J. R. PADDACK.

Direct Acting Engine.

No. 167,408. Patented Sept. 7, 1875.

Fig. 1.

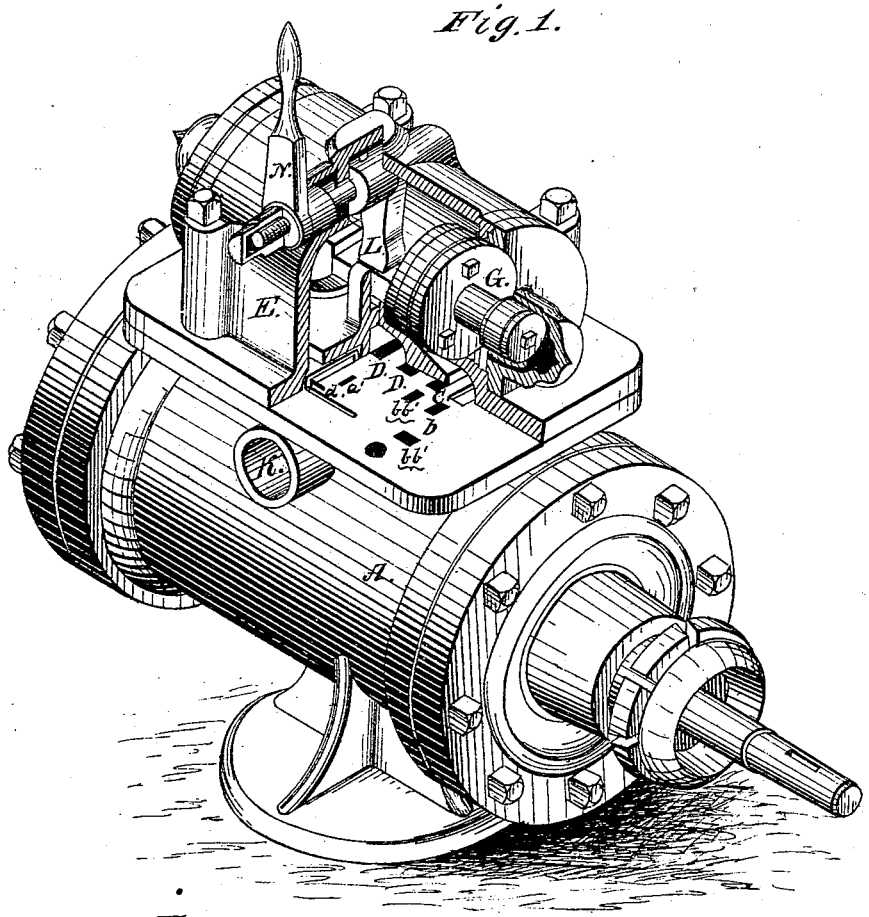


Fig. 2.

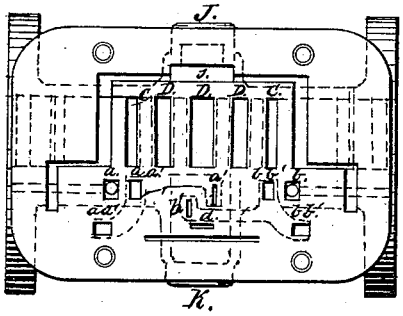
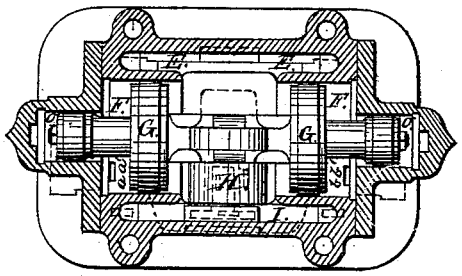


Fig. 3.



Witnesses:

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John Whitehead

Inventor:

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Fig. 4.

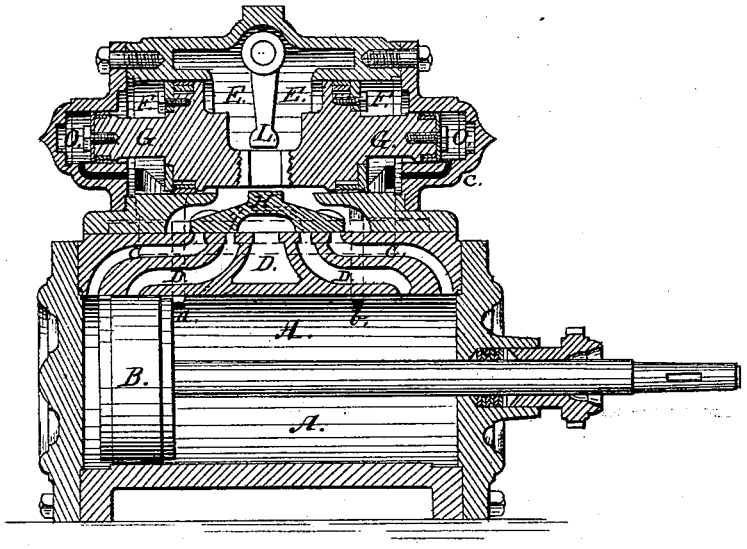


Fig. 5.

