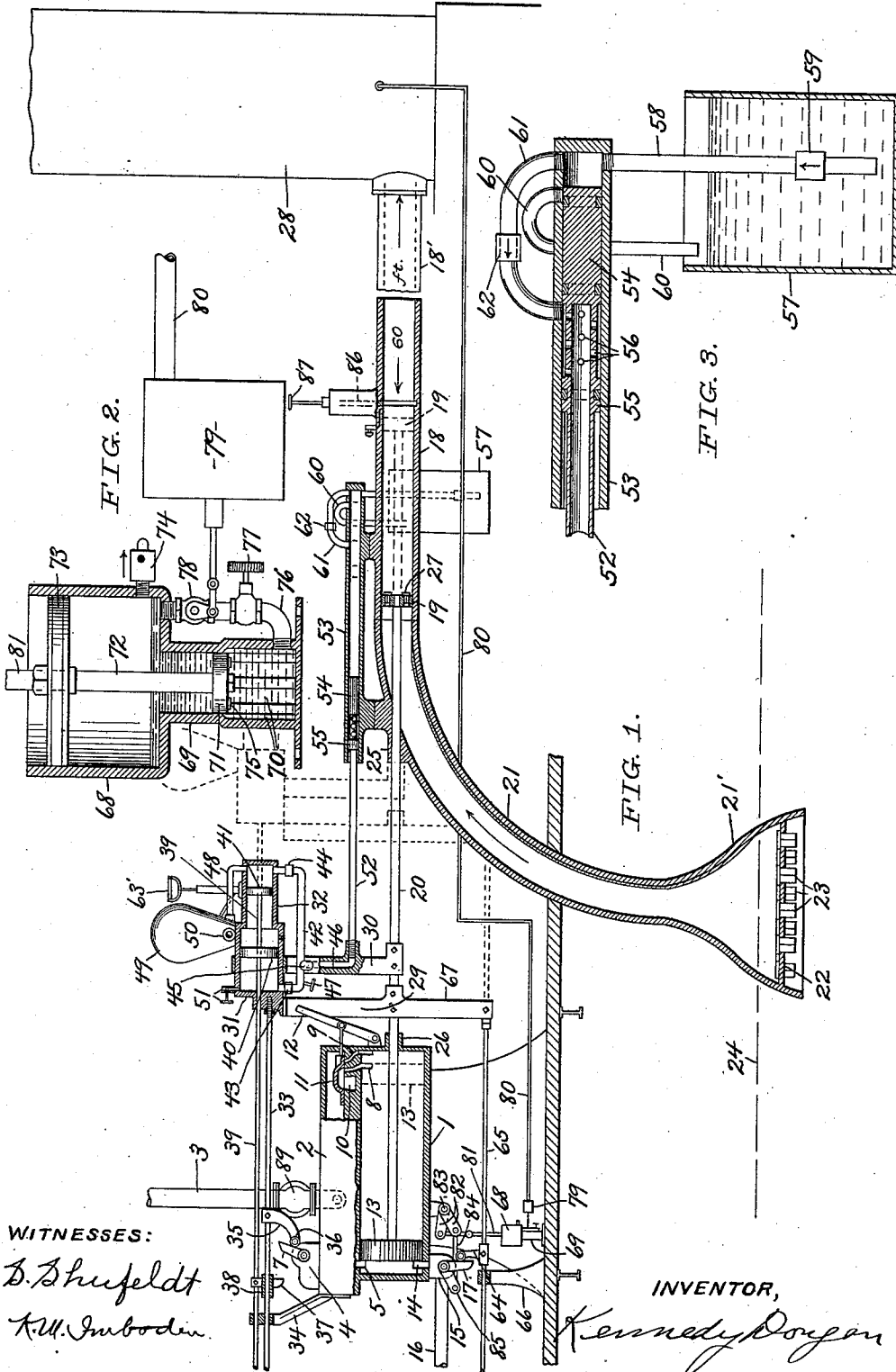


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STEAM PUMP.
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WITNESSES:

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STEAM-PUMP.

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To all whom it may concern:

Be it known that I, KENNEDY DOUGAN, a citizen of the United States, and resident of the city of Minneapolis, county of Hennepin, and State of Minnesota, have invented certain new and useful Improvements in Steam-Pumps; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The object of this invention is to provide a direct acting steam pump in which steam may be expanded in such a manner that the efficiency will be equal to that of the best type of fly-wheel steam pump.

In the invention herein disclosed the excess of steam pressure at the beginning of the stroke is utilized to give velocity to a long column of water which column of water gives out the energy stored therein after the steam pressure, owing to expansion, has fallen below the resisting pressure, which is practically making a column of water answer the purpose of a fly-wheel.

