

(No Model.)

G. S. STRONG.
STEAM ENGINE.

4 Sheets—Sheet 1.

No. 477,234.

Patented June 21, 1892.

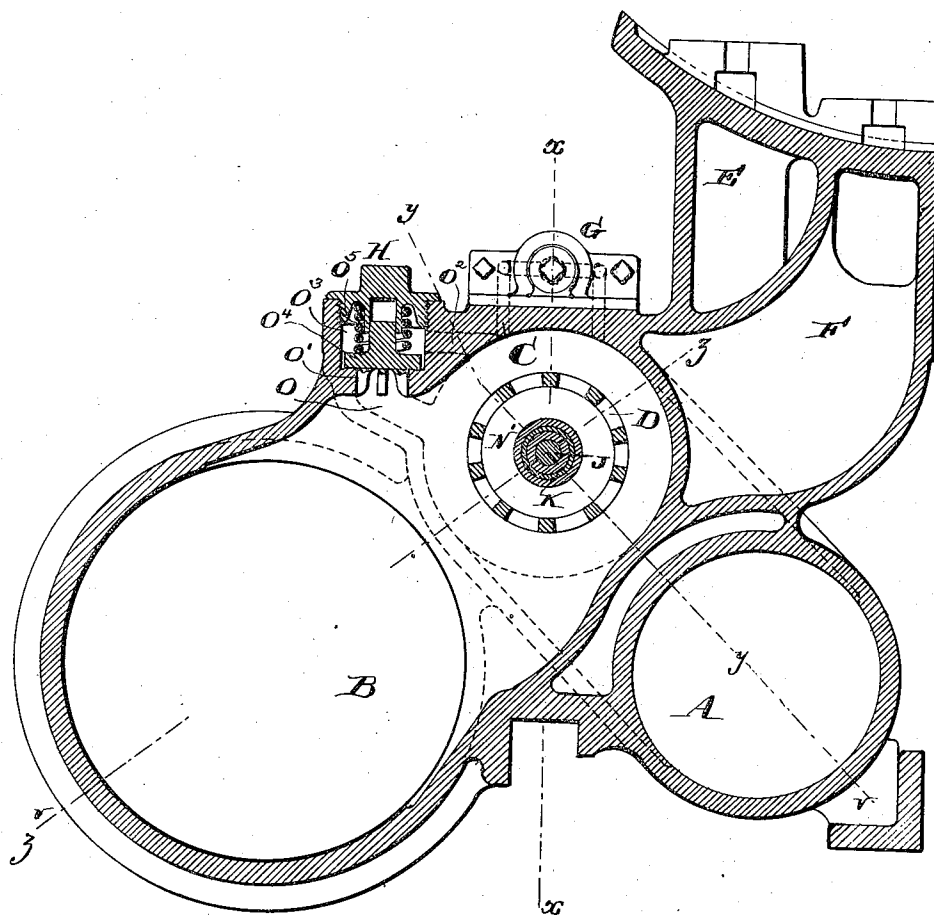


FIG. 1.

Witnesses:

Henry D. Dwyer
Joshua M. M. M. M.

Inventor:

George S. Strong
by his atty.
Frederic T. Chambers

(No Model.)

4 Sheets—Sheet 2.

G. S. STRONG.
STEAM ENGINE.

No. 477,234.

Patented June 21, 1892.

