C. E. EMERY.

PUMPING ENGINE.

No. 84,176. Patented Nov. 17, 1868.

Fig: 2

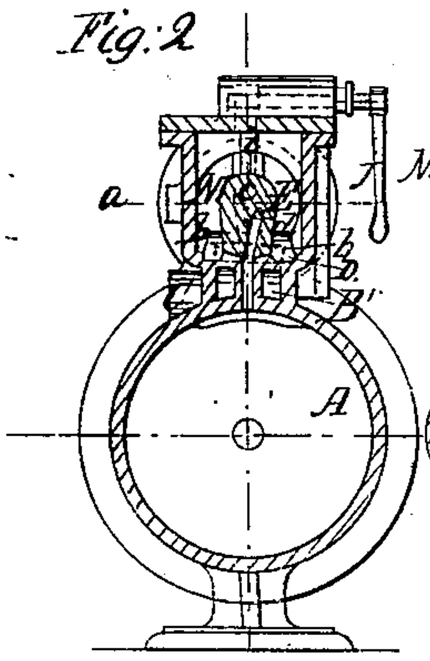


Fig: 1

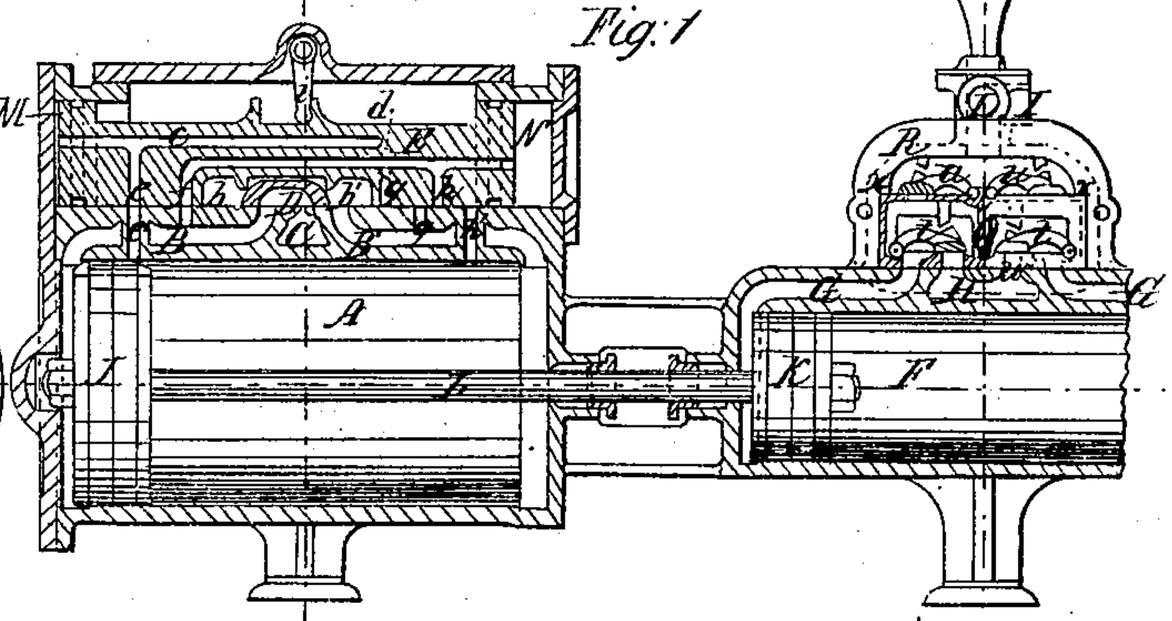


Fig: 5

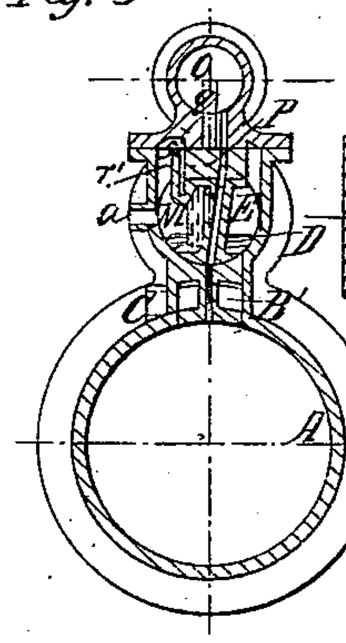


Fig: 4

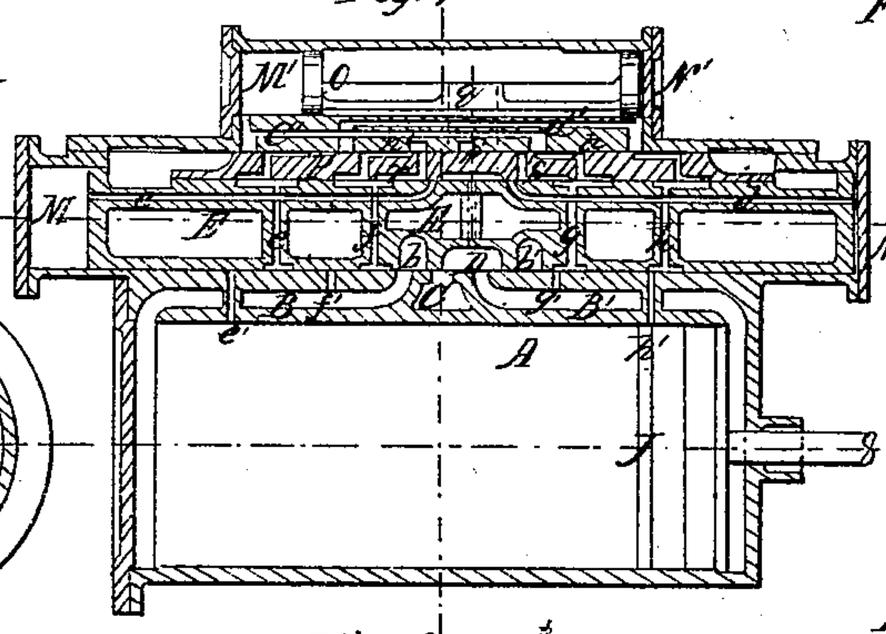


Fig: 3

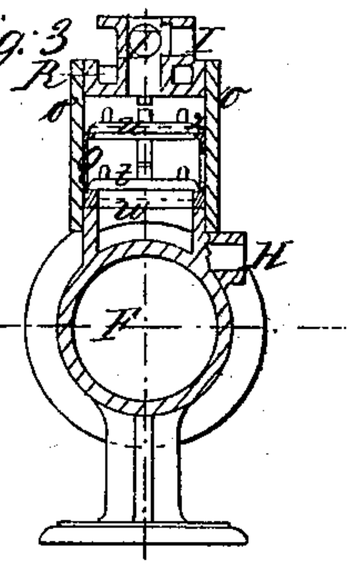


Fig: 8

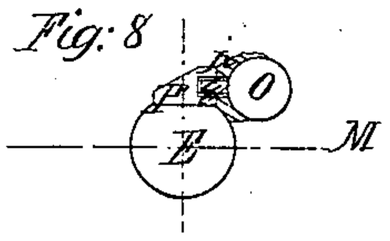


Fig: 6

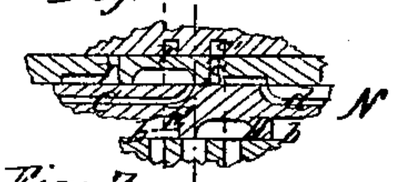


Fig: 10

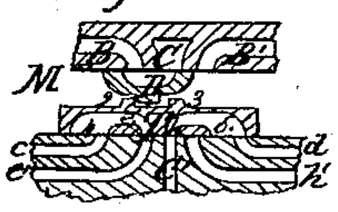


Fig: 7

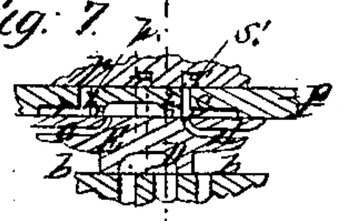
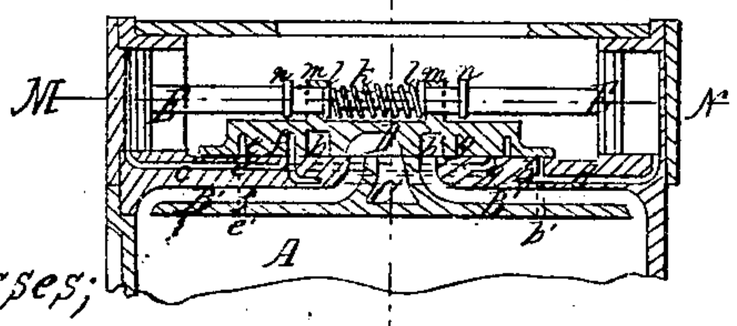


Fig: 9



Witnesses;

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J. B. Whitehead

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Chas. E. Emery

UNITED STATES PATENT OFFICE.

CHARLES E. EMERY, OF BROOKLYN, NEW YORK.

IMPROVEMENT IN PUMPING-ENGINES.

Specification forming part of Letters Patent No. 84,176, *dated November* 17, 1868.

To all whom it may concern:

Be it known that I, CHARLES E. EMERY, of Brooklyn, Kings county, New York, have invented certain new and useful Improvements in Steam-Pumps; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, making part of this specification.

The object of this invention is to secure a simple reliable steam-pump, occupying but little room.

The invention consists, substantially, in combining two auxiliary steam-pistons to operate the main valve of a steam-engine, and in the mechanical details of such combination to produce positive action without the aid of cams, levers, or tappets, operated by the main piston; and the construction is such that either of the systems used in combination may also be used separately, the first operating without