No. 824,142. PATENTED JUNE 26, 1906.

S. A. REEVE.

AUTOMATIC BOILER PUMP.

APPLICATION FILED FEB. 15, 1905.

4 SHEETS—SHEET 1.

Fig. 1

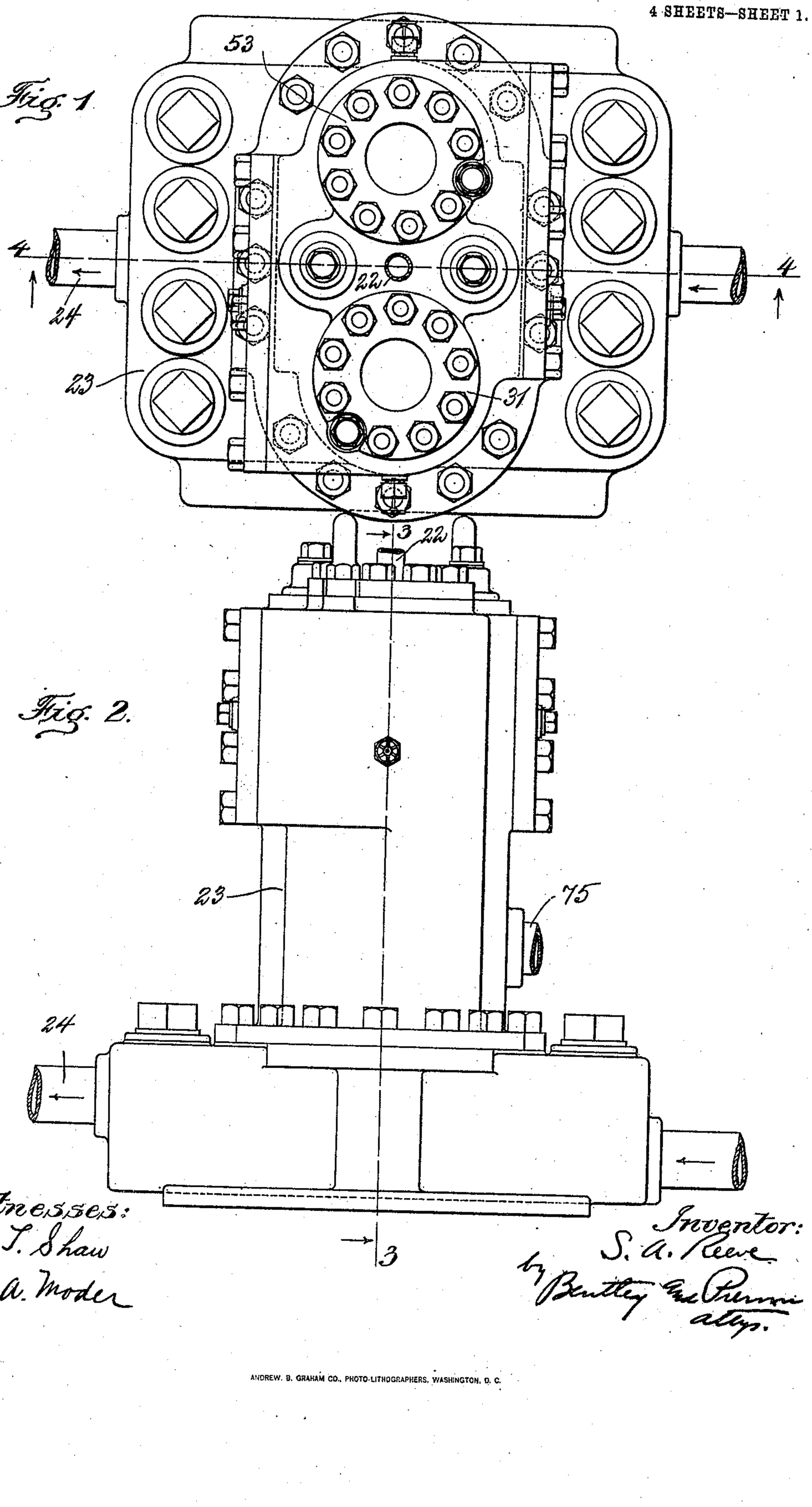

Fig. 2.

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4 SHEETS—SHEET 2.

Fig. 3.