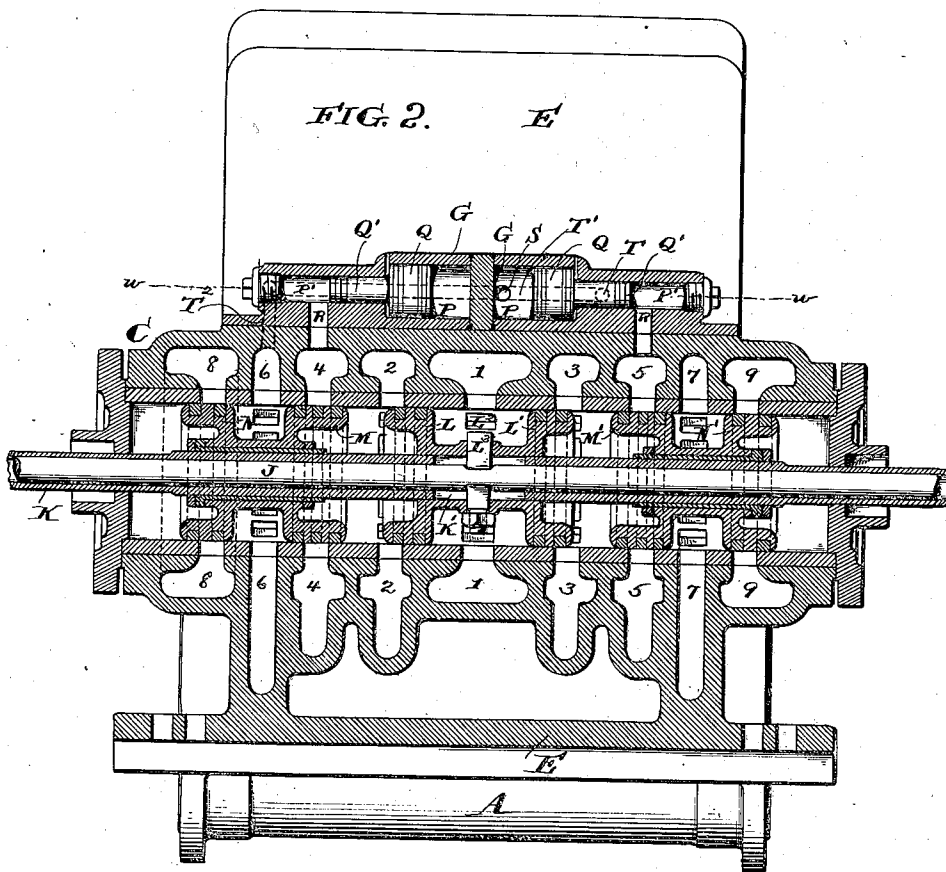
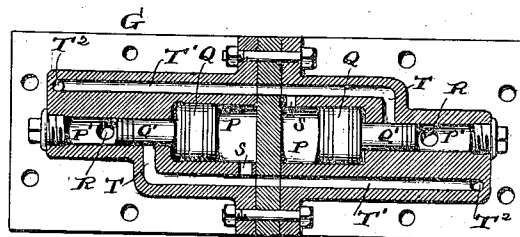


FIG. 6.



Witnesses:

Henry Denny
Joshua Makach, Jr.

inventor:

George S. Strong
by his atty.
Fannie T. Chamber.