cams or tappets when it is once started, the second starting itself and operating positively under all circumstances, when, by a lever or tappet, its valve receives an initial reverse movement from the main piston. The peculiarities of the details of construction of both steam and pump cylinders are more particularly designated hereafter.

In the drawings, Figure 1 represents a vertical longitudinal section through the steam and pump cylinders and chests, the steam-cylinder being constructed on the simpler plan of the two, afterward shown in combination. The section is drawn to show the passages clearly, though in practice they are not all in the same vertical plane, as represented. Fig. 2 is a vertical transverse section through the steam cylinder and chest; and Fig. 3 a similar section of the pump-cylinder. Fig. 4 is a vertical longitudinal section through the steam-cylinder, valves, &c., when constructed with two auxiliary pistons as heretofore referred to. Fig. 5 is a vertical transverse section of the same. The other figures will be referred to hereafter.

The same letters in all the figures refer to the same or corresponding parts.

A is the main steam-cylinder; B B′, the steam-cylinder ports; C, the exhaust-port; D, main slide-valve; and E the piston operating the same. F is the pump-cylinder, G G the ports of the same, H the receiving-pipe of pump, and I I discharge-openings. The steam-piston J and pump-piston K are connected by a piston-rod, L. The cylinders A and F are supported by feet or a proper frame, and are connected by rods or angle-bars at a distance sufficient, at least, to permit the packing of the piston-rod, and I prefer the distance should