(No Model.) 2 Sheets—Sheet 1.

A. M. HALEY.

COMPOUND EXPANSION STEAM ENGINE.

No. 560,496. Patented May 19, 1896.

Fig. 1.

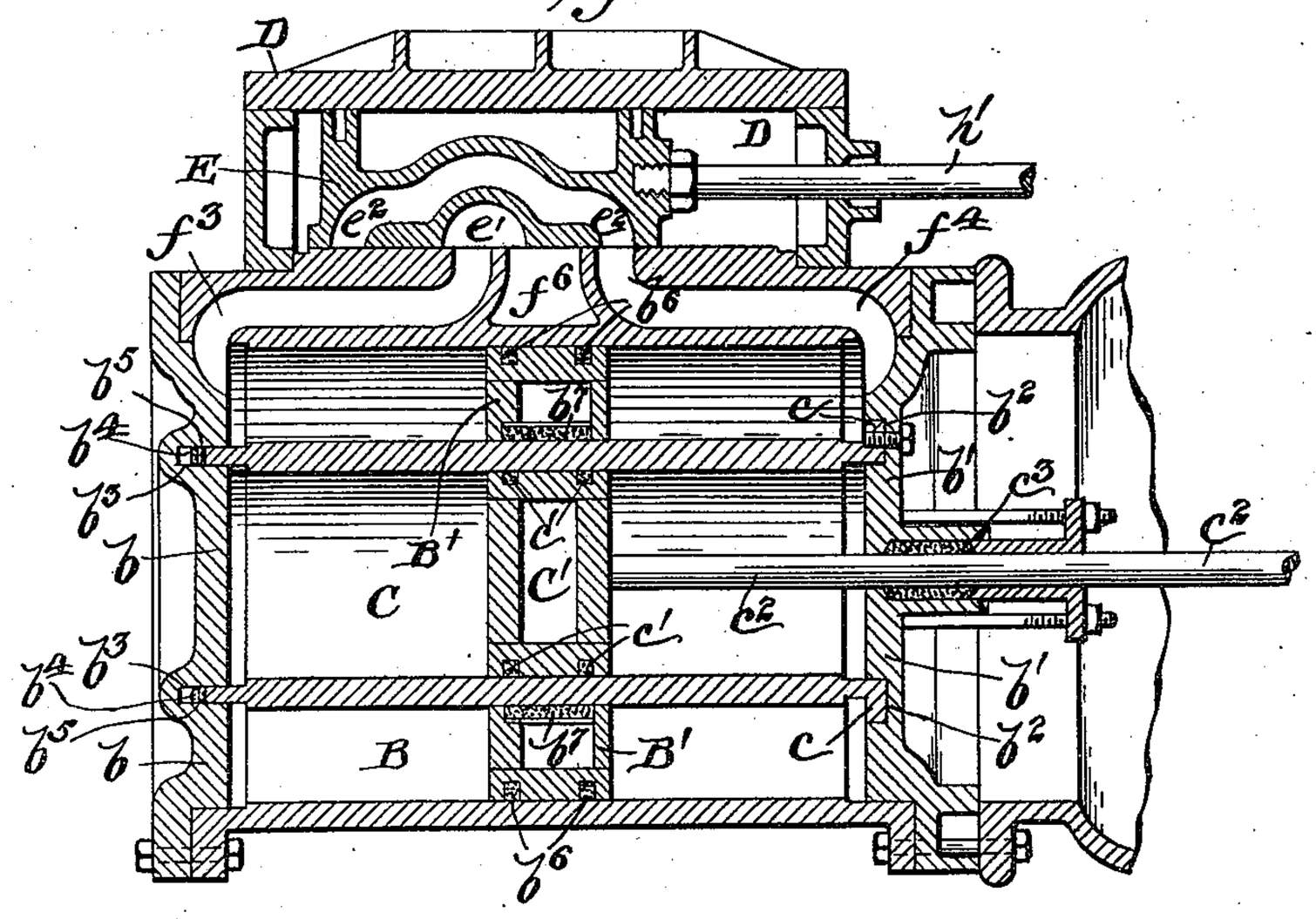
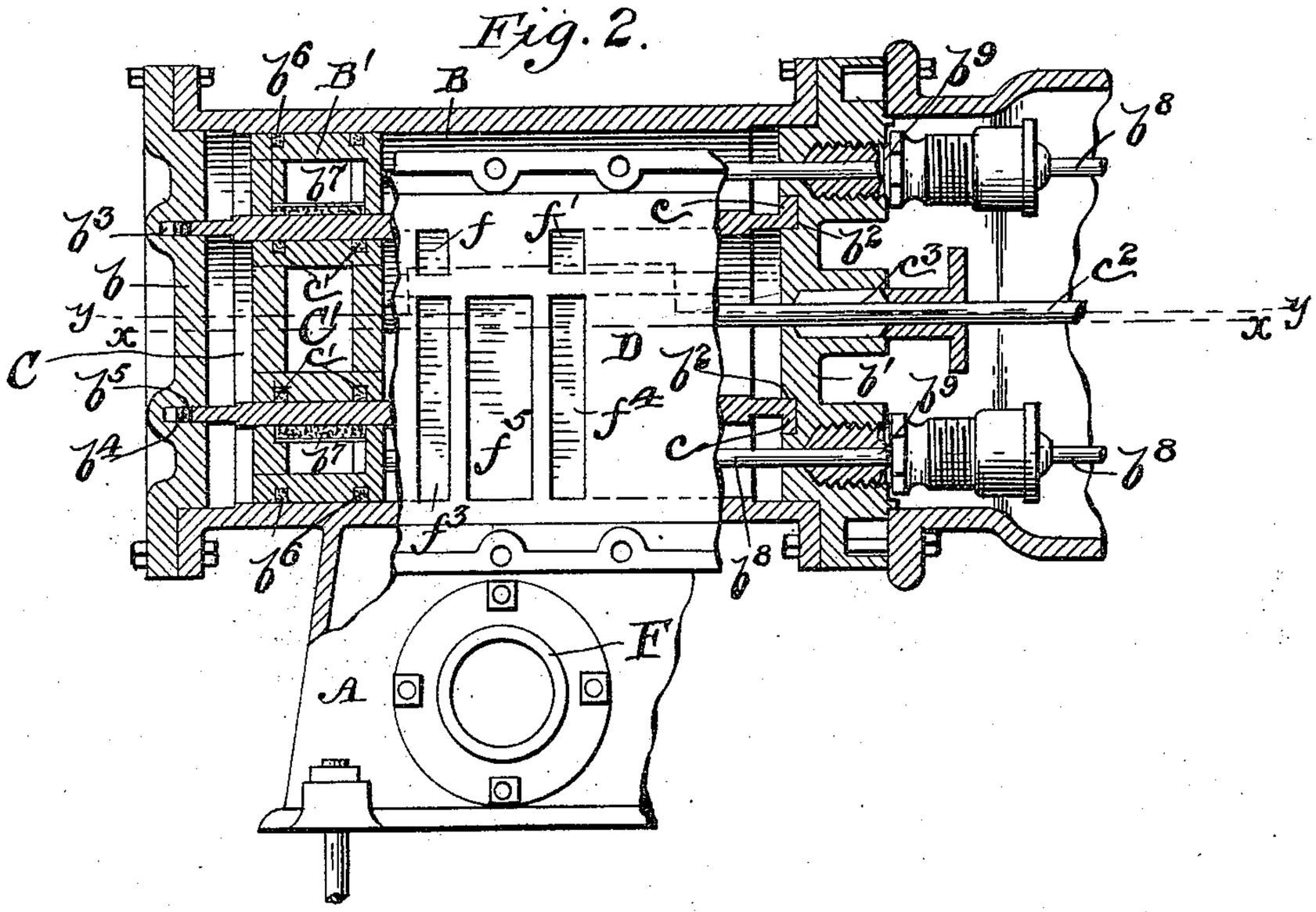


Fig. 2.