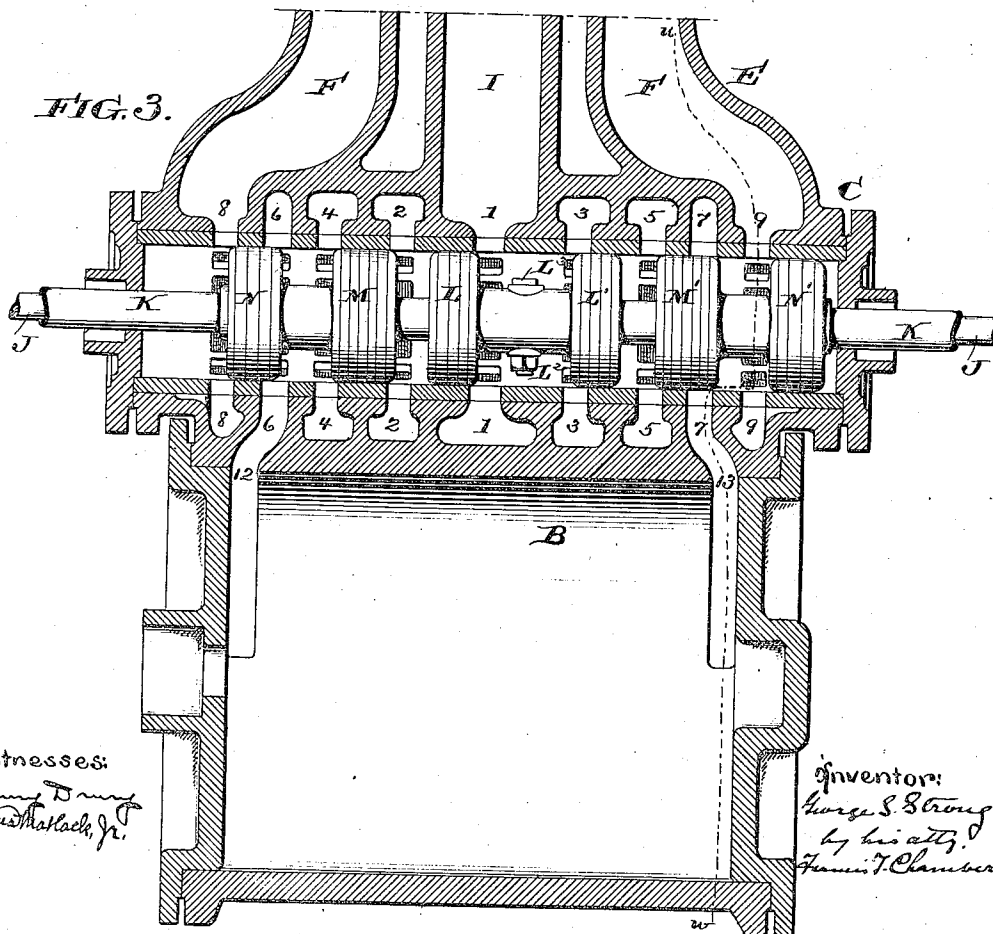
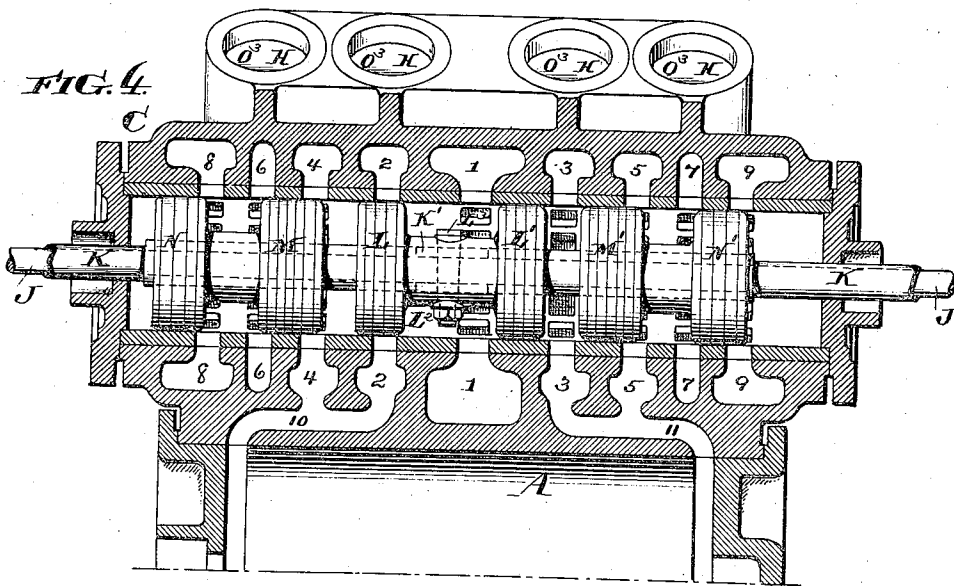
(No Model.)

4 Sheets—Sheet 3.

G. S. STRONG.
STEAM ENGINE.

No. 477,234.