be such that no part of the rod is alternately exposed to the heat of the steam and the cold of the water. The valve D is of the common or *n* variety, as shown. The *m* valve may be used, if desired, by simply changing the direction of the parts in the operating piston. The valve D is operated by an auxiliary piston, E, which has two piston-heads working in short cylinders. (Seen at M and N.) The piston E is connected in any convenient way to valve D, and, in fact, the two may be made together, if desired. The piston E bears for a considerable distance at the bottom and forms a valve for its own passages. It is reduced in size in its middle, as shown in Fig. 2, so that steam entering at *a* into the steam-chest may pass down either side of it into the spaces *b b′*, and thus into either of the ports B B′ according to the position of the valve. A passage, *c*, extends from one end of the auxiliary piston E, and terminates at its lower part, which forms a valve-face, in two branches, *e* and *g*, one on either side of the main valve. A passage, *d*, from the other end of E, in a similar manner branches into *f* and *h*. The two central passages *f′* and *g′* are for the exhaust of the auxiliary piston, and lead directly into the main steam-ports beneath, (or through side passages into exhaust-port C,) and the two exterior passages *e′* and *h′* lead directly into the cylinder, either through studs cast in the main ports B B,′ as represented, or through the metal at the side of the main ports. These passages *e′* and *h′* are so placed that the packing-rings of main piston will just pass one of them when at the proper end of its stroke, in either direction.