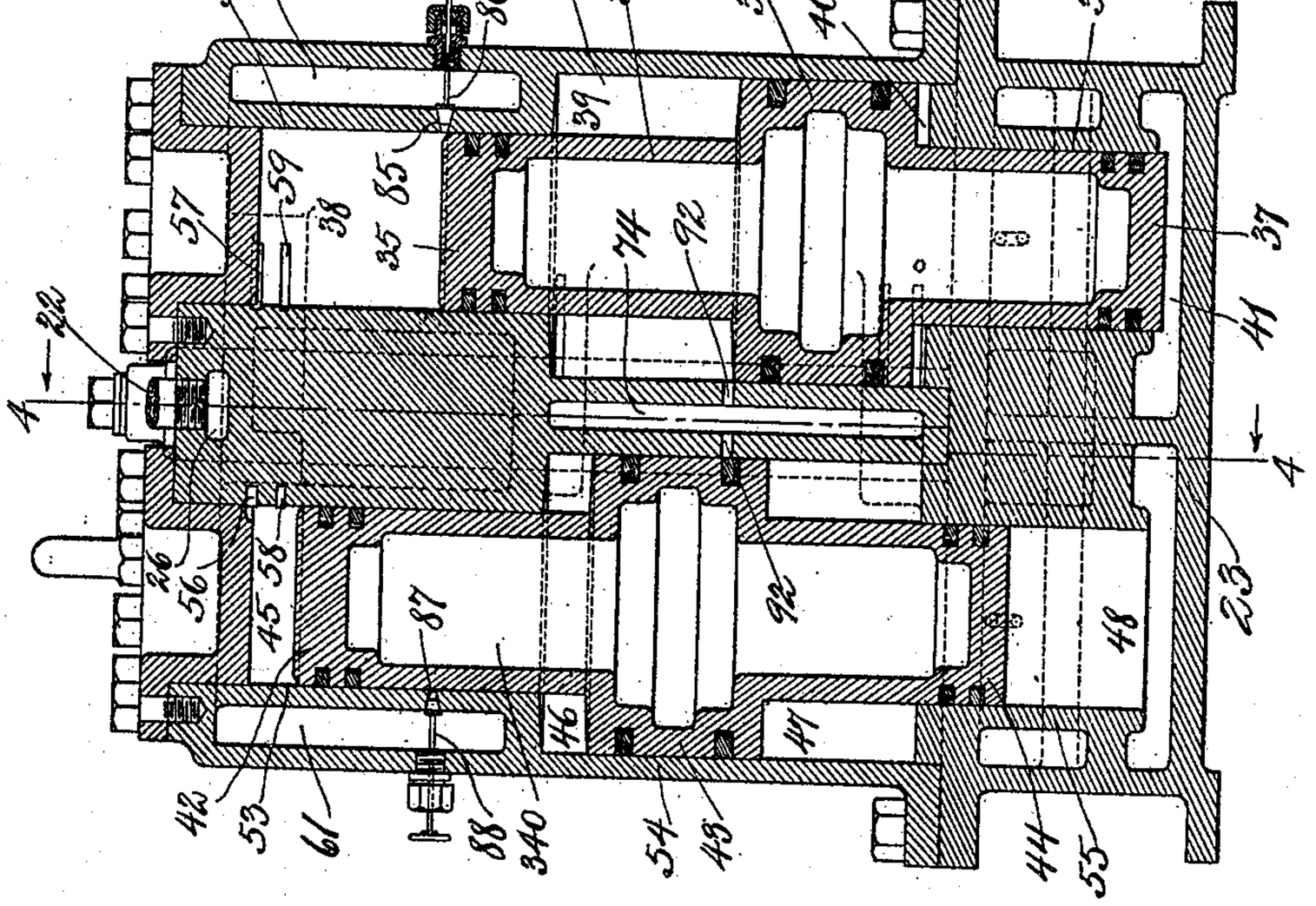
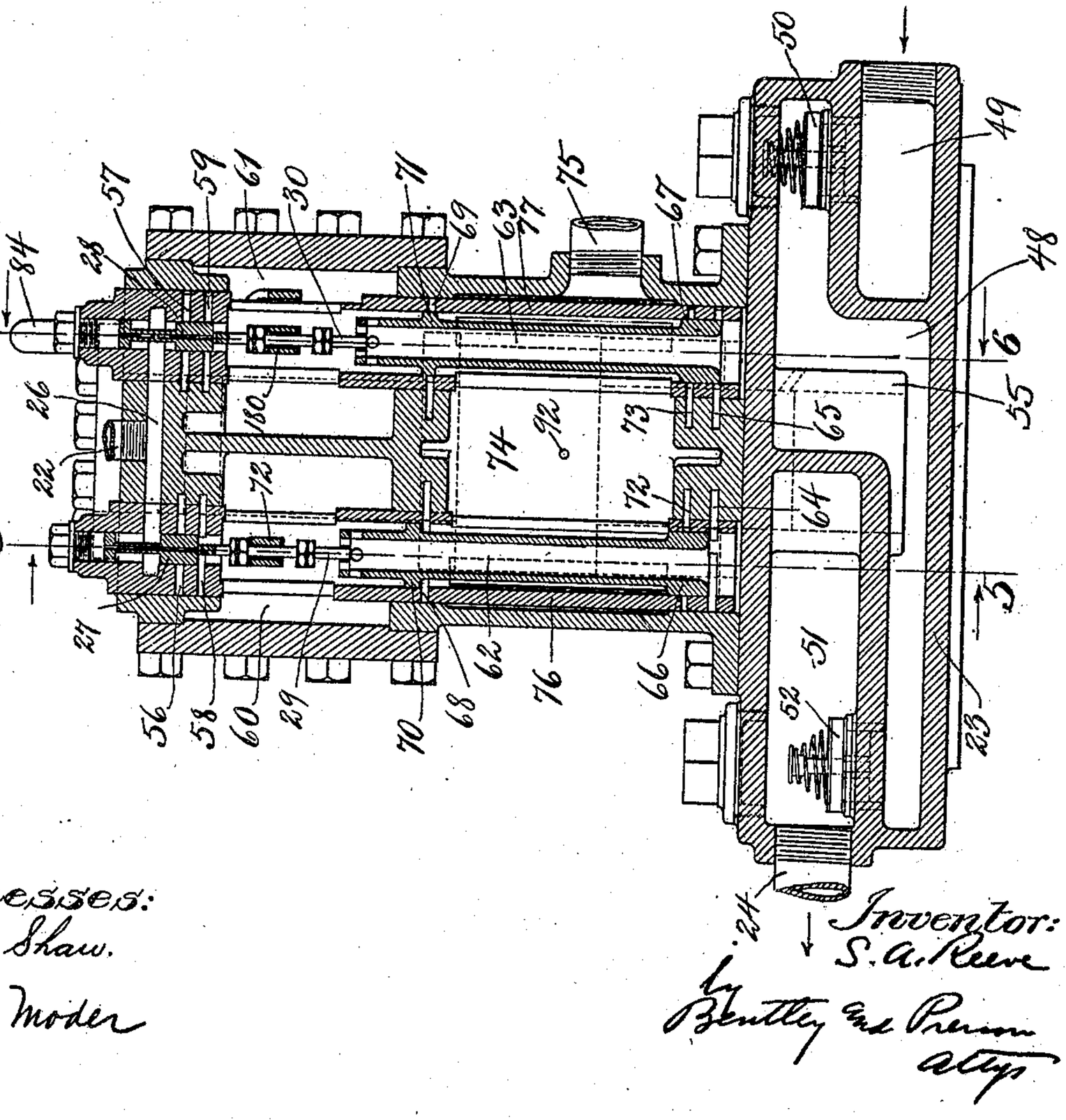