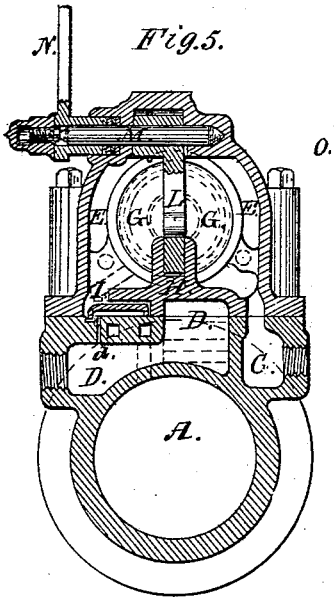


Fig. 6.

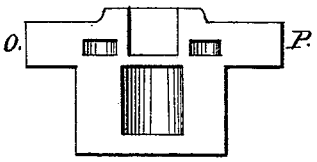


Fig. 7.

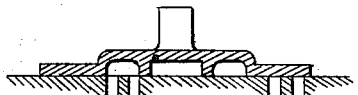


Fig. 8.

Fig. 9.

Fig. 10.

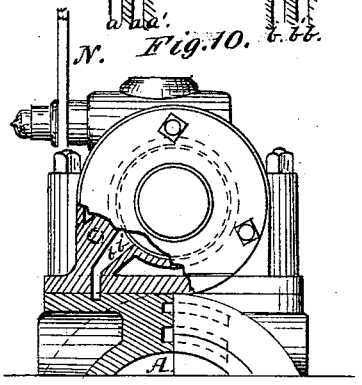
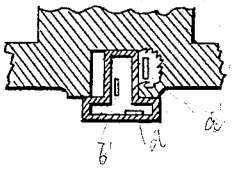


Fig. 11.



Witnesses:

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Inventor:

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UNITED STATES PATENT OFFICE.

JAMES R. PADDACK, OF CHICAGO, ILLINOIS.

IMPROVEMENT IN DIRECT-ACTING ENGINES.

Specification forming part of Letters Patent No. **167,408**, dated September 7, 1875; application filed July 27, 1875.

To all whom it may concern:

Be it known that I, JAMES R. PADDACK, of Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Direct-Acting Steam-Engines; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings making a part of this specification.

The object of the invention is to furnish a more direct, simple, reliable, economical, and durable method of operating the valves of direct-acting steam-engines. The invention consists in combining a single auxiliary steam-piston and the valve it operates with a system of steam and exhaust ports, so as to furnish a direct and continuous supply of steam to and exhaust from the heads of said auxiliary piston, to operate it during the entire distance of its travel, producing the most direct and positive action without the multiplication of auxiliary pistons and valves or the complicated intervention of mechanical combinations of levers, cranks, cams, tappets, springs, &c., with their numerous adjustments and liability to derangement, which have hitherto been employed.

Figure 1 presents a perspective view of the engine with a portion of the shell of the steam-chest cut away, so as to show the auxiliary piston, the valves, and some of the ports. Fig. 2 is a plan of the valve-seat, showing the different ports employed. Fig. 3 is a horizontal section of the steam-chest. Fig. 4 is a vertical longitudinal section through the steam-cylinder and steam-chest. Fig. 5 is a vertical transverse section through steam-cylinder and steam-chest.

The other figures will be referred to, as required, in the course of the description and explanation.

In the description all the parts directly connected with the main steam-cylinder or its operations are so designated by having the word "main" prefixed, and those with the auxiliary steam-cylinder by having the word "auxiliary" prefixed.

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

A represents the main steam-cylinder having the steam-inlet J and outlet K, main piston B, main steam-ports C, and main exhaust-ports D. E is the steam-chest inclosing auxiliary cylinder and piston, main steam-valve, and auxiliary exhaust-valve. F is the auxiliary steam-cylinder, having a space between it and the shell of the steam-chest, which affords it a steam-jacket, and having the middle portion of its shell cut away, exposing the inner heads of auxiliary piston to steam-chest.