When the main valve D is in the position shown, the passages *e* and *f* coincide with *e′* and *f′*, and *g* and *h* are closed, but when the valve D is in its opposite position, *g* and *h* communicate with *g′* and *h′*, and *e* and *f* are closed.

As represented in the drawing, the piston-

head and follower are beveled part of their circumference, so that the packing-rings, as they pass over, form a valve for the passages *e'* and *h'*.

The operation is as follows: As shown in the drawing, one end of the main cylinder is in free communication with the exhaust-port C, through port B, and main valve. So, also, the end N of auxiliary piston communicates, through passages *d*, *f*, and *f'*, with B, and the exhaust live steam enters the steam-chest at any convenient opening, *a*, surrounds the auxiliary piston, and, from the space *b'*, enters the port B', and pushes the steam-piston J to the opposite end of the cylinder, as shown, when the packing-rings pass by the opening *e*, and the live steam from the cylinder is admitted, through *e'*, *e*, and *c*, to the end of the auxiliary piston, at M, and pushes it toward N, carrying the main valve with it.

The motion of E is positive, until the main valve D laps the cylinder-ports B B. By that time the motion of E closes the two passages *e* and *f*, and the piston E, which has acquired considerable velocity, is carried by its momentum, past its mid-position, thus opening B to the steam and B' to the exhaust, and bringing *g* and *h* into communication with *g'* and *h'*, putting both ends M and N of the auxiliary piston in communication with the same side of the main piston. The auxiliary piston therefore comes to rest as soon as the friction overcomes the momentum previously acquired. When the steam entering B has pushed the piston by *h'*, steam will enter through *h'* and *h* to N, and throw the valve back to the position shown, and the operation will be repeated. By making sufficient clearance at M and N, so that the main valve may be thrown to open by the port fully half the width of the latter, no inconvenience arises from the piston E striking its heads, and rubber or equivalent cushion may easily be interposed. The main piston is permitted a movement, after it opens *e'* or *h'*, of half an inch to an inch, according to the weight of parts and the speed at which they are run. This gives time for the main valve to be shifted and admit the steam, which brings the main piston to rest and changes its direction. In practice, I usually put the passages *e* and *f* beside each other in a transverse plane, and thereby require less length to the valve-chest than is shown. The drawing is made especially to show all the passages at one view.

The above-described arrangement of valve will not always work at slow speeds, when the steam-chest is filled with water by condensation, or otherwise. A lever, *i*, or its equivalent, is therefore arranged so that by means of an external handle, *j*, the auxiliary piston and main valve may be moved by hand until the steam chest and cylinder are warm, and tolerably free of water, when the steam will operate the valve without difficulty. The lever *i* hangs in a long slot on back of piston E, and receives no motion, except when operated by hand.

For ordinary purposes, the occasional necessity of working the lever *j* by hand at starting is no objection. It is, in fact, far less trouble than to pry a crank-pump off the center. There are instances, however, when it is convenient to have the pump start invariably when the steam-valve is opened—as, for instance, when the pump is at the bottom of a mine and liable to be covered with water. Fig. 9 shows a simple manner of accomplishing this, and Figs. 4 and 5 represent more elaborate plans.