Fig. 4.



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4 SHEETS—SHEET 3.

Fig. 5.

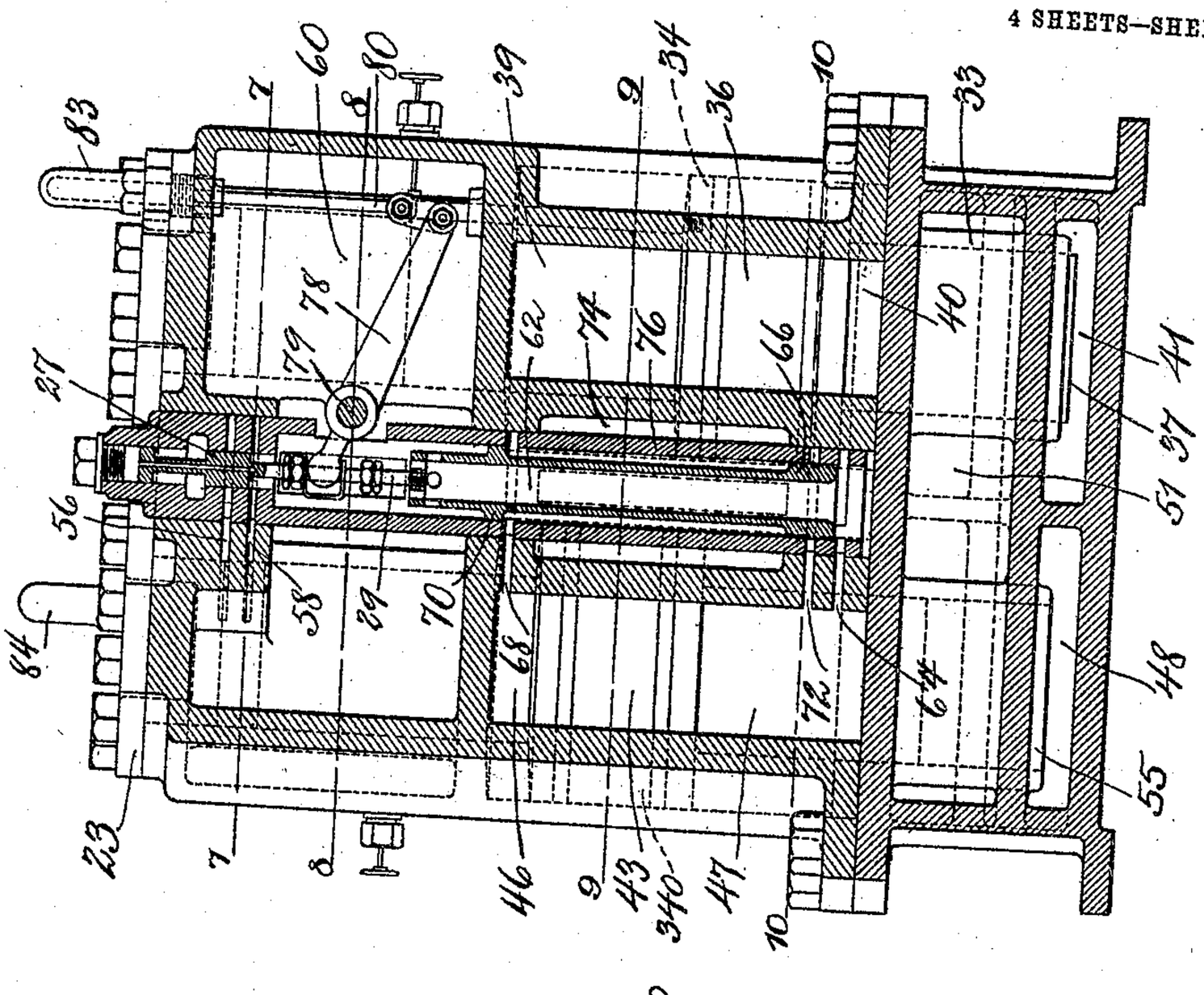
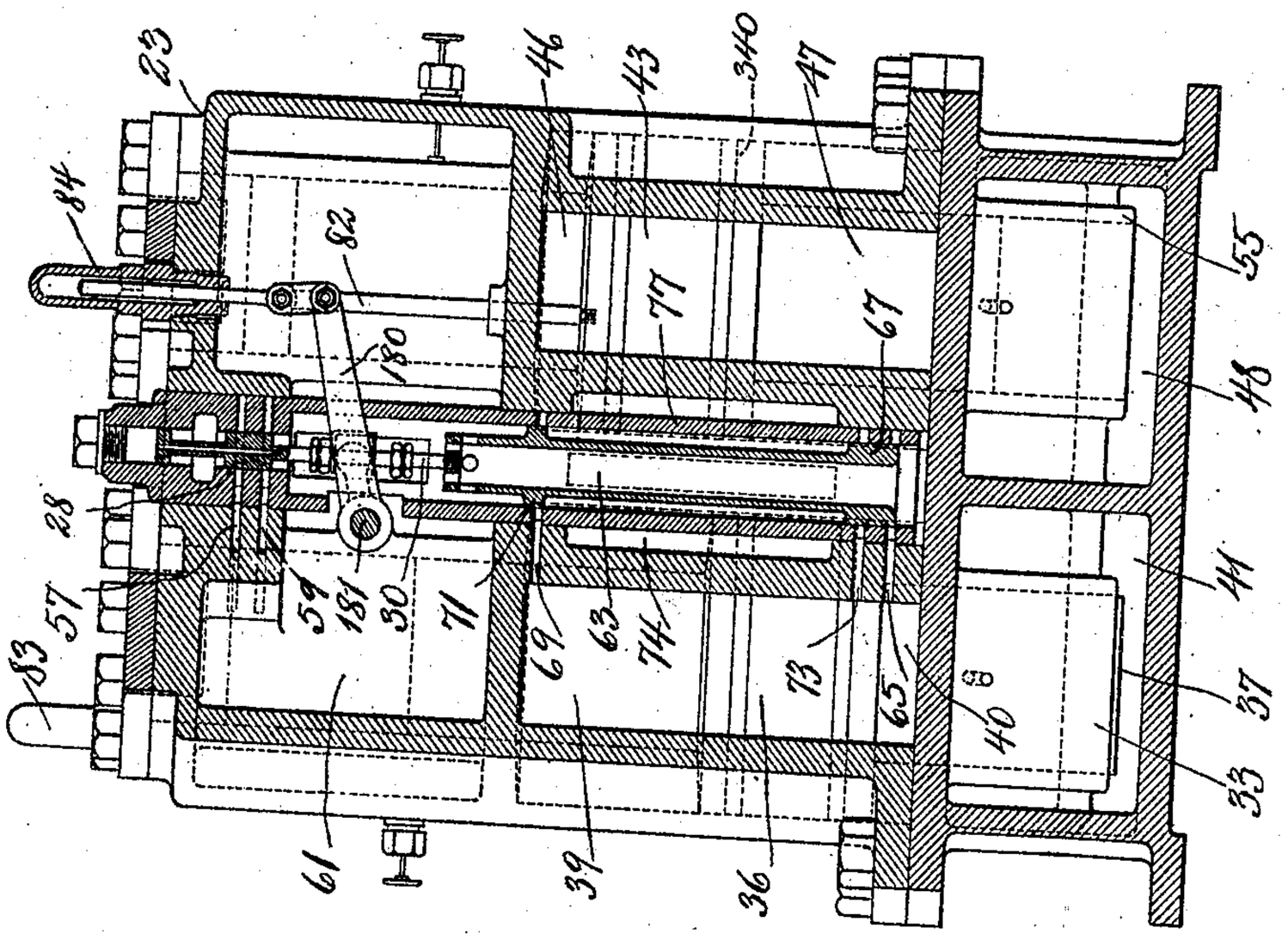


Fig. 6.



