3 Sheets. Sheet 1.

A. Seely,

Compound Steam Engine.

No. 78,764. Patented June 9, 1868.

Fig: 1.

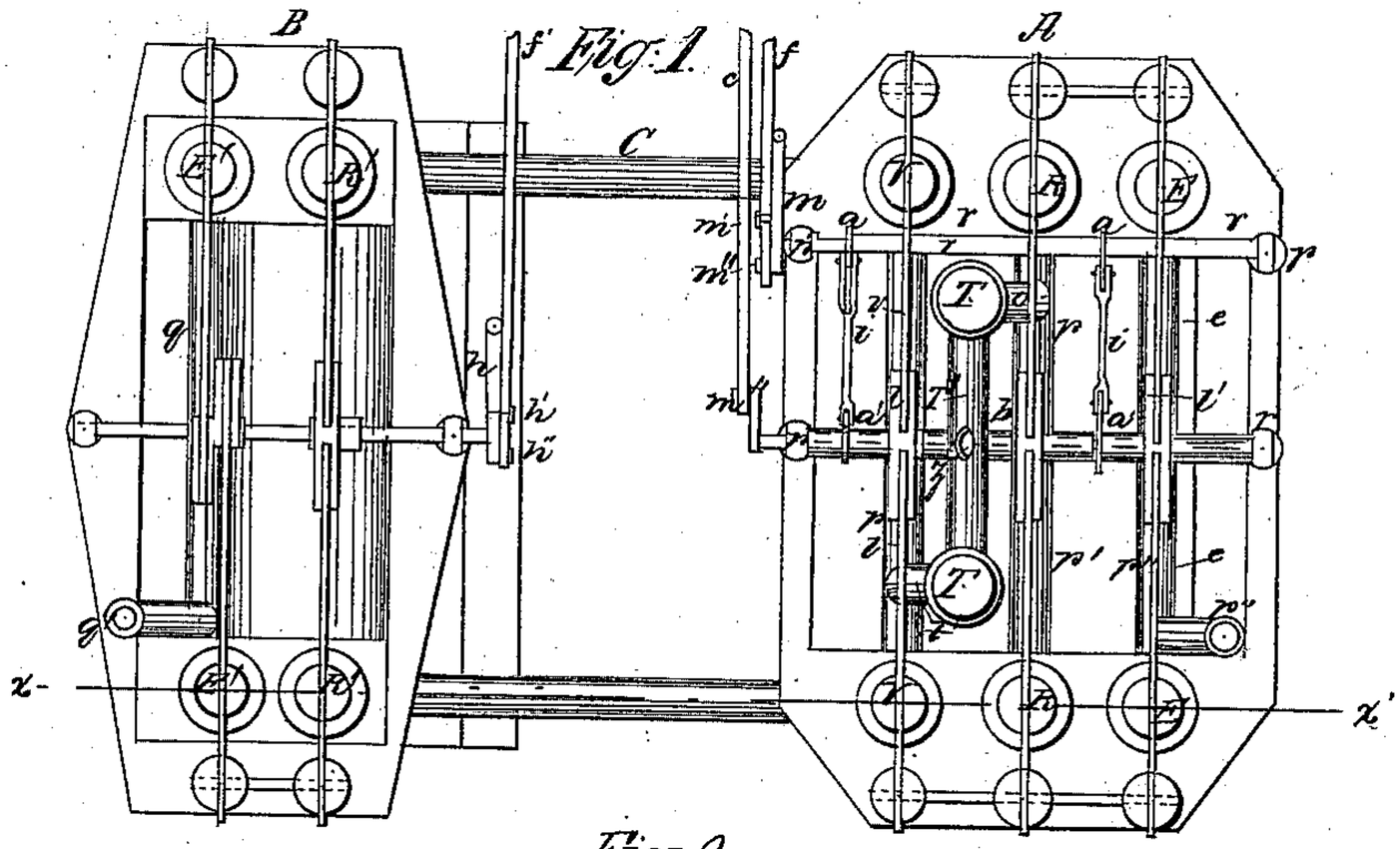


Fig: 2.