Patented June 21, 1892.



Witnesses:
Henry D. [unclear]
Joshua Matlack, Jr.

Inventor:
George S. Strong
by his atty.
Frederic T. Chambers

(No Model.)

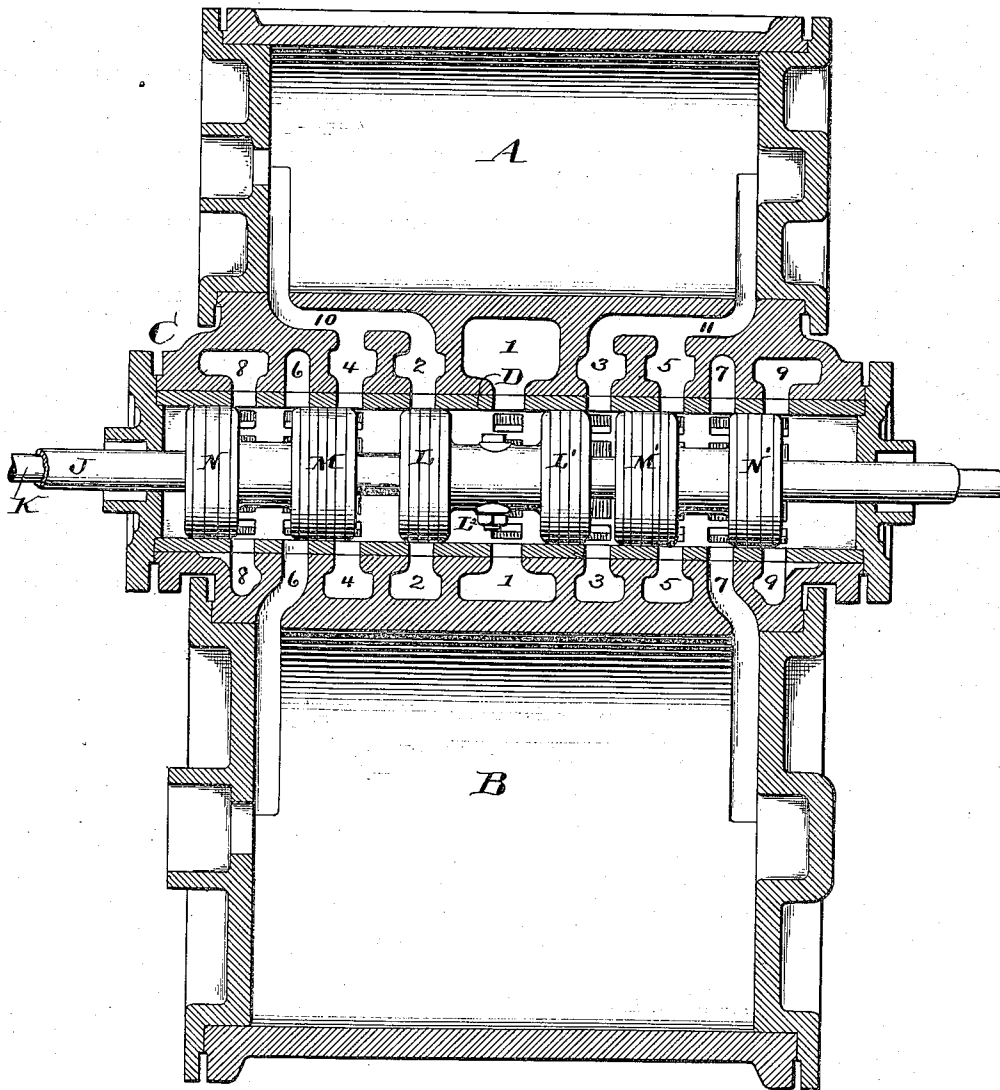
4 Sheets—Sheet 4.

G. S. STRONG.
STEAM ENGINE.

No. 477,234.

Patented June 21, 1892.