The invention consists mainly in providing a pump of such construction that a long column of water can be used to absorb and give out energy at each stroke.

One feature of the invention is to provide means for adjusting automatically, the point of cutoff in such manner that the quantity of steam admitted will only be sufficient to drive the piston to the end of its stroke.

Another feature is to provide means for automatically slowing down or speeding up the pump when the water pressure rises above or falls below a certain point.

In the accompanying drawings—Figure 1 is a diagrammatic representation in vertical longitudinal section of a single acting steam pump embodying the invention; Fig. 2 is a detail view of a device for use in connection with the valve gear; Fig. 3 is a detail view of a portion of an automatic cutoff governor shown in Fig. 1.

In the drawing, 1 designates the steam cylinder, having the valve chest 2, receiving steam from a supply pipe 3. On the valve chest 2 is a casing 4, in which is mounted a pilot valve (not shown) which controls the admission valve proper at the left hand end of the cylinder. 5 is the admission port controlled by said valve. The pilot valve is

provided with a rocking stem or shaft, on which is an arm 7, actuated as hereinafter described. At the opposite end of the cylinder 1, two separate ports 8 and 9 are provided; also an exhaust port 10. These ports are controlled by a slide valve 11, manually operable by a lever 12, connected thereto as shown. Normally the port 8 is in communication with exhaust port 10, as shown, so that as the steam piston 13 moves to the right, the air in front of it will escape to atmosphere. The regular exhaust port 14, is at the same end of the cylinder as the steam port 5. This port 14 is controlled by an exhaust valve within a casing 15, to which the exhaust pipe 16 is connected. Said valve is provided with a rocking stem or shaft, on which is an arm 17, actuated as hereinafter described.

18 designates the water cylinder, or that part thereof traversed by the water piston 19. The pistons 19 and 13 are connected by a rod 20.

Connected to the induction end of the cylinder 18 is a downwardly curved pipe 21, having a flaring bottom 21' in which is a valve seat 22, in which are a number of holes closed by a nest of valves, 23. The total opening area of these foot-valves should be at least equal to the cross sectional area of the pipe 21, so that the water will not be "wire-drawn" and the cross sectional area of said pipe, up to the end of the cylinder 18, should be equal to the exposed area of the left side of the piston 19. So, the water passage into the cylinder will be neither enlarged nor contracted (either of which is undesirable) and the best kinetic effect will be had from the column of water.

The level of a body of water from which the water is pumped is indicated by the line 24.

The cylinder 18, where the piston rod 20 enters it, is provided with a stuffing box, indicated at 25.

26 indicates the stuffing box on the steam cylinder.

The water piston 19 is provided (in a single acting pump) with one or more valves, 27, which close during the steam stroke and open on the return stroke.

The water cylinder 18 is to be extended, without any reduction of diameter, substantially horizontally. Thus, the distance be-

tween the arrow-heads may be 60 feet, or more. At the distant end this cylinder or pipe is connected directly to a tank, reservoir, or stand-pipe, 28, near the bottom thereof.

The steam admission valve is opened and closed by parts actuated by the piston rod 20. Two upwardly extending arms 29 and 30, secured to the piston rod, carry two communicating cylinders 31 and 32.

A horizontal rod 33 is secured to the cylinder or to arm 29 and passes slidably through a guide 34. Secured on rod 33 is an arm 35 provided with a roller 36, arranged to strike the valve-arm 7 to open the pilot valve. Said valve is closed by a lug 37, pivoted on a sleeve 38 mounted slidably on said rod 33. Sleeve 38 is secured to and actuated by a second rod 39, parallel with rod 33, passing through guide 34 and entering cylinder 31, being secured to a piston 40 therein. There is also a piston 41 in the smaller cylinder 32, and said pistons are connected by a rod, as shown. These cylinders and pistons are parts of an automatic mechanism for regulating the point of cutoff. Said mechanism as shown may be further described as follows: The ends of said cylinders are connected by a pipe 42, in which are two check-valves 43 and 44, near its respective ends. Said pipe is connected at 45 to a passage 46 in arm 30. Between 45 and 43, a hand valve 47 is connected in pipe 42. The end of the smaller cylinder 32 is connected by a pipe 48 with an air chamber 49, which is provided with a safety valve 50. Between the pistons, cylinder 31 has a hole for the escape of liquid and the passage of air when the pistons are moved. At the left hand end, cylinder 31 has a small outlet provided with a cock 51. Secured to arm 30, and communicating with passage 46, is a hollow rod 52, extending parallel with piston rod 20. Said rod 52 works in a small cylinder 53, and carries a head 54, fitting the bore thereof. Spaced away from the head 54 a second enlargement or head 55, is provided. Between the heads 54 and 55 the rod is perforated, as at 56. Below the cylinder 53 is an oil vessel 57, in which is a body of oil or water, oil being preferable. Depending into said vessel 57 is a pipe 58, provided with a check-valve 59 and connected at its upper end to the end of the cylinder 53. A second pipe 60, is connected to cylinder 53 at a point slightly farther from the end of the cylinder, and extends downward over the vessel 57 but does not dip into the liquid. A third pipe 61, has both ends connected to the cylinder, one to the end of the cylinder, the other at such a point that just as the head 54 covers the opening to pipe 60, the discharge opening from pipe 61 will be uncovered. In pipe 61 is a check-valve 62. Valves 62 and

