' to the valve rod 20b, whereby movement of the piston associated with the connecting rod 12a will control the inlet and exhaust of steam from the opposite hand cylinder. Likewise, it will be perceived that movement of the connecting rod 12b will result in oscillation of the cam 23' to determine the movement of the valve rod 20a. The cam slots 63' and 70' have intermediate and end sections 62, 64 and 65, illustrated in the elevational view of cam 23' in Fig. 7, to produce the control and timing of the valve action previously discussed herein.

I claim as my invention:

1. In a duplex double acting steam pump of the character described, having a right hand and a left hand power cylinder, pistons in said cylinders with piston rods extending therefrom, and right hand and left hand inlet and outlet valve means for the ends of said cylinders, the combination of: a cam connected to the right hand piston rod so as to move back and forth as said right hand piston moves; a cam follower engaging said cam; means operatively connecting said cam follower to the valve means for the left hand cylinder; a second cam connected to the left hand piston rod so as to move back and forth as said left hand piston is moved back and forth; a second follower engaging said second cam; and means for connecting said second follower to said right hand valve means.

2. In a duplex double acting steam pump of the character described, having a right hand and a left hand power cylinder, pistons in said cylinders with piston rods extending therefrom, and right hand and left hand inlet and outlet valve means for the ends of said cylinders, the combination of: a cam connected to the right hand piston rod so as to move back and forth as said right hand piston moves; a cam follower engaging said cam; means operatively connecting said cam follower to the valve means for the left hand cylinder; a second cam connected to the left hand piston rod so as to move back and forth as said left hand piston is moved back and forth; a second follower engaging said second cam; and means for connecting said second follower to said right hand valve means, said cams being so formed that said valves will be respectively opened and closed near the end of the stroke of the piston associated therewith, and so that both the inlet and outlet valve of each cylinder will be held closed during movement of the opposite hand piston from a point near one end of its stroke to a point near the other end of its stroke.

3. In a duplex double acting steam pump of the character described, having a right hand and a left hand power cylinder, pistons in said cylinders with piston rods extending therefrom, and right hand and left hand inlet and outlet valve means for the ends of said cylinders, the combination of: a cam connected to the right hand piston rod so as to move back and forth as said right hand piston moves; a cam follower engaging said cam; means operatively connecting said cam follower to the valve means for the left hand cylinder; a second cam connected to the left hand piston rod so as to move back and forth; a second follower engaging said second cam; and means for connecting said second follower to said right hand valve means, each of said cams having a middle section so formed that the valve at both ends of the cylinder controlled thereby will be maintained closed when the follower asscociated therewith is in engagement with said middle section, and each of said cams having end sections at the ends of said middle section formed so as to produce, by engagement with its associated follower, action of the valves consisting of the opening of an inlet valve at one end of the cylinder and the opening of an outlet valve at the other end of the cylinder.

4. In a duplex double acting steam pump of the character described, having a right hand and a left hand power cylinder, pistons in said cylinders with piston rods extending therefrom, and right hand and left hand inlet and outlet valve means for the ends of said cylinders, the combination of: a cam connected to the right hand piston rod so as to move back and forth as said right hand piston moves; a cam follower engaging said cam; means operatively connecting said cam follower to the valve means for the left hand cylinder; a second cam connected to the left hand piston rod so as to move back and forth; a second follower engaging said second cam; and means for connecting said second follower to said right hand valve means, each of said cams having a middle section so formed that the valve at both ends of the cylinder controlled thereby will be maintained closed when the follower associated therewith is in engagement with said middle section, and each of said cams haivng end sections at the ends of said middle section formed so as to produce, by engagement with its associated follower, action of the valves consisting of the opening of an inlet valve at one end of the cylinder and the opening of an outlet valve at the other end of the cylinder, said middle section having a length at least as great as one half the total effective length of the cam.

5. In a duplex double acting steam pump of the character described, having a right hand cylinder and a left hand cylinder, right hand and left hand pistons respectively in said cylinders with rods extending therefrom, right hand and left hand valve means respectively for said cylinders, said valve means each comprising an inlet and an exhaust valve for each end of its associated cylinder, the combination of: a first shaft and a second shaft, each supported for rotative movement on said pump; a first lever means connecting said first shaft and the rod of said right hand piston for like movement; a second lever means connecting said second shaft to said rod of said left hand piston for like movement; a first cam connected to said first shaft so as to be moved back and forth thereby; a follower operatively connecting said cam and said left hand valve means; a second cam connected to said second shaft so as to be moved back and forth thereby; and a follower operatively connecting said second cam and said right hand valve means, said cams each having a middle section and end sections, said middle sections being so formed as to hold the valve means connected thereto in intermediate position wherein the inlet and exhaust valves at both ends of the associated cylinder will be closed, and said end sections being so formed as to relatively quickly actuate the valve means associated therewith so as to open an inlet valve and an exhaust valve at opposite ends of the associated cylinder.