FIG. 5.



Witnesses:
Henry D. ...
Joshua M. ...

Inventor:
George S. Strong
by his atty.
Thomas T. Chambers

UNITED STATES PATENT OFFICE.

GEORGE S. STRONG, OF NEW YORK, N. Y., ASSIGNOR TO JAMES N. GAMBLE,
OF CINCINNATI, OHIO.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 477,234, dated June 21, 1892.

Application filed July 7, 1891. Serial No. 398,670. (No model.)

To all whom it may concern:

Be it known that I, GEORGE S. STRONG, of the city and county of New York, State of New York, have invented a certain new and useful Improvement in Steam-Engines, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part of this specification.

My invention relates to the construction of steam-engines, and particularly to compound steam-engines, although certain features of my novel construction are applicable to engines which are not compound engines.

The object of my invention is to simplify the construction of steam-engines and combine the necessary parts thereof in such a way that they shall be as few in number and as compactly arranged as possible.

The nature of my invention will be best understood as described in connection with the drawings in which they are illustrated, and in which—

Figure 1 is a cross-section through a Cross compound engine embodying my improvements, taken on the line *u u*. Fig. 2 is a cross-sectional elevation taken on the line *x x* of Fig. 1; Fig. 3, a longitudinal section taken on the line *v v* of Fig. 1; Fig. 4, a longitudinal cross-section taken on the line *y y* of Fig. 1; Fig. 5, a sectional view representing the parts intersected by sectional lines passing through the centers of each cylinder to the center of the valve-chamber, as indicated at *v v v*, the parts being represented in the figure as on the same plane; and Fig. 6 is a plan view of the starting-valve, taken on the line *w w* of Fig. 2.

A is the high-pressure cylinder; B, the low-pressure cylinder; C, the valve-chamber, and D the sleeve or lining of the valve-chamber in which the valves move. The two cylinders, the valve-chamber, and the ports of the engine are all formed in a single casting E, which, as shown in the drawings, is adapted for use in connection with a locomotive.

I is a passage formed in the casting E for the admission of live steam from the boiler, and F F are passages through which the exhaust-steam from the low-pressure cylinder

is carried into the smoke-box of the locomotive.

G and G^x are starting-valves, the construction of which will be described hereinafter.

H H H are relief-valves, also described later on.

J is a valve-stem, and K also a valve-stem formed as a sleeve embracing the stem J and having inside of the valve-box slots K' to permit the passage of a bolt or key L³, which passes through the stem J and is used to secure to said stem a spool admission-valve L L', which works in the valve-box C.

On each side of the admission-valve L L' exhaust-valves M M' are secured to the sleeve K, and where the valve is used in connection with a compound engine additional valves N N' are also secured to the stem K to regulate the exhaust of the low-pressure cylinder.

Around the box C and opening into it through its sleeve D are a series of ports. (Indicated by the numbers 1 to 9, inclusive.) The port 1 is connected with the steam-supply passage I, and the ports 2 and 3, situated on each side of it, lead, respectively, to the two ends of the high-pressure cylinder, the motion of the spool-valve L L' being such as to connect the tangs of the passages I² and I³. The ports 2 and 3 enter the high-pressure cylinder through the passages 10 and 11, with which passages also the ports 4 and 5 are respectively connected. The ports 6 and 7 are the exhaust-ports of the high-pressure cylinder, and in the construction shown they are also the admission-ports to the low-pressure cylinder, and the ports 8 and 9 serve as the exhaust-ports of the low-pressure cylinder and connect with the passages F F. By placing the spool admission-valve L L' on an independently-actuating rod I am enabled to vary the admission of steam to the high-pressure cylinder, while the exhaust-valves of said cylinder and the admission and exhaust to and from the low-pressure cylinder remain constant and unvaried or are only varied at will, the stem K, for instance, having its motion regulated by a governor, while the motion of the sleeve-stem J is only under the positive control of the engineer.