WITNESSES.

Severance.

W. Harry Muzzy.

INVENTOR

Andrew M. Haley

by his Attys

Mann Semmick & Severance.

(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

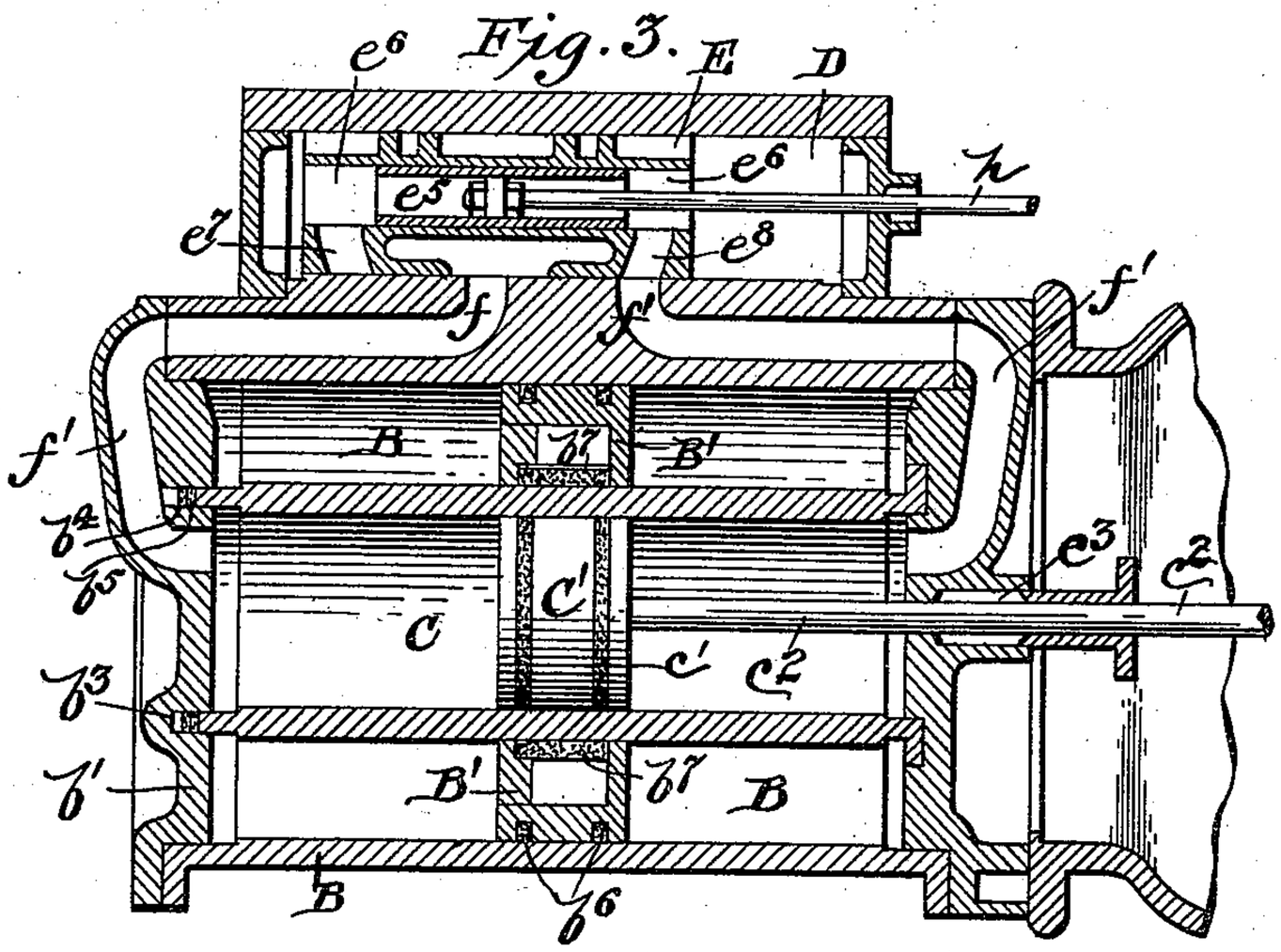


Fig. 4.