59 open in the direction of the arrows thereon.

The hollow rod 52, passage 46 and pipe 42, and the cylinders 31 and 32 between their ends and the pistons, are to be filled with oil. When the piston 13 has reached the end of its normal steam stroke, the head 54 will be at the position shown in Fig. 3, having just cut off the escape of oil through pipe 60. Any movement beyond the normal stroke, due to decreased water pressure, increased boiler pressure, or other cause, will force the head 54 beyond the position shown, forcing oil back through pipe 61 into the cylinder between the heads 54 and 55, through holes 56 into the hollow rod 52, through passage 46, pipe 42 and valves 43, 44 into the cylinders 31 and 32. If the apparatus has never been used air must be forced into chamber 49 to a predetermined pressure by a hand pump 63 or otherwise. The hand valve 47 may be partly closed. Owing to the greater area of piston 40 than that of piston 41, said pistons will now be moved to the right, a distance proportional to the excess movement of the rod 52. The piston 40 shifts its rod 39 to the right, thereby moving the member 37—38 to the right, the effect of which is to shorten the cutoff of the steam admission valve.

At the instant the hollow rod 52 starts back, the compressed air in chamber 49 slowly moves piston 41 to the left, which movement is permitted by the constant, slow escape of oil from cylinder 31 through cock 51. This movement is very slow, however. It operates to gradually lengthen the cutoff, and in time the cutoff will be so lengthened that the steam will again drive the piston 13 beyond its normal stroke, when the above described operation will be repeated.

During the back (leftward) stroke of the rod 52, oil will be drawn into the cylinder 53 through pipe 58, until pipe 60 is uncovered, when oil will no longer be drawn in and air will be drawn in through pipe 60. The oil drawn in will be retained, as check-valve 59 is normally closed. On its forward stroke the rod will expel air through pipe 60 and, if the stroke is normal, will stop at about the point shown in Fig. 3. A small pump may be employed to return the leakage to vessel 57.

After closing the pilot valve, the member 37 passes over the rock-arm 7, and also passes over it on the return stroke, after which said arm is thrown to open position by member 35. The exhaust valve at 15 is closed by a member 64 striking rock-arm 17 before the piston 13 has covered the exhaust port 14. Said member 64 is carried by a rod 65, passing through a guide 66 and secured to an arm 67, integral with arm 29.

My invention comprises means for regulating the speed (number of strokes) of the

pump, both manually and automatically, on the principle of controlling the opening time of either the exhaust valve or the admission valve.

In Fig. 1, the controlling means is shown as applied to the exhaust valve, and comprises a dashpot 68, a retarding device, and mechanical connections between these and the exhaust valve. The dashpot and retarding device consists of two communicating cylinders 68 and 69, the upper of which is considerably the larger in diameter. The lower part of the bore of the smaller cylinder 69 is scored with vertical grooves 70. The surfaces between the grooves form guides for a piston 71, which is connected by a rod 72 with a piston 73 fitted into the larger cylinder 68. The lower cylinder is filled with a non-evaporable liquid, as indicated. Above the level of said liquid a relief valve 74 is connected in cylinder 68. In the small piston 71 are one or more downwardly opening valves 75. The lower parts of the respective cylinders are connected by a by-pass pipe 76, in which are two valves—a manually operable valve 77, and an automatically operable valve 78. The latter is suitably connected with a fluid-pressure responsive device in a casing 79, connected by a pipe 80 to the stand pipe or reservoir 28. Increase of pressure in the reservoir 28 causes the device 79 to turn valve 78 toward open position; decrease, toward closed position. The piston 73 is connected by a rod 81 and link, with a bell-crank 82, pivoted at 83. Said bell-crank is connected by a rod 84 with a rock-arm 85 fixed on the exhaust valve stem.