In Fig. 2 of the drawings the valves are

shown in an intermediate position, useful as indicating the lead of the various valves. In Fig. 3 the position of the valves is such that the steam from the boiler will pass from port 1 to port 3, thence, as indicated in Fig. 4, it passes through the passage 11 to the right-hand end of the high-pressure cylinder, the port 5, also leading into passage 11, being in the position of the valve shown in Fig. 3, cut off by valves L' and M' from all communication with other ports or passages.

Looking to the left of Fig. 3, it will be seen that the port 4, which, as indicated in Fig. 4, communicates with passage 10, which leads to the left-hand end of the high-pressure cylinder, opens into the space between the valves N and M, and as said space also communicates with the port 6 the exhaust from the high-pressure cylinder then enters the left-hand end of the low-pressure cylinder through passage 12, which is in communication with port 6. The exhaust from the low-pressure cylinder escapes through passage 13 at its right-hand end to port 7 and thence between valves M' and N' to the exhaust-port 9 and the exhaust-passage F.

In Fig. 4 the valves are shown in the position they occupy when the valve L is moving toward the center to cut off the admission of steam to the left-hand end of the high-pressure cylinder, and in Fig. 5 the valves N M N' M' are shown in the same position as in Fig. 4, and the valves L L' as having made an earlier cut-off of the steam-admission to the high-pressure cylinder.

It is unnecessary to describe in detail the passage of the steam through the various ports and cylinders, as in view of the description already given it is a simple and easy matter to follow the passage of the steam in all positions of the valves, and the simplicity and compactness of the arrangement for controlling the steam in its passage through the engine is of course apparent. It will be noted that by having the two ports 3 and 5 and 2 and 4 connecting with the passages leading to the high-pressure cylinder and arranged as described the clearances are cut down and all the steam-passages made less tortuous, the passages particularly for the exhaust from the high-pressure cylinder to the low-pressure cylinder being very short and direct, whereby the efficiency of the engine is greatly enhanced.

At G, I have indicated a simple and efficient arrangement for admitting steam at a proper pressure to the low-pressure cylinder of the compound engine in starting and before the exhaust from the high-pressure engine is available.

Referring to Figs. 2 and 6, I will state that the starting-valve is shown double, or, rather, I should say, an independent starting-valve is provided for each end of the low-pressure cylinder, the one valve being indicated at G and the other at G'. Each valve consists of a differential cylinder P P', the diameter of

the part P being four times that of the part P'. From the outer end of the cylinder P—that is, from the part farthest from its extension P'—a port S leads into a passage T', which communicates through a passage T² with the admission-port at one end of the low-pressure cylinder, as shown, the passage T' T² from the starting-valve G leads to the port 6, and the corresponding passage from the starting-valve G' leads, of course, to the port 7. The passage T' also communicates through a port T with the inner end of the cylinder P'—that is, its end nearest to the cylinder P—and another port R leads from the back of cylinder P' to the admission-port of the high-pressure cylinder on the opposite side from that end of the low-pressure cylinder which is in communication with the passage T'. As shown, this communication for the valve G is to the port 5 and for the valve G' to the port 4. Assuming now that the valve is in the position, for instance, shown in Fig. 3, the live steam will pass from port 1 to port 3 and thence through passage 11 to the right-hand end of cylinder A; but port 5 is also filled with high-pressure steam, which will pass through passage R to the outer end of the cylinder P'. Now in the said cylinder P' is a piston-valve Q', to the inner end of which is secured a piston Q, working in the cylinder P, the two together constituting a differential piston with areas, respectively, as one to four. The high-pressure steam acting on the end of piston Q' will push it and the piston Q before it until the port T is open and the steam will then pass through passage T' T² and port 6 into the passage 12, which leads to the left-hand side of the low-pressure cylinder. The steam will also pass from the passage T' through port S to the outer end of the cylinder P, and obviously as soon as the pressure in said cylinder exceeds one-quarter of the pressure in cylinder P' the pressure acting on the piston Q will move it and the piston Q' back to their original position, closing the port T and cutting off further admission to the low-pressure cylinder. In this way both cylinders are started together and with a proper amount of pressure with respect to each other. The companion valve G' of course acts in the same way with respect to the opposite ends of the respective high and low pressure cylinders.