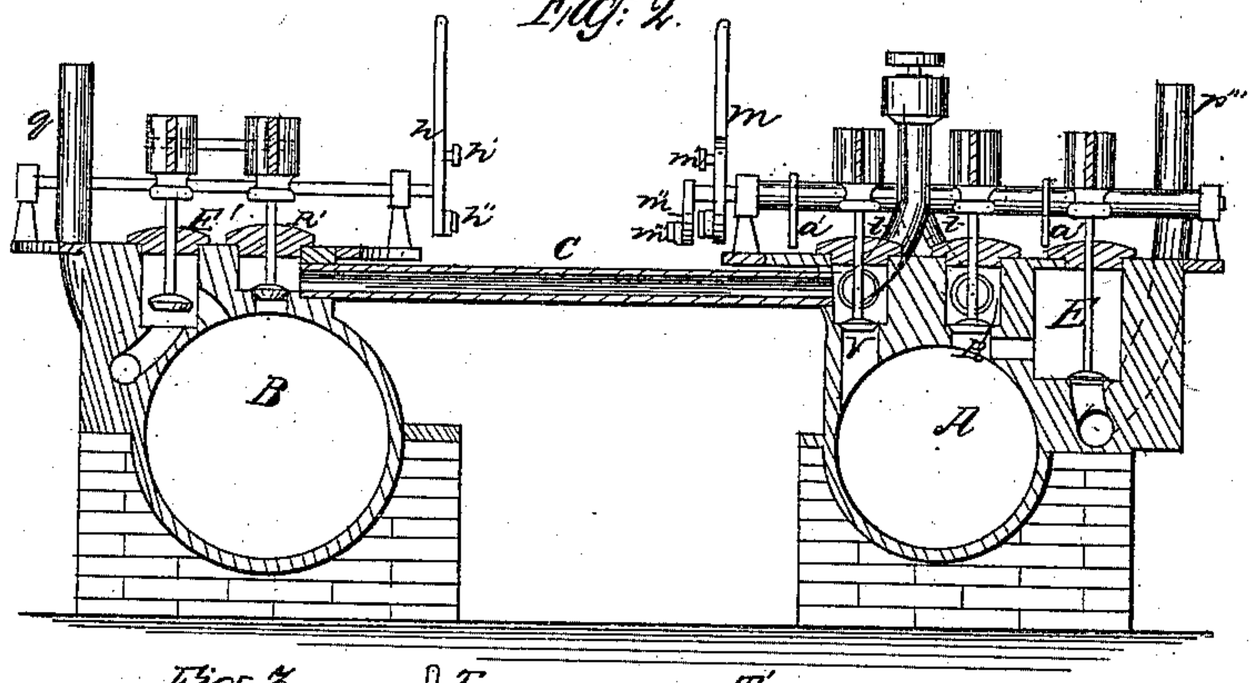
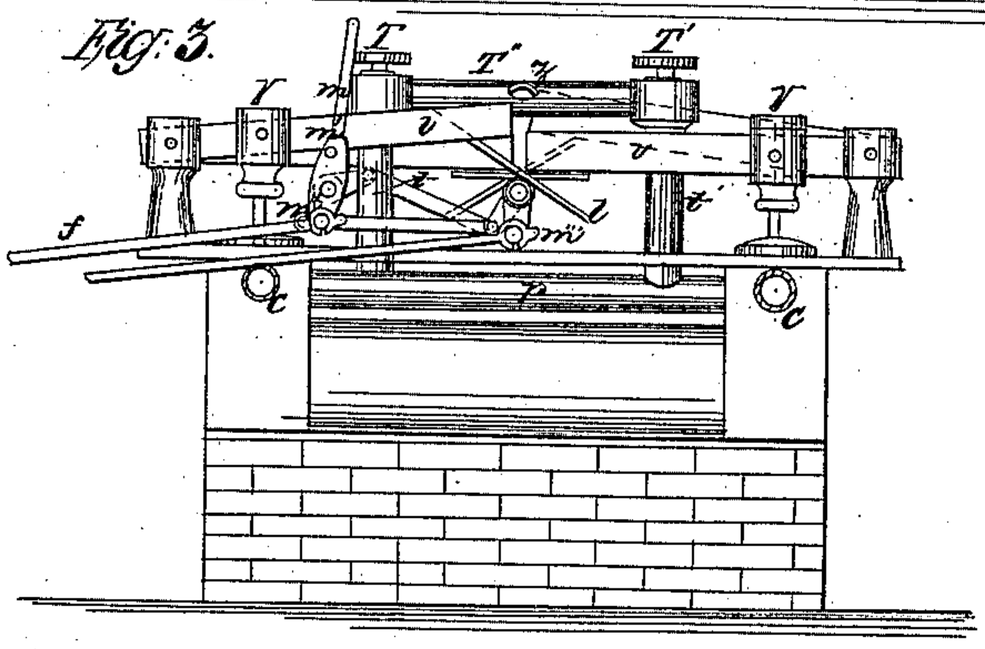


Fig: 3.