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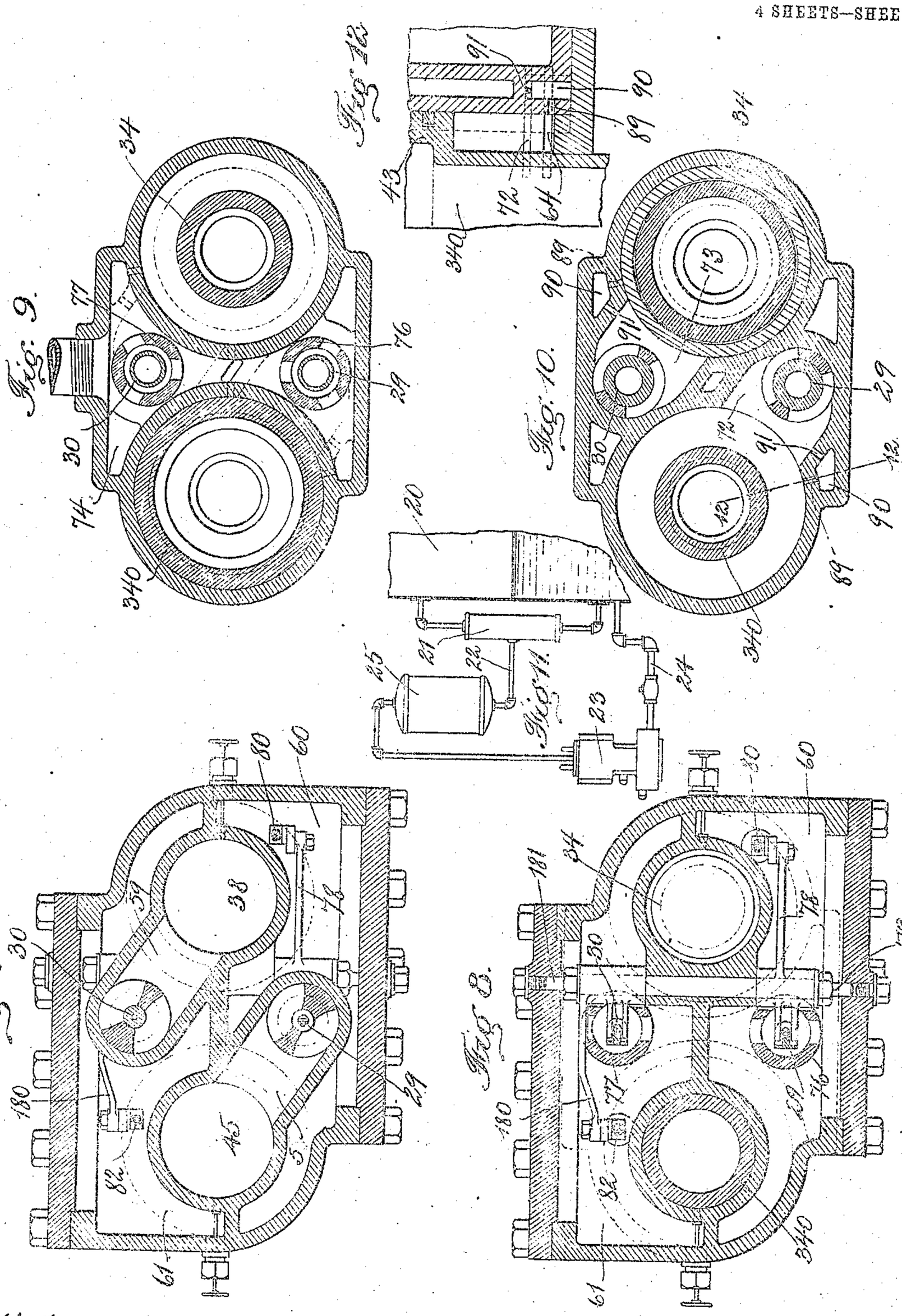
4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC BOILER-PUMP.

No. 824,142. Specification of Letters Patent. Patented June 26, 1906.

Application filed February 15, 1905. Serial No. 245,654.

To all whom it may concern:

Be it known that I, SIDNEY A. REEVE, a citizen of the United States, residing at Worcester, county of Worcester, State of Massachusetts, have invented certain new and useful Improvements in Automatic Boiler-Pumps, of which the following specification and accompanying drawings illustrate one form of the invention, which I now regard as the best out of the various forms in which the invention may be embodied.

This invention relates to water-level controllers for steam-boilers whose automatic action depends upon the immersion or non-immersion of the inlet to the steam-pipe which supplies steam for operating the boiler feed-pump, the action being such that when the steam-pipe is uncovered the pump operates freely, with the steam as the motive agent, and raises the water-level; but when the water is high and covers the steam-pipe water enters the pump-motor and causes it to slow down or discontinue its operation. Heretofore devices of this class have failed of wide adoption, among the causes being the inefficiency of the device from an economical standpoint and the noise and stress developed when the water first enters the pump-motor or steam enters it after flooding if the motor be not throttled, whereas if it is throttled there is uncertainty in the action of the device under wide variations of load imposed on the boiler.

My invention aims to overcome these difficulties and provide a more efficient pumping apparatus which may be left unthrottled, which will work under wide variations of load on the boiler, which will quickly free itself of water when the water-level drops below the steam-inlet, and in which the noise and stress ordinarily caused by fluctuations of the water-level above and below the steam-inlet are diminished.