6. In a duplex double acting steam pump of the character described, having a right hand cyl-

inder and a left hand cylinder, right hand and left hand pistons respectively in said cylinders with rods extending therefrom, right hand and left hand valve means respectively for said cylinders, said valve means each comprising an inlet and an exhaust valve for each end of its associated cylinder, the combination of: a first shaft and a second shaft, each supported for rotative movement on said pump; a first lever means connecting said first shaft and the rod of said right hand piston so that it will be oscillated back and forth in keeping with the back and forth movement of the right hand piston; a second lever means connecting said second shaft to said rod of said left hand piston so that it will oscillate back and forth in keeping with the back and forth movement of the said left hand piston; a first cam connected to said first shaft so as to be oscillated back and forth thereby; a follower operatively connecting said cam and said left hand valve means; a second cam connected to said second shaft so as to be oscillated back and forth thereby; and a follower operatively connecting said second cam and said right hand valve means, said cams each having a middle section and end sections, said middle sections being so formed as to hold the valve means connected thereto in intermediate position wherein the inlet and exhaust valves at both ends of the associated cylinder will be closed, and said end sections being so formed as to relatively quickly actuate the valve means associated therewith so as to open an inlet valve and an exhaust valve at opposite ends of the associated cylinder.

7. In a duplex double acting steam pump of the character described, having a right hand cylinder and a left hand cylinder, right hand and left hand pistons respectively in said cylinders with rods extending therefrom, right hand and left hand valve means respectively for said cylinders, said valve means each comprising an inlet and an exhaust valve for each end of its associated cylinder, the combination of: a first shaft and a second shaft, each supported for rotative movement on said pump; a first lever means connecting said first shaft and the rod of said right hand piston for like movement; a second lever means connecting said second shaft to said rod of said left hand piston for like movement; a first cam connected to said first shaft so as to be moved back and forth thereby; a follower operatively connecting said cam and said left hand valve means; a second cam connected to said second shaft so as to be moved back and forth thereby; and a follower operatively connecting said second cam and said right hand valve means, said cams each having a middle section and end sections, said middle sections being so formed as to hold the valve means connected thereto in intermediate position wherein the inlet and exhaust valves at both ends of the associated cylinder will be closed, and said end sections being so formed as to relatively quickly actuate the valve means associated therewith so as to open an inlet valve and an exhaust valve at opposite ends of the associated cylinder, said middle section of each cam being at least one half the total effective length of the cam.

8. In a duplex double acting steam pump of the character described, having a right hand cylinder and a left hand cylinder, right hand and left hand pistons respectively in said cylinders with rods extending therefrom, right hand and left hand valve means respectively for said cylinders, said valve means each comprising an inlet and an exhaust valve for each end of its associated cylinder, the combination of: a first shaft and a second shaft, each supported for rotative movement on said pump; a first lever means connecting said first shaft and the rod of said right hand piston so that it will be oscillated back and forth in keeping with the back and forth movement of the right hand piston; a second lever means connecting said second shaft to said rod of said left hand piston so that it will oscillate back and forth in keeping with the back and forth movement of the said left hand piston; a first cam connected to said first shaft so as to be oscillated back and forth thereby; a follower operatively connecting said cam and said left hand valve means; a second cam connected to said second shaft so as to be oscillated back and forth thereby; and a follower operatively connecting said second cam and said right hand valve means, said cams each having a middle section and end sections, said middle sections being so formed as to hold the valve means connected thereto in intermediate position wherein the inlet and exhaust valves at both ends of the associated cylinder will be closed, and said end sections being so formed as to relatively quickly actuate the valve means associated therewith so as to open an inlet valve and an exhaust valve at opposite ends of the associated cylinder, said middle section of each cam having an arcuate length of at least one half of the total arcuate length of the cam.

9. In a duplex double acting steam pump of the character described, having a right hand cylinder and a left hand cylinder, right hand and left hand pistons respectively in said cylinders with rods extending therefrom, right hand and left hand valve means respectively for said cylinders, said valve means each comprising an inlet and an exhaust valve for each end of its associated cylinder, the combination of: a first shaft and a second shaft, each supported for rotative movement on said pump; a first lever means connecting said first shaft and the rod of said right hand piston so that it will be oscillated back and forth in keeping with the back and forth movement of the right hand piston; a second lever means connecting said second shaft to said rod of said left hand piston so that it will oscillate back and forth in keeping with the back and forth movement of the said left hand piston; a first cam connected to said first shaft so as to be oscillated back and forth thereby; a follower operatively connecting said cam and said left hand valve means; a second cam connected to said second shaft so as to be oscillated back and forth thereby; and a follower operatively connecting said second cam and said right hand valve means, said cams each having a middle section and end sections, said cams having sections at the ends so formed as to cause movement of said valve means in opposite directions.

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