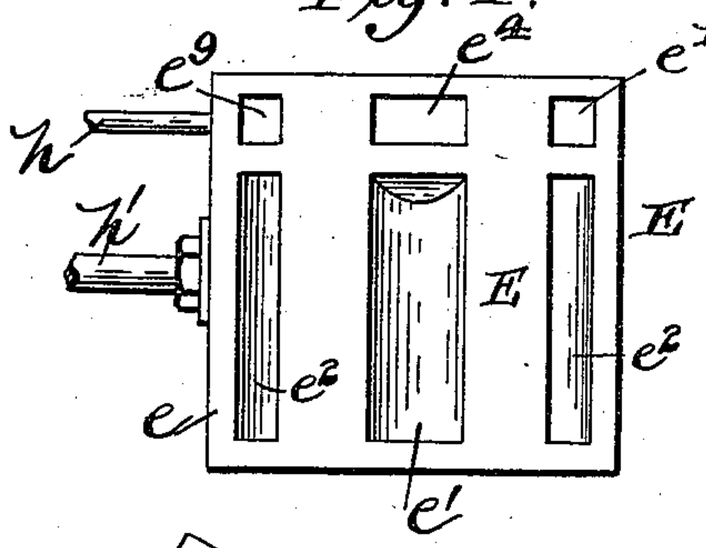


Fig. 5.

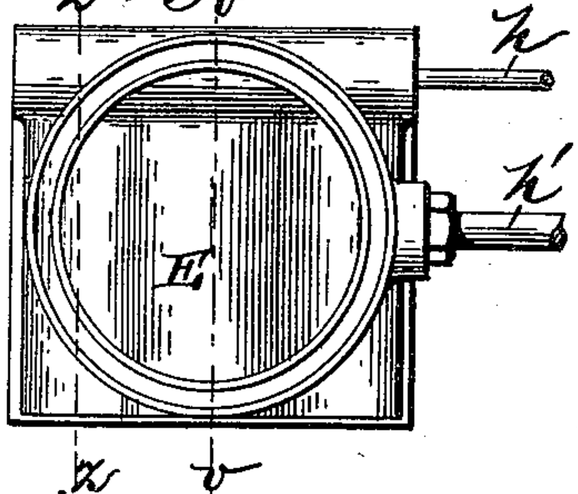


Fig. 6.