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3 Sheets. Sheet 2.

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Fig: 4.

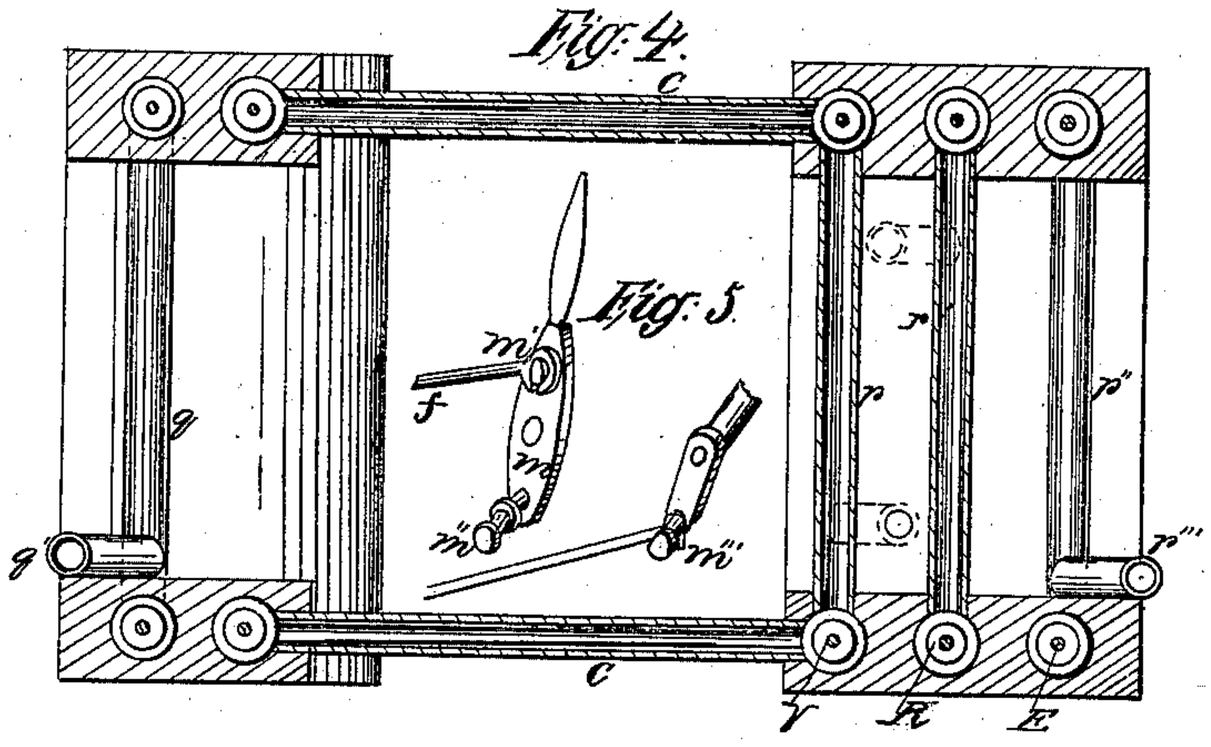
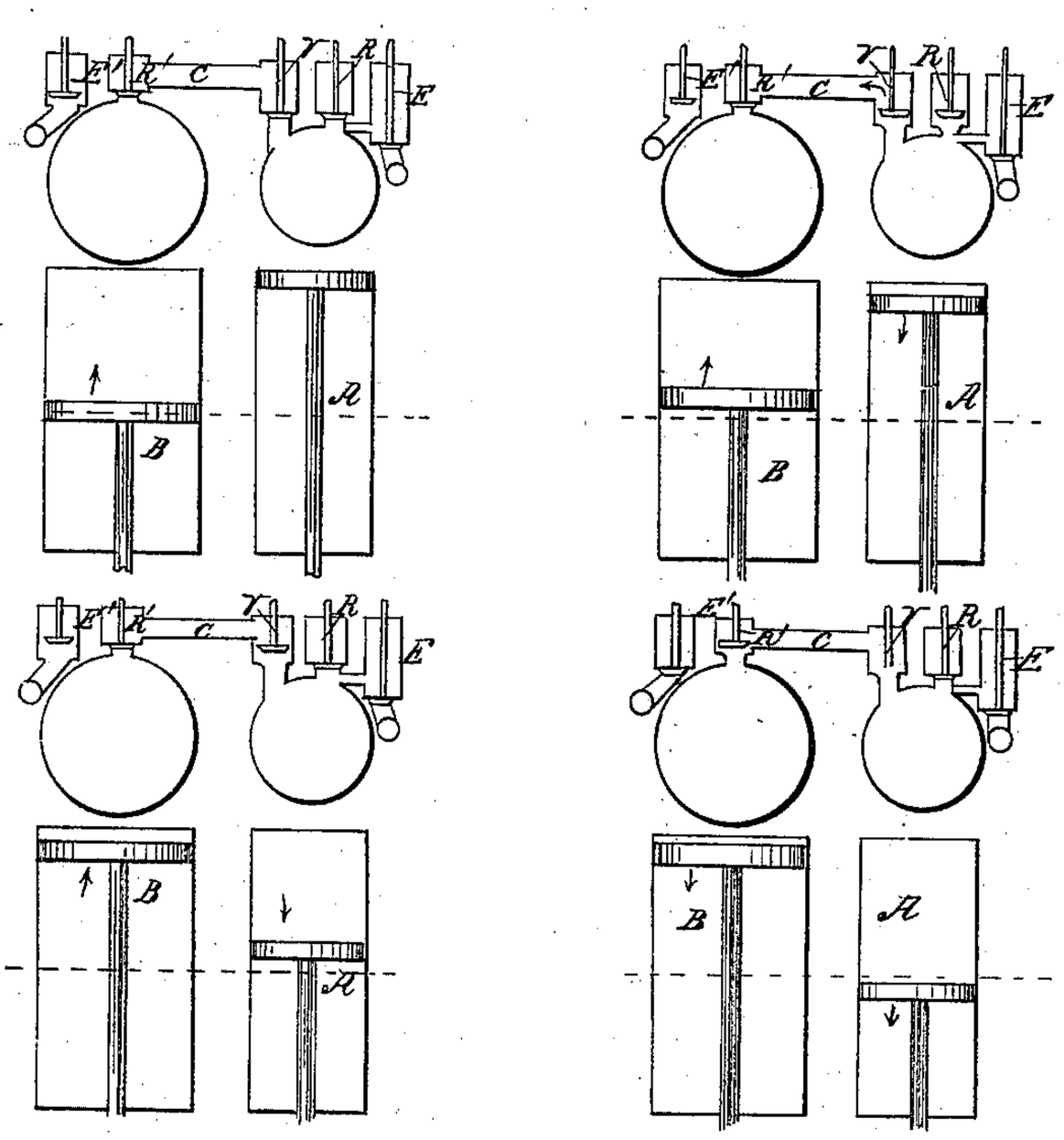