In Fig. 9 the auxiliary piston E operates the main valve through a spring, K. Any kind of a spring may be used. As represented, the piston E is in two parts, connected by a rod of varying diameter, which passes loosely through two lugs, *m m*, on back of valve D.

Inside the lugs *m m* are collars *l l* between which is a spiral spring, *k*. The collars *l l* slide loosely on the center of rod connecting E E, and rest against shoulders on said rod, which ordinarily are in the plane of the inner faces of the lugs *m m*. The operation then is such that if E be moved in either direction one of the rollers *l* compresses the spring against the other collars, and that drives the valve by pressing one of the lugs *m*. The spring is so adjusted that it must be compressed somewhat to overcome the friction of the valve. When, therefore, the valve is once in motion the tension of the spring K carries it on past its mid-position, though the impulsive force from E should cease at that point. In this arrangement the valve D is prolonged, as shown, and the posts *e*, *f*, *g*, and *h* run laterally, and at the proper time put *e'*, *f'*, *g'*, and *h'* in communication with the auxiliary cylinders M and N through passages *c* and *d* in the valve-seats, the operation being identical with that of the arrangement in Fig. 1.

In Figs. 4 and 5 a small auxiliary piston, O, is operated in the same manner as E in Fig. 1, but O only operates a valve, P, of another auxiliary piston, E, which moves the main valve D. As in Fig. 1, the passages are all represented in the same longitudinal plane, so as to show the operation, but, in practice, they are placed beside one another, and occupy much less length. The valve D and piston E are represented as being in one piece, though this is, of course, not essential. The valve P has two faces, one sliding on the large auxiliary piston E, (or the valve D when it forms the valve for passages *c* and *d*,) and the other against a stationary face, *p*. The piston O operates the valve P through an arm, *q*, which is attached to P and enters a proper recess in O. The arm *q* works back and forth in a slotted hole in face *p*. The passages *c* and *d*, which lead the steam to and from the ends of piston O, are placed in the metal of face *p*, and, by suitable openings, as shown, connect, through the valve P, with *e f g h* in

larger auxiliary piston E. The passages *f e g h* are put in communication with *e' f' g' h'*, precisely as in Fig. 1, by the movement of piston E, and the steam enters and operates piston O in the same way that piston E is operated in Fig. 1, the steam simply traveling by the longer route referred to, and which can readily be traced out on the drawing. The middle of valve P is a common slide-valve with a central exhaust-cavity communicating by a side passage with the exhaust-cavity in valve D. On each side of the exhaust-cavity are steam-ports *r* and *s*, which, at proper times, as hereafter explained, communicate with steam-ports *r'* and *s'* in face *p*, which open at the side directly into the steam-chest. The common valve in middle of valve P is arranged to permit the passage of the steam to and from the ends M and N of piston E. As shown in Fig. 4, the ports *c* and *d* are lapped by the valve, so E is at rest. The main valve D is in such position that the main steam-port B is open to the steam and B' to the exhaust. The piston J has been moved by the steam past passage *h'*, so that the steam will enter *h'*, pass into *h*, upward into *d'*, and finally press at N' on end of piston O. The end M' is meanwhile open to the exhaust through *c'*, *g*, and *g'*; so the piston O moves toward M' and the valve P assumes the position shown in Fig. 6. The steam-port *s* then communicates with the steam-chest through *s'* and with end N of piston E through *d*, while the end M is exhausted through *c* into the exhaust-cavity of P. The piston E is therefore pressed by the steam in the direction M, and takes the position shown in Fig. 7. The main valve is then admitting steam to the opposite end of the main piston, and the return stroke is commenced. It will be observed that, should the piston E, by its momentum, move farther than is shown in Fig. 7, the ports *c* and *d* will run under the face of the valve P, whereby steam will be shut off one end of piston E, and compressed on the other, and the piston and main valve be brought smoothly to rest in the same relative position respecting P as in Fig. 4, though both P and E will be at the other extreme of their motion in relation to the cylinder. As O and E receive their impulses at different instants and from different sources, there is no position in which the pump can be stopped when in operation but what it will start by admitting pressure of steam or water without external assistance.