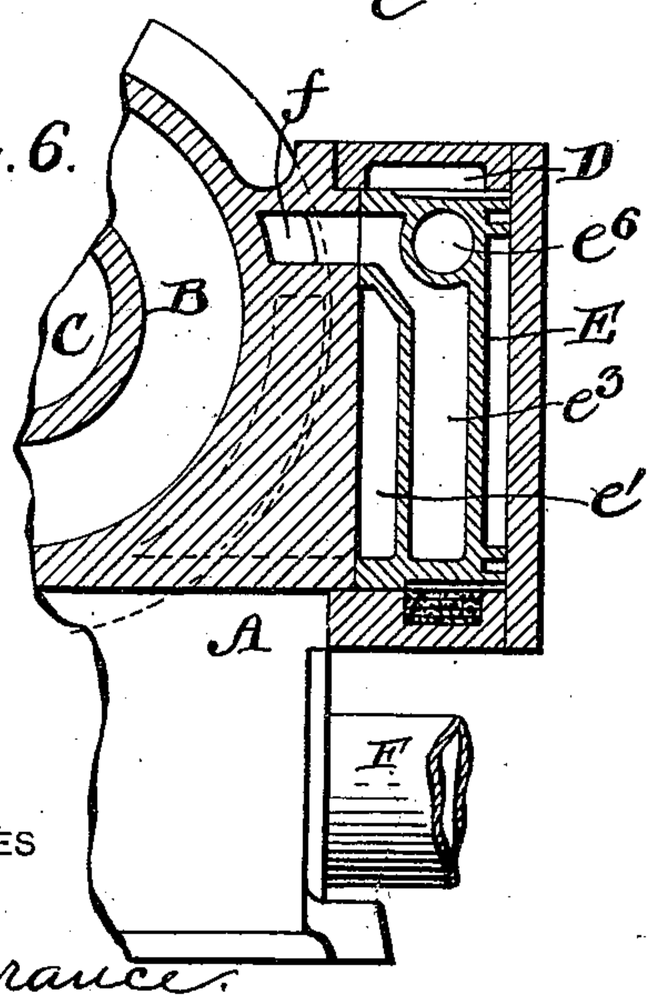
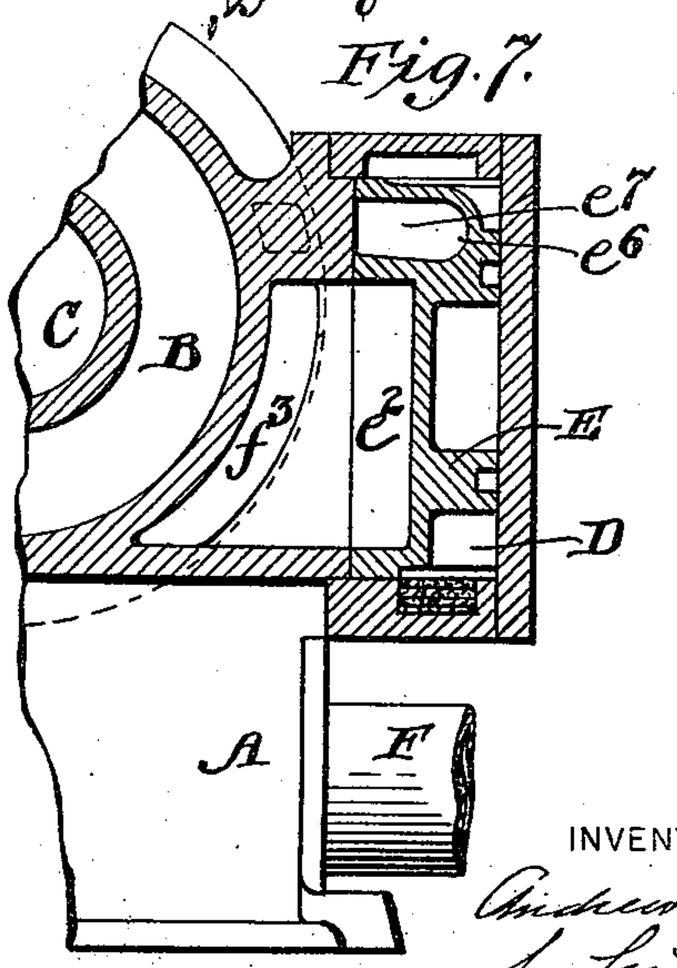


Fig. 7.



WITNESSES

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W Harry Munn Jr.

INVENTOR

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by his Attys

Munn & Patrick Lawrence

UNITED STATES PATENT OFFICE.

ANDREW M. HALEY, OF SIOUX CITY, IOWA.

COMPOUND EXPANSION STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 560,496, dated May 19, 1896.

Application filed July 29, 1895. Serial No. 557,440. (No model.)

To all whom it may concern:

Be it known that I, ANDREW M. HALEY, a citizen of the United States, residing at Sioux City, in the county of Woodbury and State of Iowa, have invented certain new and useful Improvements in Compound Expansion Steam-Engines; 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.

My invention relates to improvements in compound expansion steam-engines; and it consists of certain novel constructions, combinations, and arrangements of parts, all of which will be hereinafter more particularly set forth and claimed.