Fig: 6.



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3 Sheets. Sheet 3.

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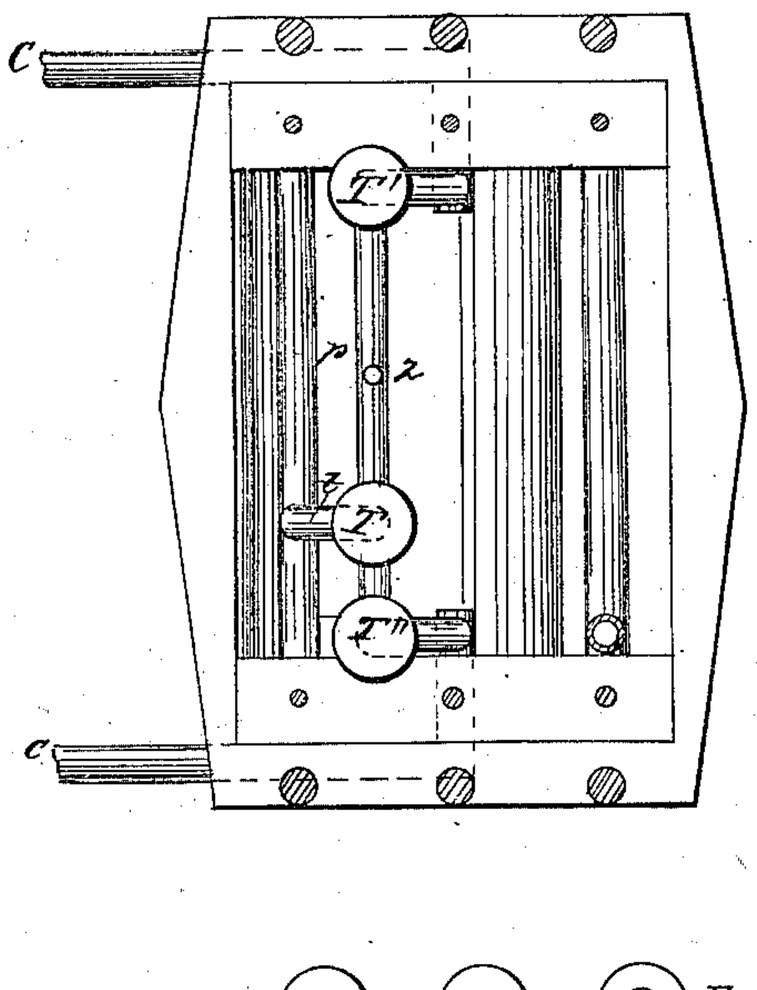
No. 78,764. Patented June 9, 1868.

Fig: 1.



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UNITED STATES PATENT OFFICE.

AUSTIN SEELY, OF ALTON, ILLINOIS.

IMPROVEMENT IN VALVE-GEAR FOR STEAM-ENGINES.

Specification forming part of Letters Patent No. **78,764**, dated June 9, 1868.

To all whom it may concern:

Be it known that I, AUSTIN SEELY, of Alton, in the county of Madison, and State of Illinois, have invented a new and improved Expansion-Engine; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to make and use the same, reference being had to the accompanying drawings, forming part of this specification.

Figure 1 is a top view of cylinders.

Figure 2 is a vertical section of the same, through *x x'*, fig. 1.

Figure 3 is a side elevation of cylinders A, fig. 2.

Figure 4 is a horizontal section of the two cylinders through the connecting-pipes and valve-chests.

Figure 5 is a detail perspective view of the cam-rod on the pin used for reversing the engine.

Figure 6 is a series of diagrams, showing the relative positions of the valves and pistons.

Figure 7 is a modification of the pipe-connections.

Similar letters of reference indicate corresponding parts.

My invention consists in the arrangement of devices as will be hereinafter more fully described.

Engines have been constructed with auxiliary expanding-cylinders, for using the steam at a lower pressure after it has driven the piston in the first cylinder. These have the exhaust side of the first cylinder communicating with the receiving or steam side of the auxiliary cylinder.

In my improvement the receiving sides of both cylinders are connected, and a portion of the steam used in the first cylinder is exhausted into the air in the usual way, and another portion by expansion drives the pistons of both cylinders, as will be shown. In 1854, B. F. Day obtained Letters Patent, No. 11,119, for a compound engine using the steam expansively in two cylinders, connected as last described.

Slide-valves are used, and both cylinders receive steam from the same throttle, which presents a variable adjustment of the expanded steam.

Practical difficulties in reversing and otherwise manœuvering or handling this engine render it incapable of successful application on boats, and my invention is designed to so improve, and substitute for some of its parts, improved devices, that the expansion of steam in two connected cylinders can be made available and practicable on boats or elsewhere.

To apply my improvements, two cylinders, A and B, figs. 1 and 2, are connected by the pipes C C, which open into the steam-chests of the two cylinders, as shown at figs. 2 and 4. The pistons of the two engines connect to the same shaft by cranks, at right angles with each other.

On the shaft are cams and yokes, of the usual construction for operating the valve-gear of both cylinders. The cam-rods connecting them with the rock-shafts are shown at *f*, *c*, and *f'*, fig. 1.

In fig. 1, the valves R R are the receiving or steam-valves, and E E are the exhaust-valves, of cylinder A. The first take steam from the throttles T, through the side-pipe *p'*, which opens into their valve-chests, and the second exhausts a portion of the steam used through the exhaust side-pipe *p''*, leading to the escape-pipe *p'''*.