I prefer to make the piston O move in the direction M more than half the throw of E before *s* reaches *s'*, and admits steam to *d* and N. Were steam admitted earlier, and from any cause E moved easier than O, E might suddenly move the port *d* under the face of valve P, and stop the motion of the main valve D, and perhaps that of the whole machine. The valve P may be operated by a tappet, as in other pumps, or a simple lever, *t*, (shown in outline in Fig. 7,) may be operated by main piston-rod, and, by a link, give P the opposite motion reduced, so that *s* will reach *s'* and *r r'* at the proper times to change the direction of main piston. It will be observed that were the face *p* entirely removed, (or in any way steam admitted to *r* and *s* in all positions,) and P moved in either direction, E would tend to follow it with a force proportioned to the pressure on the piston, and would move till it shut off the ports *c* and *d*; and thus a small force operating valve P could be multiplied into a very large one, acting through the same space, when the piston and valve-seat were made as shown, or a greater space if the valve-seat and piston were connected by a reducing-lever. The seat *p* and its valve may evidently be combined with a moving cylinder, with stationary piston, to produce the same results. I propose to use a modification of the above arrangement for operating the link or cut-off gear of steam-engines when the valve is moved by hand or the governor; also in other applications having similar requirements. It is necessary only that the valve P shall move on a face which receives motion from the piston or moving cylinder, and that the ports be led in such direction that the valve-face will, by the motion of the piston or cylinder, follow in the same direction that the valve is moved. I prefer to make the valve D, Fig. 1, with little or no lap, so that the direction of the steam is changed by a slight movement on either side of said position. In Fig. 4 the valve P is shown sliding between parallel seats E and *p*. It would be difficult to keep that exact arrangement tight in practice, and the drawing is made so for the only purpose, without changing the principle, of showing all the principal parts in one view. I prefer to put the two seats of the valve P (on E and *p*) at right angles to each other, as shown in Fig. 8. The face on E is represented as horizontal and on *p* as vertical. The arm *q* performs the same office as before, and the ports make a bend in P, from one face to the other, and accomplish the same purpose as in Fig. 4. I propose to operate the main valve D, Fig. 1, by the piston E, in the same indirect manner that O operates P. The object of interposing a valve-seat between the valve and its operating piston is to prevent leakage from the steam-chest to the ends M and N of the auxiliary piston when they are in communication with the exhaust. In Fig. 1 the two ends of piston E are furnished with packing-rings to prevent leakage. In most instances, however, it is better to inclose the piston entirely in a cylinder, separate from the steam-chest, as O is arranged in Fig. 4, and operate the valve by an arm passing through a valve-seat, as shown in Figs. 4, 5, and 8. As the valve covers, on all sides, the slot in which *q* plays, no steam from the chest can enter the auxiliary cylinder, except through the regular passages. The planes of the two seats must

be parallel in the direction of motion, but they may incline laterally at any angle.

The general principle involved in operating the piston E by steam from the cylinder, as shown in Fig. 1, is not new, but is believed to have been anticipated by Wheeler's patent in A. D. 1855, and afterward by Hopkins's patent in A. D. 1866. I consider, however, that my details of construction are an improvement upon theirs, and that, with simpler means, I obtain the same or a better result. In both the above patents the principle has been applied by using double pistons of unequal area, and the passages are designed and adapted to this method of construction. The distinctive feature of this part of my invention is, then, the arrangement and adaptation of a system of passages with an ordinary auxiliary piston, of uniform size, to accomplish the specified result. With such a piston it is easy to use a simple slide for a main valve.