In the preferred constructional embodiment I employ a compound pump-motor direct-connected to the pump-piston and having a high-pressure motor-piston of an area substantially equal to the area of the pump-piston, so that the boiler-pressure is substantially balanced against these two pistons. The low-pressure piston serves to overcome friction and force water into the boiler when steam is the motive agent; but when water takes the place of steam the pressure in the receiver intermediate between the high and low pressure motor-cylinders falls to zero, and the pump stops. Novel provisions are made for draining and for working under wide variations of steam-pressure, and provisions are made for applying the duplex principle, wherein each of a pair of pumps operates the valve mechanism of the other one of said pair.

Of the accompanying drawings, Figure 1 represents the plan view of a boiler feed-pump embodying the invention. Fig. 2 represents a side elevation. Fig. 3 represents a cross-section on line 3 3 of Fig. 2 through the axial plane of the pistons. Fig. 4 represents a section on line 4 4 of Fig. 1. Figs. 5 and 6 represent sections on the lines 5 5 and 6 6 of Fig. 4. Figs. 7 to 10, inclusive, represent sections on the correspondingly-numbered lines on Fig. 5. Fig. 11 represents a view in elevation and section showing the connections of the pump with the boiler. Fig. 12 represents a section on a line 12 12 of Fig. 10.

The same reference characters represent the same parts in all the figures.

In the drawings, 20, Fig. 11, represents a boiler having an outside water-column 21, with which the steam-supply pipe 22 of the pump apparatus 23 is connected at the water-line level.

24 is the feed-pipe leading from the pump to the boiler.

The steam-pipe 22 has a portion extending above the water-line and enlarged into a reservoir-chamber 25, designed to moderate the frequent and violent alternations of water and steam supply to the pump-motor under the fluctuations of water-level above and below the inlet of the steam-pipe. Not until said inlet is fully and for a period permanently covered does water pass to the pump-motor. When the inlet is again uncovered, water gurgles back into the chamber 25, which serves as a reservoir of hot boiler-feed, upon which the boiler can rely while the pump is freeing itself of water and resuming operation. This is especially important in boilers of relatively small water capacity, such as water-tube boilers.

The steam-pipe 22 enters a chamber 26 antecedent to the valves 27 28, controlling the admission and exhaust of the high-pressure cylinders. These valves form parts of two valve structures 29 30, controlling the steam

distribution of the pump-motors. Two compound direct-acting motors are employed, of which 31 is the high-pressure cylinder of one, 32 the low-pressure cylinder, and 33 the pump-cylinder. A single piston structure 34 embodies the single-acting high-pressure piston 35, double-acting low-pressure piston 36, and a single-acting pump-piston 37 of the same area as the high-pressure motor-piston 35. 38 is the high-pressure cylinder-chamber, 39 the upper low-pressure chamber, 40 the low-pressure chamber, and 41 the pump-chamber. In the other pump the corresponding pistons of its piston structure 340 are marked 42 43 44, the corresponding cylinders 53 54 55, and corresponding chambers 45 46 47 48.

49 is an admission-chamber common to the two pump-chambers 41 48 and admitting thereto past check-valves 50, and 51 is a discharge-chamber common to the two pump-chambers and receiving therefrom past check-valves 52.

Steam admission from the chamber 26 occurs past valves 27 and 28 through ports 56 57 into the high-pressure cylinder-chambers 45 and 38, respectively, and exhaust occurs therefrom under control of the valves 27 28 through ports 58 59 into two receiver-spaces 60 61, occupying the upper portion of the casing. The exhaust-ports 58 59 are located below the admission-ports 56 57, so that the upward termination of the piston-stroke is cushioned when the high-pressure pistons cover these exhaust-ports.

From the receivers 60 61 the steam exhausted from the high-pressure cylinders passes to the corresponding low-pressure cylinders and operates expansively on the low-pressure pistons 36 43. The first draft from the receivers is by way of the hollow interiors 62 63 of the lower parts of the valve structures to the admission-ports 64 65 for the lower low-pressure spaces 47 40 under control of valves 66 67, formed on the valve structures, and the second draft from said receivers is to the upper low-pressure spaces 46 39 through ports 68 69, carrying both admission and exhaust and controlled by valves 70 71 on the valve structures. Exhaust occurs from the lower chambers under control of the valves 66 67 through ports 72 73 into an exhaust-chamber 74, communicating with the atmosphere or with a condenser through the pipe 75. The upper chambers 46 39 are opened to the exhaust-chamber 74 when the valves 70 71 rise above ports 68 69. The exhaust-ports 72 73 are located above the admission-ports 64 65 to afford cushion at the lower extremity of piston travel.

76 77 are removable valve cages or guides in which the valve structures operate.

Arrangement is made for operating the valve mechanism of each pump by the piston of the other pump in accordance with the duplex principle. The valve structure 29 is reciprocated by a lever 78 of the first class, fulcrumed at 79 and oscillated by a rod 80, attached to piston 36, while the valve structure 30 is reciprocated by lever 180 of the second class, fulcrumed at 181 and oscillated by rod 82 from the piston 43. These rods operate in guides 83 84 at their upper ends. The movements of the valve structure 29 controlling piston structure 340 are opposite to those of the piston structure 34 producing said movements, while those of the valve structure 30 are in the same direction as the movements of the piston structure 340.