These valves may be double or single puppet-valves, of the ordinary construction, and are operated by levers and lifters, as heretofore made, nothing new being claimed in their specific operation. These valves are shown in section at R and E, fig. 2.

The steam-chests of cylinder A contain, in addition to the valves just described, auxiliary valves V, in separate chests, the ports of which open into cylinder A, and the valves, when lifted and seated, open or shut off steam communication from the said cylinder. The pipes C C, connecting cylinders A and B, open into these valve-chambers, just above the valves V, as shown at fig. 2, and by the lifting of these valves, part of the steam within cylinder A escapes into cylinder B, and, by expansion, drives the piston of the latter.

The said valves, when seated, prevent the reaction of the steam into cylinder A at that end which is exhausting, and the timely lifting of these auxiliary valves, to admit the steam into cylinder B, and again seating to prevent the reaction aforesaid, is accomplished by levers and lifters, operated by the full-stroke cam-rod *f*, which also operates the

exhaust-valves E E of the same cylinder, for the lifter *l* which raises the levers *v v* of the auxiliary valves V V, and the lifter *l'*, which raises the levers *e e* of the exhaust-valves E E, are all loose lifters, and work with sleeves on the rock-shaft *r*, the latter carrying the fast lifter *b*, which receives its motion from a cut-off cam, by the rod *c* and pin *m'''*. Said lifter *b* raises the steam-valves R. The loose lifters receive their motion from a full-stroke cam by the rod *f*, which vibrates a secondary rock-shaft, *r' r'*, communicating its motion to the loose lifters *l l'*, by arms *a a* and links *i i*, the latter being connected with arms *a' a'*, attached to the said loose lifters.

Both of these rock-shafts are provided with outer arms and pins, for hooking on the cam-rods *c* and *f*, to their respective rock-shafts, as will be shown.

The valve-gear of cylinder B consists of a single rock-shaft, with fast lifters, and an arm, *h*, with upper and lower pin, *h' h''*, to hook thereon a full-stroke cam-rod, *f'*. The valves are lettered R' R', E' E', and, together with its levers and lifters, are of the ordinary construction, and are shown in figs. 1 and 2. The secondary rock-shaft *r' r'*, on cylinder A, has a lever-arm, *m*, for working the rock-shaft by hand, and upper and lower pins *m' m''*. *m'''* is the pin on the cut-off rock-shaft *r r*.

The throttle-valve T admits steam to the receiving-valves R R, by means of a pipe, *t'*, leading from it to the side-pipe *p'*. A similar throttle-valve, T', admits steam to the pipe *p*, connecting the two valves V V, by means of a pipe, *t'*. These pipes *t* and *t'* are connected by a horizontal pipe, T'', which is shown with an opening, *z*, for the main steam-pipe from the boiler.

The throttle T' admits, when opened, additional steam to the cylinder B, so that the steam expanded in both cylinders can be augmented in cylinder B, by admitting steam from the boiler through the said throttle-valve.

By this means the engineer is enabled to increase the power of the auxiliary cylinder at will, when it is necessary to do so, for the regular action of the valves on cylinder B does not interfere with the continuous pressure of the steam through T', as will be shown. This arrangement of a second throttle is of great advantage, for the current around river bends, and in other places, is often very strong, requiring the full power of the engines to be exerted in propelling a boat against it.

When the steam is admitted through both throttles, a variable expansion is the result, and this can be controlled and regulated by the amount admitted through either throttle, or by entirely closing one of them.

The relative action of the valves of both cylinders is shown in the skeleton diagrams, fig. 6. As the action of the valves at both ends of the cylinders is identical, those of one end only will be shown, together with the relative position of the pistons T.

In Diagram I, the piston A is up, piston B at the centre, and going up, the valves E R V R' are seated, E' being up, and the crank of B on its upper half centre.

Diagram II. The piston A begins to descend, valves R and V lifting together. A takes steam for the down stroke, through R, and steam also fills the pipe C, stopping at the valve R', which has not yet lifted. The piston B is past the centre, its crank just past the half centre.

Diagram III. Valve R seats, cutting off the steam from piston A, when nearly at half stroke down, piston B has arrived nearly up.

Diagram IV. Valve R' lifts, E' having seated, and the steam expands in both cylinders, driving piston A to the bottom, and piston B to the centre, and its crank to the lower half centre.