When the member 64 strikes valve-arm 17 and closes the valves, arm 85 is turned therewith, and lifts the piston 73, thus rarefying the air in cylinder 68. The member 64 now recedes, and piston 73 is moved down by atmospheric pressure, but this downward motion will be retarded, in any required degree, by valves 77 and 78 choking the flow of oil until piston 71 passes the ungrooved part of the cylinder, from which point it will obviously descend quickly, as the grooves form by-passes for the oil. The exhaust valve is not to open until after piston 71 passes into the enlarged portion of cylinder 69, thus the opening of said valve is retarded or delayed by a predetermined interval, which interval is, however, subject to adjustment by either of the valves 77 or 78. When piston 71 is raised, its valves 75 open, so that the movement will be unimpeded. When piston 73 descends, air will escape through valve 74. The exhaust valve is thus opened at a certain time after the beginning of the steam piston stroke, regardless of the distance said piston may be driven by the expanding steam.

When the water pressure in the stand-

pipe 28 increases beyond the point required, the delay interval is lengthened automatically by the means shown and described, thereby decreasing the number of strokes of the pump per unit of time. When the said pressure decreases the reverse follows.

The ports 5 and 14 are located inward from the extreme end of the cylinder, to provide a compressed air cushion for the piston 13 whenever it is forced back beyond the limit of its normal stroke. Live steam will also be present between the piston and cylinder head, as the admission valve will be open. In the water cylinder 18 just beyond the extreme stroke limit of piston 19, is a gate valve 86 for closing communication between the cylinder and the reservoir 28.

If the water inlet pipe 21 be full of water but the reservoir 28 and cylinder 18 empty, the operation of starting the pump is as follows: The pistons will probably be in the position shown, in which case the steam admission valve will be open. The operator turns up the pivoted cutoff lug 37, causing it to be temporarily inoperative, and slightly opens the throttle valve 89. Steam enters the cylinder through port 5 and slowly moves the piston 13 to the end of its stroke, the air ahead of the piston escaping through ports 8 and 10 to atmosphere. Water is forced up through foot-valves 23 by atmospheric pressure and follows the piston 19. If the steam piston 13 passes and covers the port 8, it will be checked by the air compressed within the end of the cylinder. Valve 11 is held to its seat by steam pressure, and will not be lifted therefrom by the air pressure created when the piston moves too far.

The pistons are now ready for the first return stroke. Normally, this is accomplished by the back water pressure on piston 19, but as such pressure requires a head of water in the reservoir 28, (which has not yet been created) it is necessary to admit steam to the right hand end of the cylinder, which is done by moving lever 12 to open the steam port 9. This motion also cuts off the port 8 from the exhaust port 10. Steam now moves the piston 13 back. As the water piston 19 moves back its valves 27 open, and water flows into the cylinder 18. When piston 13 reaches its starting point again the operator restores valve 11 to the position shown. The regular exhaust valve is closed automatically and the regular admission valve opened automatically in the manner described herein.

When the piston has finished its return stroke, the operator reopens valve 11 at the proper time. In this way the pistons are worked back and forth by steam until the head of water in pipe 28 is sufficient to drive the pistons back. This backward motion will be due to the excess of water pres-

sure on the right hand side of piston 19, which excess will be equivalent to the force that would be exerted on a piston whose diameter would equal the diameter of piston rod 20.

As soon as the operation becomes fully automatic the throttle 89 is fully opened, and the operator drops the cutoff member 37 into operative position. In the manner hereinbefore described, the cutoff will be automatically controlled causing the expanding steam to give to the piston a stroke of normal length. Should the steam pressure at any time fail to carry the piston to the end of a full stroke, the exhaust valve will be opened at the end of the retarded movement of the parts connected therewith.

The regulation of the frequency of the stroke is done manually by means of valve 77, and automatically by means of valve 78 and pressure-responsive device 79, as already described herein.

When the air pressure in chamber 49 reaches a certain point, due to the occasional entrance of oil past the check valve 44, the safety valve 50 will open and a small quantity of oil be ejected, thus preventing dangerous pressure in chamber 49.

In respect to the general principal of operation of this pump, I will repeat that the excess of steam pressure at the beginning of the stroke is utilized to give velocity to the long column of water (in pipes 21 and 18) and said column of water gives out the energy stored therein after the steam pressure, owing to expansion, has fallen below the resisting pressure. The efficiency of this pump will be equal to that of the best type of fly-wheel steam pump, and it is cheaper in construction.