In the side of the high-pressure cylinder 31 is a port 85, uncovered by the piston 35 at the lower end of its stroke and leading to the receiver 60, which supplies the low-pressure cylinder of the other pump. This port is controlled by an adjustable hand-valve 86. A similar port 87, controlled by hand-valve 88, leads from the high-pressure cylinder 45 into the receiver 61. These ports serve a double function. First, they give the pump an adaptability to wide ranges of boiler-pressure and speed. Since the motive power for the low-pressure cylinders is simply the expansive power of the steam exhausted from the high-pressure cylinders, this at times of low boiler-pressure might prove insufficient to keep the pump in motion. If, however, the valves 80 88 be opened, the receivers will receive an added supply of live steam direct from the boiler through the high-pressure cylinders at the lower ends of the piston-strokes, since the admission-valves are open throughout the downstroke. This added receiver-pressure, caused by either of the high-pressure pistons, serves to accelerate the upward movement of the other piston, and thus produces a quicker closing of the valve controlling this live-steam supply and an ensuing quickened upward movement of the first said piston, closing the port 85 or 87. Hence these ports may be left open at all times, since if the boiler-pressure is high the piston movements are accelerated and less pause occurs at the end of the strokes, while if the boiler-pressure is low the pause is greater and affords the needful supply of live steam to the receivers. The ports 85 87, furthermore, promote the drainage of the high-pressure cylinders into the receivers after the pump-motors have been flooded.

Provision is made against the entrance of much of the water from the receivers into the lower low-pressure cylinder-chambers 40 47 by extending the sleeve portions of the valve structure above the valves 70 71, thus causing the water to seek the ports 68 69 and the upper low-pressure chambers 46 39. Such water as enters below the low-pressure pistons passes out through the exhaust-ports 72 73 until these ports are covered by the descent of the pistons and the remainder passes out

from the bottoms of the cylinder-chambers, as shown in Figs. 10 and 12, through ports 89, passages 90, and ports 91 into the exhaust-ports 72 73 and therethrough into the exhaust-chamber 74 when the valves 66 67 are depressed.

The upper low-pressure cylinder-chambers 39 46 are drained through ports 92, leading from the low-pressure cylinders into the exhaust-chamber 74 and uncovered by the pistons 36 43 at the bottom of their strokes. No useful steam-pressure is lost through these ports, since the steam which reaches them is the second draft from the receivers and has done its work.

The operation is as follows: Assuming at first that the water-level is below the inlet to pipe 22, the pump will operate freely under steam-pressure and tend to raise the water-level. As shown in the drawings, the piston structure 34 is at its lowest limit of movement and the piston structure 340 is moving upwardly and about to bring the valve structure 30 to its upward limit to cover the admission-port 57 of high-pressure cylinder 31, to uncover the exhaust-port 59 thereof, admitting the contents of said cylinder to receiver 61, to uncover port 69 and allow the upper low-pressure cylinder-space 39 to exhaust to the atmospheric chamber 74, to cover the exhaust-port 73 to the lower low-pressure chamber 40, and to uncover the admission-port 65 thereof and admit receiver-steam below the piston 36. This causes the piston structure 34 to rise and shift the valve structure 29 to its lower limit, uncovering the ports 56, 68, and 72 and covering the ports 58 and 64, thereby admitting live steam on top of piston 42 and receiver-steam on top of piston 43 and exhausting the lower low-pressure chamber 47, whereby the piston structure 340 is forced downwardly. At the lower limit of the movement of piston 340 it admits steam to the chambers 38 39 and exhausts the chamber 40, whereby the piston structure 34 is depressed and shifts the valve structure 29 to the position shown in Fig. 29, whereupon the cycle is repeated. It will thus be seen that the movements of the piston structures and valves of the two pump devices alternate. First the piston structure 340 rises, followed by the piston structure 34, and then 340 descends, followed by 34. The high-pressure motor-cylinders and pumps are single-acting and the low-presssure cylinders are double-acting. When water covers the inlet of pipe 22 and enters the motor-cylinders, the pressure in the receivers 60 and 61 soon drops substantially to zero, and since the boiler-pressure is then balanced against the equal-sized pistons 35 37 and 42 44 the pumps come to a stop until the water drops out of the boiler-leg of pipe 22. The pump-motors soon free themselves of water through their admission and exhaust ports and the drainage-ports already described and resume the operation of pumping water into the boiler.

It will be understood that wide variations may be made in the construction of the apparatus without departing from the principles of my invention.

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

1. An automatic boiler-feeder comprising a boiler, connected motor and pump pistons substantially pressure-balanced against each other, a second motor-piston working by the exhaust-steam from the first motor-piston, and a water-line connection from the boiler to the motor.

2. An automatic boiler-feeder comprising a boiler, and a compound motor steam-pump supplying the same and having a steam connection to the boiler at the water-line, the relative areas of the motor and pump pistons being such that the boiler-pressure is substantially balanced when the motor is filled with water.

3. An automatic boiler-feeder comprising a boiler, and a pump apparatus for feeding the same having a steam connection with the boiler at the water-line and high and low pressure motor-pistons and a pump-piston, the latter of the same area as the high-pressure motor-piston.