G is the auxiliary or valve-moving piston, having two heads, provided with metallic packing-rings, one head working in each end of auxiliary steam-cylinder, the two connected by a yoke extending between them, which has square notches in the middle, to receive lugs, which project up from the top of main steam-valve. It also has two plugs, one extending from each end, which work in the small cylinders or cushioning-chamber formed in the heads or caps of auxiliary cylinder.

H is the main steam-valve, having two lugs projecting up from its top, and fitting into the square notches in the yoke of the auxiliary piston connecting the two, so they shall move together as one piece. It also has three cavities, D-shaped, in its face, as seen in Fig. 6. The main cavity, or larger and central one, moves over the main steam-ports in the usual manner. The two auxiliary cavities or smaller ones are placed in wings provided for them, extending each way, right and left, from the body of the valve. They move over the auxiliary steam-ports, as shown in Fig. 7. The space between the wings leaves room for the auxiliary exhaust-valve to move in, as seen in Fig. 11. I is the auxiliary exhaust-valve. It moves in the space between the wings of the main steam-valve. It has two grooves in its face, one crossing at the end of and intersecting the other, forming a T-shaped cavity, as shown in Fig. 8. It also has a lip or projecting strip along one edge of its face, as shown in Fig. 9, which works in a groove in the valve-seat, and serves as a guide. The cross-portion of its cavity moves over, and is in constant communication with, auxiliary exhaust-port *d*. The wider and main portion of the cavity moves over, and alternately covers and communicates with, steam-ports *a'* and *b'*. L is a finger, attached to

shaft M, which is operated by lever N, for shifting auxiliary piston by hand, if desired. O is a cushioning-cylinder, for auxiliary piston, formed in the heads or cups of auxiliary cylinder. *aa'* is an auxiliary steam-port. It starts from the left end of auxiliary cylinder, and leads down to an outlet in the valve-seat, under the main steam-valve. It is the trunk in a system or series of ports, in which *a* and *a'* are tributaries. *bb'* is an auxiliary steam-port at the right end of auxiliary cylinder, and corresponds with *aa'* on the left. It is the trunk in a system or series of ports, in which *b* and *b'* are tributaries. A portion of *bb'* is shown in Fig. 10, extending down from auxiliary cylinder, penetrating into the valve-seat, and running under its surface in the direction indicated by the dotted lines in Fig. 2, and reappearing at the point indicated by the letters representing it, adjacent to port *b*. *aa'* reappears adjacent to port *a*. *a* is an auxiliary steam-port, extending up from near the left end of main steam-cylinder, as seen in Fig. 4, to an outlet in the face of the valve-seat, under the main steam-valve, as seen in Fig. 7. It is a tributary in the series in which *aa'* is the trunk. *b* is an auxiliary steam-port near the right end of main steam-cylinder. It corresponds to *a* on the left, and is a tributary in the series in which *bb'* is the trunk.

a' is an auxiliary steam-port descending from an outlet, marked *a'*, near the middle of the valve-seat, and running under the surface of the seat in the direction indicated by the dotted lines, Fig. 2, and entering the auxiliary port *aa'*, of which it is a tributary. *b'* is an auxiliary steam-port corresponding to *a'*, and entering *bb'*, of which it is a tributary. *d* is the auxiliary exhaust-port descending from the valve-seat, under auxiliary exhaust-valve, and entering the main exhaust, as shown in Fig. 5. *c* is a channel or p ssage connecting auxiliary cylinder with cushioning-chamber.

The operation is as follows: As seen in Fig. 4, the main piston B is at the end of its stroke to the left. Just before reaching this position it passed and exposed auxiliary steam-port *a*, so the steam that was driving it passed up this port, and into its trunk-port *aa'*, with which it is connected at this time by the left auxiliary cavity of main steam-valve, as shown in Fig. 7, and on into the left end of auxiliary steam-cylinder F, driving auxiliary piston G, which carries with it main steam-valve H from left to right.

In Fig. 4 the main steam-valve is shown to have reached its mid position. Before reaching this position its left auxiliary cavity passes out of connection with auxiliary port *a*, and cuts off communication between the main and auxiliary steam-cylinders. This is rendered necessary in order to prevent steam from returning to main steam-cylinder when its exhaust should be reversed by the main steam-valve passing its mid-position; but should no further supply of steam be furnished the auxiliary cylinder its piston would have to depend for the balance of its throw on the momentum it had gained and the expansion of the steam received. Experience having shown this to be insufficient, a further supply of steam is rendered necessary.

This further supply I furnish direct from steam-chest, through auxiliary steam-port *a'*, as follows: When the main steam-valve is at the end of its travel to the left its right wing covers auxiliary port *a'*, as seen in Fig. 11; but on the first movement to the right the wing passes away from and leaves the port exposed. Steam immediately enters it, and through it and its trunk-port *aa'*, with which it connects, into left end of auxiliary cylinder, and completes the required throw of auxiliary piston.