On the pump side the invention consists chiefly of the manner in which the valve-seats are secured and jointed in the valve-chamber. For pumping salt water it is necessary—and for fresh water better—that the pump-valves and seats should be of brass, or similar material, and as this is expensive an economical method of construction is desirable. I arrange my pump-valves inside and outside a double box shaped piece, Q, Figs. 1 and 3, open at the sides, and perforated at the top and bottom for the delivery and receiving openings, covered by valves *u u t t*. The piece Q sits within a valve-chamber, R, which is preferably cast on the pump-cylinder. The chamber is also open at the sides, and is of sufficient height to permit free action of the delivery-valves *u u*. The delivery-openings I I and air-chamber are arranged on R. The sides of chamber R are made flush with the sides of piece Q, and both are covered tightly by bonnets *v v*, secured by one bolt in the center, or, better, by one or more at each end. The piece Q on its bottom and the pump-cylinder on the line *w* are faced, so that the joint is formed there in any usual way to prevent any communication of ports G G with H, or each other, except through the valves *t t*, and also, when desired, to prevent any water passing the ends of Q from the discharge-chamber above it. The piece Q is forced down to make the joint *w* by screws on its top backing against R, or by wedges *x x*, as represented. The wedges, after being driven, can be cut off flush with the sides of Q and R, and, if properly fitted, will themselves stop water passing to the ends of Q from the discharge-chamber above it. In the latter case the ends of Q need not be closed. I prefer, however, to have them closed, and make all the joints on the line *w*. The piece Q may be made in two or more parts and afterward put together, if desired. So also the chamber R may be bolted on the cylinder. The idea of putting all the pump-valves together for convenience of access is not new. The general arrangement is believed to have been abandoned by Worthington years ago. Hardik uses it, but makes the piece Q and chamber R in one piece of brass, bolted to the cylinder on a plane surface, all the valves being internal. Another maker uses a circular chamber corresponding to R, and fits a rectangular piece, Q, so that it bears tightly at the ends, and through its ends the parts G G are made to enter. The piece corresponding to Q neither touches bottom nor top of chamber R, the space in the circular chamber below Q being the induction, and above the delivery. In both arrangements the passages are necessarily somewhat contracted, to prevent which, in my plan, I make the piece Q with internal and external valves, like one maker, but lengthen it, to get any desired area or number of valves, and put it inside a separate pump-chamber, making the joint on the face of the pump, as has been shown. This peculiarity attaches, also, when the induction and eduction valves, for each end of the pump, are separated and placed on pieces like Q, secured at the bottom of valve-chambers like R.

I will further call attention that, when the valve P, Fig. 4, has but little lap over the parts *c* and *d*, the piston E may run beyond the valve-faces and reverse the openings. In such case, when the face *p* is not used, the steam will immediately enter and force the piston back till *c* and *d* again come under the valve-faces. It will be seen, in fact, that, with little lap on the valve-faces, the piston E cannot follow any faster or any farther than P is moved. When the face *p* is used, extra openings can be made, if desired, beyond *r'* and *s'*, to connect with *r* and *s*, and make the action the same, substantially, as above described.

When, for any reason, it is desired to use in this arrangement the *m* or double-chambered valve, it may be done without difficulty if the cylinder-ports be crossed—that is, the port covered by the left of the valve should lead to the right-hand end of the piston, and vice versa. Or I may say, in general, that it is necessary, for successful operation on this plan, that the valve-face should follow in the same direction as the valve, in order that the ports may be closed when the desired movement is attained. Conversely, the face may receive the initial movement, and the valve the motion of the piston or moving cylinder, when desired, taking care only that the secondary movement closes the ports against the part that has the initial movement. This latter plan would complicate the passages somewhat, but still it could easily be arranged, especially with the double-chamber slide.