4. An automatic boiler-feeder comprising a boiler, a pump-piston for supplying feed-water thereto, high-pressure and low-pressure motor-pistons in direct-acting relation to said pump-piston and both operating in the same direction, automatic valve mechanism intermediate between said motor-pistons, and a pipe connection from the water-line of the boiler to supply the high-pressure piston.

5. An automatic boiler-feeder comprising a single-acting pump and a motor directly connected thereto and having a single-acting high-pressure piston and a double-acting low-pressure piston.

6. An automatic boiler-feeder comprising a compound motor and pump comprising a single piston structure having formed thereon a pump-piston or plunger, a high-pressure piston and a low-pressure piston, and means whereby steam is admitted to and exhausted from one side of the high-pressure piston and both sides of the low-pressure piston.

7. An automatic boiler-feeder comprising a boiler, a combined pump and motor including a single-acting pump supplying feed-water to said boiler and a motor operated from the water-line level of the boiler and including a single-acting high-pressure cylinder and piston, and a double-acting low-pressure cylinder and piston, the motor and pump pistons forming a single structure.

8. An automatic boiler-feeder comprising a boiler, a combined pump and motor includ ing a single-acting pump supplying feed-water to said boiler and a motor operated from

the water-line level of the boiler and including a single-acting high-pressure cylinder and piston, and a double-acting low-pressure cylinder and piston, the motor and pump pistons forming a single structure, said pump-piston having substantially the same area as the high-pressure motor-piston.

9. An automatic boiler-feeder comprising a boiler, and a duplex pumping apparatus for supplying feed-water thereto and having a motor-supply connection with the boiler at the water-line, said apparatus comprising alternately-operating piston structures including high-pressure motor and pump pistons of substantially equal areas, low-pressure motor-pistons, and valve mechanisms for the motors, each of which is operated by the piston structure of the other motor.

10. An automatic boiler-feeder comprising a duplex pumping apparatus comprising alternately-operating motors and pumps, each motor and pump having a single-acting high-pressure motor-piston, a single-acting pump-piston, and double-acting low-pressure motor-piston all in one piston structure, and valve mechanisms for said motors each operated by the piston structure of the other motor.

11. An automatic boiler-feeder comprising a pair of combined motors and pumps each having high and low pressure motor-pistons and pump-pistons forming the alternately-operating piston structures, valve mechanisms for the motors each operated by the piston structure of the other motor, receivers interposed between the high and low pressure cylinders, and a casing forming the cylinders and receivers and entirely inclosing the working parts.

12. An automatic boiler-feeder comprising high and low pressure motor cylinders and pistons, a pump-piston operated by said motor-pistons, means controlled by movement of the high-pressure piston for admitting live steam to the low-pressure piston at the termination of the working stroke of the high-pressure piston, and a device for rendering said means operative or inoperative at will, during the operation of the remaining parts.

13. An automatic boiler-feeder comprising a pump, a low-pressure piston operating the same, a cylinder therefor, a receiver antecedent to the said cylinder, a high-pressure piston and cylinder, a port connecting the high-pressure cylinder with the receiver and uncovered by the high-pressure piston at the end of its stroke, and means for adjusting the aperture of said port.

14. An automatic boiler-feed comprising high and low pressure motor cylinders and pistons, a pump-piston operated by said motor-pistons, means whereby the low-pressure cylinder receives live motive fluid, a boiler supplied by the pump, and a connection from the water-line level thereof to the pump-motor.

15. An automatic boiler-feeder comprising a duplex pumping apparatus including two alternately-operating combined motors and pumps each controlling the steam distribution of the other, each motor having high and low pressure cylinders and an intermediate receiver, pistons in said cylinders, and ports connecting each high-pressure cylinder with the receiver of the other motor and controlled by the piston in said cylinder.

16. An automatic boiler-feeder comprising a boiler, a compound motor and pump apparatus for supplying feed-water thereto, and having a motive connection with the water-line level of the boiler, said motor having high and low pressure cylinders with ports for the admission and exhaust of motive fluid, automatic valve mechanism for controlling said ports, and additional provisions for automatically draining one or more of said cylinders.

17. An automatic boiler-feeder comprising a boiler, a pump supplying the same with feed-water, a motor for operating said pump having a single-acting high-pressure cylinder, a double-acting low-pressure cylinder, and a drainage-port from that end of said low-pressure cylinder which receives the second part of the exhaust from the high-pressure cylinder, said port controlled by the low-pressure piston.

18. An automatic boiler-feeder comprising a boiler, a feed-water pump therefor, a motor to operate said pump having a supply connection from the water-line level of the boiler and including a motor-cylinder having an admission-port, and an exhaust-port covered by the piston before the end of its stroke, whereby cushion-steam is entrapped, and means for draining the cushion-space after the exhaust-port is covered.

19. An automatic boiler-feeder comprising a boiler, a pump to supply the same with feed-water, and a motor to operate said pump, supplied from the water-line level of the boiler, said pump having an upwardly-acting piston, a cylinder therefor having an exhaust-port covered by the piston at the lower end of its stroke, and a drainage-port leading from the said cylinder below the exhaust-port.

In witness whereof I have hereunto set my hand this 3d day of February, 1905.

SIDNEY A. REEVE.

Witnesses:
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