The extra space between the left wing of main steam-valve and auxiliary exhaust-valve, as seen in Fig. 11, allows the main valve to travel all the distance required of it before it drives the auxiliary exhaust-valve over the port *a'*. In driving this valve over the port *a'*, at the end of its own throw, it cuts steam off from the auxiliary piston at the end of the throw required of it, leaving only its momentum to be arrested by its cushion. The cushion is provided at this precise juncture by the ring on the plug at the right end of auxiliary piston closing the channel *c*, thereby retaining in the cylinder O the remaining steam for a cushion.

Before the throw of the auxiliary piston is arrested the auxiliary exhaust-valve is carried over, and the wider portion of its cavity covers and communicates with auxiliary steam-port *a'*; and, as the narrower portion of this cavity is in constant communication with auxiliary exhaust-port *d*, communication is thus opened between the left end of auxiliary cylinder and the main exhaust, providing a full exhaust from that end of auxiliary cylinder. When the main steam-valve reaches the end of its throw to the right, its right auxiliary cavity is brought into communication with auxiliary steam-port *b*, and connects it with its trunk-port *bb'*, and thus opens communication between the right ends of main and auxiliary cylinders. The main steam-valve has also at this time opened steam to the left end, and exhaust from the right end of main piston B, causing it to follow the direction taken by auxiliary piston from left to right; and when it passes and exposes auxiliary steam-port *b*, steam passes up the port, and into the right end of auxiliary cylinder, as it did before through port *a* into the left end, and then a similar series of movements takes place from right to left, as those just described from left to right, and so on.

The number and arrangement of valves here presented have been selected as the best adapted to illustrate and explain the invention. Any other number or form may be employed. The auxiliary valve may be straight, and made to vibrate on a pivot, or it may be cir-

cular in form, and made to vibrate on a pivot through one of its circles, or to partly rotate on an axis at the center of its circle, or two may be used—one at each end of the steam-valve.

The auxiliary cavities may be placed in a separate valve, whose seat may be on the same plane with the seat of the main valve, or one at an angle to it, or they may be placed in a separate face of the main valve at an angle to the face containing the main cavity, or the main valve may be a piston-valve and the other a slide-valve, and the substantial features of the operation all preserved. All these different arrangements have been considered and contemplated.

The general feature of operating an auxiliary piston by steam taken from either steam-cylinder or steam-chest is not new. Two auxiliary pistons have been used—the first taking steam from main steam-cylinder and operating the valve of the second, and the second taking steam from steam-chest and operating main steam-valve. This arrangement is expensive, complicated, liable to derangement, and involves loss of time in reversing the engine, as the movement of main steam-valve is a secondary one, an auxiliary valve having to be operated before it can move. A single auxiliary piston has also been used, taking steam from the main steam-cylinder only. With this arrangement a supply of steam can only be furnished during half the distance the auxiliary piston is required to travel, and this is insufficient to do the work except at high steam-pressures and at high speed, and is not reliable then.

The distinctive feature of this part of my invention is the combining a single auxiliary piston and the valve it operates with a system of steam-ports, so as to give a continuous supply of steam to operate the piston during the entire distance it is required to travel, taking the supply that gives it its initial movement from the main steam-cylinder, and the supply that continues and completes its movement from the steam-chest.

The peculiar feature of that part of my invention that relates to exhausting steam from the auxiliary steam-cylinder consists in combining an auxiliary exhaust-valve, moved by a main steam-valve, with a system of ports arranged so as to secure the results specified.

The peculiar feature of that part of my invention that relates to cushioning the auxiliary piston is employing a channel connecting auxiliary and cushioning cylinders in combination with an auxiliary exhaust-valve in such a manner that at the precise instant that steam is cut off and retained in the cushioning-cylinder to arrest the motion of the piston steam is also exhausted and the pressure relieved from the opposite end of the piston.

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

1. The combination, with main piston B, auxiliary piston G, and main steam-valve H, of a system of ports composed of *aa'* and *aa'*, *bb'* and *bb'*, arranged substantially as described, to accomplish the results specified.

2. The combination, with auxiliary piston G and main steam-valve H, of an exhaust-valve, I, and a system of ports composed of *aa'*, *a'*, and *d*—*bb'*, *b'* and *d*, arranged substantially as described, to accomplish the result specified.

3. The combination, with auxiliary cylinder F, auxiliary piston G, and cushioning-cylinder O, of channel *c*, and auxiliary exhaust-valve I, arranged substantially as described, to accomplish the result specified.

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Witnesses:
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JOHN WHITEHEAD.