Some manufacturers take steam from the main cylinder to move the auxiliary piston, and utilize the pressure exerted while the steam is exhausting. In order to accomplish this in my arrangement I make the passages corresponding to *e f g h* in a valve, separate

from the main valve, but moved by it, by means of a tappet having some lost motion; the object being to have the main valve move past its mid-position before the ports of the auxiliary cylinder are reversed. The principal features of the modifications are shown in Fig. 10, in which D is the main valve and T the valve governing the passages of the auxiliary piston. In practice D and T would be placed side by side on the same face. They are represented on opposite faces, so as to show all the openings at once. The auxiliary piston (not shown) moves D, and D, in turn, by the projection 1, moves T by striking 2 and 3. C′ is a passage leading direct to the exhaust. The passages leading to the ends of the auxiliary piston are represented by *c* and *d*, and *e′* and *h′* are, as before, the passages leading to the bore of the main cylinder. The passage *c* communicates at all times with 4 *e* in the valve, and *d* with 5 *h*. The passage *c*, through *e*, communicates in turn with *e′* and C; and *d*, through *h*, in turn, with C′ and *h′*. D is shown in the same position as in Fig. 1. If, then, steam enters *e′* in Fig. 10 from the cylinder, it will pass through 4, *e*, and *c* to the auxiliary piston, the other end of the latter meanwhile exhausting, through *d*, 5, and *h*, into C′, *h′* remaining closed, so that the action is as before described. The only difference is that when D moves, the projection 1 strikes 3 at such time that *e* is not shut off until after B′ is open to the exhaust. The pressure of the exhausting steam is, therefore, kept on the auxiliary piston until after it, with D, has passed into position. The reverse movement is identically the same.

An arrangement somewhat similar to the above may be found in Hopkins's patent heretofore referred to. By employing two loose rings, he, in a measure, utilizes the pressure of the exhausting steam. I propose putting both the induction and eduction passages in a slide-valve, which is easily kept tight and in order. The operation of the two plans is substantially the same, the distinctive features evidently being in the construction.

In some cases I put in the face of the valve P, near the steam ends, extra exhaust-openings *z z*. (Shown only in Fig. 7.) It will be observed that if *c* and *d* move under the faces of P, the steam on the end M will be cushioned, and on the end N exhausted through *z*. I make *z* narrow, so that E will move on and shut it, and thus leave *c* and *d* closed to the exhaust, to prevent leakage during the return-stroke. The distinctive feature of the arrangement in Fig. 4 is the combination of two auxiliary pistons—the first moving the valve of the second, and the second operating the main valve. Any other arrangement than that shown may be used to admit the steam, or give the initial movement to the first piston, and a different valve and arrangement of passages may be used for the second piston.

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

1. The combination, with cylinder A, main-piston J, and the equal heads M and N of auxiliary piston E, of the ports *e f g h* in a valve-face operated by E and *e′*, *f′*, *g′*, and *h′*, in the valve-seat, when arranged substantially in the manner specified.

2. The arrangement of the exhaust-passages *f′* and *g′* with reference to the ports B and B′, substantially as described, to accomplish the results specified.

3. The combination of two auxiliary pistons, the first to operate the valve of the second in both directions, without the assistance of tappets, and the second to operate the main valve in the usual manner, to accomplish the results specified.

4. The connection of a moving piston or cylinder with the seat of its slide-valve in such manner that the motion of the piston or cylinder causes the valve-seat to follow the initial movement of the valve and close, and, if necessary, reverse, the parts, and thus bring the moving piston or cylinder to rest, substantially in the manner described, to secure the results specified.

5. The passages *r′* and *s′*, so arranged, in combination with *r* and *s*, as to admit steam to the auxiliary piston E after the valve P has moved the desired distance.

6. The extra exhaust-ports *z z*, when arranged, as shown, in the face of the valve, substantially as described.

7. The particular arrangement of the valve-seat piece Q with the valve-chamber R and the face of the pump-cylinder at *w*.

CHAS. E. EMERY.

Witnesses:
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