In order to avoid shock and injury to the engine by excessive pressure or by the presence of water in the cylinders, I provide relief-valves, the construction of which is indicated at H in Fig. 1, one valve being provided for each end of each cylinder. The valve consists of a chamber O³, having a cord communication or passage O leading into it from the admission-port at the end of a cylinder, a valve-seat O' being formed at the point where the passage O enters the valve-box or chamber O³. Another passage O² leads from the steam-supply passage into chamber O³, and a valve O⁴ is normally held seated on O' by the pressure of steam entering the cham-

ber through passage O². A spring O⁵ may be advantageously used as additional means for holding the valve to its seat. The valve O⁴, being held to its seat by a pressure as great or greater than that in the cylinder, will remain seated under ordinary conditions; but wherever the piston meets with an excess of resistance at the end of its stroke the pressure communicated through port O will lift the valve from its seat and permit water, if it be present, to pass from the end of the cylinder into chamber O³ and thence through passage O² to the steam-supply. The advantage gained in this form of relief-valve is that the steam escaping from the cylinder through the valve is not lost, as it would be if the outlet-passage communicated with the atmosphere or with the exhaust, but is returned into the general steam-supply, while at the same time the small amount of water admitted by the valve into the steam-supply is flashed or taken up by the steam and when next admitted to the cylinder passes off with the exhaust. When the admission-valve L L' is moved independently of the valves controlling the exhaust, the provision of the two ports 2 and 4 and 3 and 5, connecting, respectively, with the passages 10 and 11, enables me to provide sufficient room between the valves M and M' to permit of the necessary movements of the admission-valve, while at the same time the valve-chamber as a whole is compact and well arranged; but even aside from this point this peculiar arrangement of the ports is valuable, because it diminishes the clearance in the steam-passages to practically a minimum, also enabling me to shape them so as to afford as little resistance as possible to the passage of steam and particularly enabling me to make a very short and very direct passage through which the exhaust-steam from the high-pressure cylinder passes to the low-pressure cylinder.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a steam-engine, the combination of an independent admission-valve L L' with exhaust piston-valves M M', situated on each side of the admission-valve and in the same valve-box, but movable independently of the admission-valves.

2. In a steam-engine, the combination of a piston-valve chamber, the concentric independently-movable valve-rods J and K, extending through the same, an admission-valve L L, secured to one rod, and exhaust-valves M M, situated on each side of the admission-valve, but secured to the other valve-spindle.

3. The combination of the independent admission-valves L L' with exhaust-valves M M', situated on each side of the admission-valve and in the same valve-box, and ports 2 4 and 3 5, leading into the valve-box, the pair 2 4 connecting with the passage 10, leading to one end of the cylinder, and the pair 3 5 with the passage 11, leading to the other end there-

cf, all substantially as and for the purpose specified.

4. In combination with the high and low pressure cylinders of a compound engine, the common valve-chamber C, having ports 1, 2, 3, 4, 5, 6, and 7, arranged as described, the ports 10 and 11, connecting ports 2 and 4 and 3 and 5, respectively, and leading to the opposite ends of the high-pressure cylinder, the ports 12 and 13, leading from ports 6 and 7, respectively, to the opposite ends of the low-pressure cylinder, and the piston-valves L L' M M' N N', working in said valve-chamber and over the ports.

5. In combination with the high and low pressure cylinders of a compound engine, the common valve-chamber C, having ports 1, 2, 3, 4, 5, 6, and 7, arranged as described, the ports 10 and 11, connecting ports 2 and 4 and 3 and 5, respectively, and leading to the opposite ends of the high-pressure cylinder, the ports 12 and 13, leading from ports 6 and 7, respectively, to the opposite ends of the low-pressure cylinder, the independent admission-valve L L', and the exhaust-valves M M' N N', situated in each side of the admission-valve.