I claim:

1. In a steam pump of the kind described a steam cylinder and piston, a water cylinder and piston, an induction and an eduction pipe formed as continuations of the water cylinder, the eduction pipe being equal in diameter to the water cylinder, and valves in the induction pipe.

2. In a steam pump of the kind described a steam cylinder and piston, a water cylinder and piston, an extension from the eduction end of the water cylinder, of relatively great length and equal diameter to that of the water cylinder, an extension from the induction end of the water cylinder, approximately equal in diameter to that of said cylinder, valves in the last named extension, and valves in the water piston.

3. In a single acting steam pump of the kind described, a steam cylinder and piston, a water cylinder and valved piston, a water induction pipe, a water eduction pipe having uninterrupted connection with a reser-

voir, the water being impelled through the eduction pipe by the steam end of the pump, and said piston being driven in the reverse direction by a head of water in the eduction pipe acting upon the water piston.

4. In a single acting steam pump of the kind described, a water cylinder, a piston therein, an eduction pipe leading therefrom, equal in diameter to said cylinder, means for driving the piston in one direction by steam pressure, and the piston being driven in the opposite direction by a head of water in the eduction pipe.

5. In a steam pump of the kind described, a water cylinder, a piston therein having valves, an induction pipe of large bore but less than that of the water cylinder, and an eduction pipe of equal diameter to said cylinder, having uninterrupted connection with a reservoir.

6. In a direct acting steam pump, a water cylinder, an induction and an eduction pipe formed as continuations of said cylinder, the eduction pipe being of equal diameter to said cylinder, and the induction pipe of approximately equal diameter, and a valved piston in said cylinder, in combination with the steam end of the pump.

7. In a direct acting steam pump, a water cylinder, an induction and an eduction pipe formed as extensions of said cylinder, the eduction pipe being of relatively great length and equal diameter to said cylinder, and the induction pipe of approximately equal diameter, and a valved piston in said cylinder, in combination with the steam end of the pump.

8. In a direct acting steam pump, in combination with the steam end of the pump, a water cylinder, a valved piston therein, a water induction pipe, a water eduction pipe having uninterrupted communication with a reservoir, the water being impelled through the eduction pipe by the steam end of the pump, and said piston being driven in reverse direction by a head of water in the eduction pipe acting upon the water piston.

9. In a direct acting steam pump, in combination with the steam end of the pump, a water cylinder, a valved piston therein, an eduction pipe leading therefrom, equal in diameter to said cylinder, means for driving the piston in one direction by steam pressure, the piston being driven in the opposite direction by a head of water in the eduction pipe.

10. In a direct acting steam pump, a water end comprising a water cylinder, an eduction pipe of relatively great length and equal diameter to said cylinder, and having uninterrupted connection with a reservoir; a piston rod passing into said cylinder, a piston thereon, and an induction pipe opening into the end of said cylinder opposite the

eduction end, the cross sectional area of said induction pipe being equal to the exposed area of the rod side of said piston.

11. In a direct acting steam pump, a water
5 end comprising a water cylinder, an eduction pipe of relatively great length and equal diameter to said cylinder, and having uninterrupted connection with a reservoir; a
10 piston rod passing into said cylinder, a valved piston thereon, and an induction pipe opening into the end of said cylinder opposite the eduction end, the cross sectional area of said induction pipe being equal to the
15 exposed area of the rod side of said piston, and foot-valves in said induction pipe.

12. In a direct acting steam pump, a
20 water end comprising a water cylinder, an eduction pipe of relatively great length and equal diameter to said cylinder, and having an uninterrupted connection with a reservoir, a piston rod connected to the pump
25 piston and passing into said cylinder, a valve piston on said piston rod within the cylinder, and an induction pipe connected to the said cylinder at the opposite end from the eduction end, the cross area of which is equal to the exposed area of the rod side of said

piston, and having an enlarged lower end, and foot valves in said end.

13. In a direct acting steam pump, a 30
water end comprising a water cylinder, an eduction pipe of relatively greater length and equal in diameter to said cylinder, a reservoir in direct communication with the
35 eduction pipe, a piston rod connected direct to the pump piston and passing into the said cylinder, a valve piston on said piston rod within the cylinder, and an induction pipe connected to the said cylinder
40 at the opposite end from the eduction end, the cross sectional area of which is equal to the exposed area of the rod side of the piston and equal to the cross sectional area of the eduction pipe, the induction pipe curved
45 downwardly and having a flared lower end, and foot valves in said flared lower end, the total area of these valves being equal to the cross-sectional area of said induction pipe.

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Witnesses:

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