The same action then follows at the other ends of the cylinders, so that while the piston of A is driven by expanded steam, the greater portion of its stroke each way, that of B is wholly driven by expanded steam, unless the throttle T' is opened, in which case the pressure in both cylinders is equally augmented.

To prepare this engine for reversing, ship the full-stroke rod *f* on its reversing-pin *m'*, then throttle T being closed and T' opened, the valves R become neutral, the valves V acting as receiving-valves.

The cut-off cam-rod need not therefore have a hook, but be provided with a strap-joint, as shown at fig. 5.

For reversing cylinder B, ship the rod *f'* on the upper pin *h'* of the arm *h*. The steam is shut off at T, and throttle T' used only in reversing.

After getting under headway, to work the engines expansively, T' is closed and T opened.

When using throttle T' alone, the valves R R become neutral, being simply lifted and seated without admitting steam, and to prevent the pressure from within the cylinder from raising the said valves and their levers, the former are fitted with a slight slip on their stems, just sufficient to admit the steam to the space above the valve, thus preventing the raising of their stems and levers.

A similar slip may be given to the valves V V for the same object. By means of the double throttle the expansion of steam may be varied between the maxima and minima extremes.

The cost of my engine will be no greater than that of the common ones of equal nominal horse-power now used on stern-wheel boats, and will be an improved substitute for the same by connecting the cranks at each end of the wheel with one cylinder.

By this arrangement of an auxiliary cylinder, I propose to expand steam to ten volumes, which give an effect, in proportion to that of a half-stroke cam, as 31 to 17, nearly.

I have contemplated various modifications of the valve-gear of my engine, each of which

would be attended with certain advantages. For example, in the valve-gear of cylinder A, the positions of the rock-shafts could be reversed, also the cams on the main shaft, which would connect the full-stroke rod with the rock-shaft now shown at r' r'. This would necessitate the lapping of one pair of full-stroke levers; there would then be two tight lifters and one loose one, the reverse of the present arrangement. Again, by connecting the full-stroke rods to common links, the operation of reversing would be reduced to the simple motion of raising and lowering the same.

To obviate the filling of both pipes C each time the steam is admitted by the valves R, a modification of the pipe-connections may be made, as shown at fig. 7, in the red diagram, where T and T'' are additional throttle-valves, one on each side of the main throttle-valve T.

The connections are made as shown, t being the pipe connecting the three throttles. z is the opening for the steam-pipe. From the boiler p p are short pipes, leading to the valve-chambers V V. t' is a short pipe leading from the chamber of the throttle-valve T to the receiving side-pipe p'.

By this improvement, when valves T' and T'' are closed, the steam is admitted to the pipe C alternately, and only when the valves V rise from their seats.

This arrangement dispenses with the side-pipe p, connecting the chambers of the valves V, as shown in the other figures. When the throttle-valves T' T'' are opened, the steam from the boiler then augments the expansion of steam in the cylinder B, and consequently equalizes the pressure in both cylinders.

This improvement will be found to economize the steam by lessening the radiation and condensation which take place when both the pipes C are kept filled.

The shaded drawing at fig. 7 exhibits another and preferable manner of arranging the connections of the three throttle-valves. In this modification, the valves V V are connected by the side-pipe p, and the receiving side-pipe p' dispensed with, the throttles T' and T'' being situated in a pipe connecting the three throttles, as shown in the drawings at fig. 7. From this pipe, short pipes t' connect with the receiving-valves R R, and a single short pipe t connects the side-pipe p, of the valves V V, with the pipe connecting the three throttles, as shown. z is the point of junction of the steam-pipe from the boilers. In this figure the elbow-pipes, shown in the red diagram, are employed to connect the throttles T' T'' with the receiving-valves, and the single throttle, T, is used to admit steam from the boiler to the auxiliary cylinder B. The valves T' and T'' are closed when the engine is backing, thus rendering the receiving-valves R R neutral, as before mentioned. This arrangement I consider preferable to any of the others where only two throttles are used.

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

1. The additional throttles T, arranged with reference to both cylinders, substantially as shown, for the purpose of operating the engines, and controlling and modifying the expansion of the steam used, all as set forth.

2. The expansion-cylinder B, in combination with the additional throttle T', substantially as and for the purpose shown and described.

3. The additional throttle-valves T' T'', arranged in the pipe-connections, substantially as shown, and for the purpose specified.

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