6. In combination with the high and low pressure cylinders of a compound engine, the common valve-chamber C, having ports 1, 2, 3, 4, 5, 6, 7, 8, and 9, arranged as described, the ports 10 and 11, connecting ports 2 and 4 and 3 and 5, respectively, and leading to the opposite ends of the high-pressure cylinder, the ports 12 and 13, leading from ports 6 and 7, respectively, to the opposite ends of the low-pressure cylinder, and piston-valves L L' M M' N N', working in said valve-chamber and over the ports.

7. The combination of the independent admission-valve L L' with exhaust-valves M M', situated on each side of the admission-valve and in the same valve-box, but movable independently of the admission-valve, and ports 2 4 and 3 5, leading into the valve-box, the pair 2 4 connecting with the passage 10, leading to one end of the cylinder, and the pair 3 5 with the passage 11, leading to the other end thereof, all substantially as and for the purpose specified.

8. In combination with the high and low pressure cylinders of a compound engine, the common valve-chamber C, having ports 1, 2, 3, 4, 5, 6, and 7, arranged as described, the ports 10 and 11, connecting ports 2 and 4 and 3 and 5, respectively, and leading to the opposite ends of the high-pressure cylinder, the ports 12 and 13, leading from ports 6 and 7, respectively, to the opposite ends of the low-pressure cylinder, and the piston-valves L L' M M' N N', working in said valve-chamber and over the ports, the valve L L' being movable independently of the valves M M' and N N'.

9. In combination with the high and low pressure cylinders of a compound engine, the common valve-chamber C, having ports 1, 2, 3, 4, 5, 6, 7, 8, and 9, arranged as described,

the ports 10 and 11, connecting ports 2 and 4 and 3 and 5, respectively, and leading to the opposite ends of the high-pressure cylinder, the ports 12 and 13, leading from ports 6 and 7, respectively, to the opposite ends of the low-pressure cylinder, and piston-valves L L' M M' N N', working in said valve-chamber and over the ports, the valve L L' being movable independently of the valves M M' and N N'.

10 10. In combination with a steam-engine, a valve-chamber O³, a port O², leading to said chamber from the steam-supply, a port O' leading to said chamber from one end of the engine-cylinder, and a valve O⁴, seated on port O' and situated below port O².

15 11. In combination with a valve-box C of a compound engine constructed substantially as specified, a series of valve-chambers O³, formed in the same casting with the valve-box and each connected, as by port O², with the steam-supply of the respective cylinders, and each connected by ports O with the valve-ports leading, respectively, to the respective ends of the two cylinders, and normally-closed
25 valves O⁴, seated on each of ports O, all substantially as and for the purpose specified.

12. In a compound engine, a starting-valve G, consisting of differential cylinders P P',

cylinder P having a port S leading by passage T' to the admission-port of the low-pressure engine, and cylinder P' having a port T near its inner end leading to passage T' and a port R leading to the steam-supply port of the high-pressure cylinder, and differential pistons Q Q', connected together and operating in the cylinders P P', substantially as and for the purpose specified.

13. In a Cross compound engine, substantially as described, a starting-valve G, consisting of differential cylinders P P', cylinder P having a port S leading by passage T' to the admission-port at one end of the low-pressure cylinder, and cylinder P' having a port T near its inner end leading to said passage T' and a port R leading to the steam-supply port of the high-pressure cylinder, and differential pistons Q Q' working in the cylinders, as described, in combination with a similar valve G^x, the passage T' of which leads to the admission-port at the opposite end of the low-pressure-cylinder.

GEORGE S. STRONG.

Witnesses:

J. W. BEACH,

JOSHUA MATLACE, Jr.