In the accompanying drawings, forming part of this specification, Figure 1 represents a horizontal section through an engine embodying my invention on the line $x\ x$ of Fig. 2. Fig. 2 represents a side elevation partly in section of the same, the steam-chest being removed. Fig. 3 represents a vertical section through my engine on the line $y\ y$ of Fig. 2. Fig. 4 represents a bottom plan view of the valve. Fig. 5 represents a top plan view of the same. Fig. 6 represents a vertical section through said valve on the line $v\ v$ of Fig. 5, and Fig. 7 represents a vertical section through said valve on the line $z\ z$ of Fig. 5.

A in the drawings represents the base of the engine; B, the low-pressure cylinder; C, the high-pressure cylinder within the same; D, the steam-chest, and E the valve.

The base A is of any ordinary and suitable construction and supports the low-pressure cylinder B. This cylinder is provided with two heads b and b', respectively. The head b' is provided with an internal annular groove b^2, into which the flanged end c of the high-pressure cylinder C is bolted. The opposite end of the said cylinder C fits into an annular groove b^3 in the head b, but does not completely fill the same. Two packing-rings $b^4\ b^5$, respectively, one of hard and the other of soft metal, fill the remaining portion of the said groove b^3 and are pressed against the end of said cylinder C by live steam introduced into the groove b^3, as hereinafter described.

The above-described construction allows the longitudinal expansion of the cylinder C.

The high-pressure cylinder is provided with a piston C', having suitable packing-rings c' in its periphery, and a piston-rod c^2, the latter passing through a suitable packing-gland c^3 in the head b'. The cylinder B is provided with an annular ring-piston B', which completely surrounds and slides upon the cylinder C. This piston is provided with both internal and external packing-rings b^6 and b^7, respectively, the former bearing against the cylinder B and the latter against the cylinder C.

The piston B' is provided with a plurality of piston-rods b^8, which pass through suitable packing-glands b^9 in the head b'. If so desired, the several piston-rods of both pistons may be coupled together and then to the crank-shaft, or they may be connected independently to the latter, as in either case both the pistons move together in the same direction at the same time.

The cylinder B is provided with steam-passages $f\ f'$, connecting the respective ends of the high-pressure cylinder and the steam-chest D. The passage f communicates with the annular groove b^3 by a short passage f^2, whereby steam is introduced back of the packing-rings b^4 and b^5 and forces them firmly against the end of the cylinder C and forms a steam-tight but movable joint. Passages f^3 and f^4 are also formed in the cylinder B and connect the steam-chest with the respective ends of the low-pressure cylinder. The ports of the respective passages f, f', f^3, and f^4 are clearly shown in Fig. 2, the two latter being elongated and occupying positions on both sides of an exhaust-port f^5. This latter port communicates by passage f^6 in the cylinder B with the exhaust-pipe F.

The steam-chest D is suitably secured by bolts to the cylinder B and contains the valve E. This valve is of the D pattern and comprises a balanced valve-casing e, provided in its bottom with an exhaust-recess e', adapted to connect the respective steam-passages f^3 and f^4 with the exhaust f^6 as the valve is moved to one side or the other. On each side of said recess e' is an elongated opening or port e^2, said ports both being connected by a suitable passage e^3 in the valve with an exhaust-port e^4, which is alternately thrown into communication with the passages $f\ f'$

and receives the exhaust from the same and conveys it to the ports e^2, which discharge it into either one or the other of the passages f^3 f^4. The valve is provided at one side with a cylindrical cut-off valve e^5, which operates in a passage e^6. This passage communicates at each end with the steam-chest, and as the cylinder e^5 is hollow and open at both ends this valve, as well as the main valve, is fully balanced. Passages e^7 e^8 lead from the respective ends of the passage e^6 to ports e^9 e^{10} in the bottom of the valve. These ports communicate, respectively, with the ports of the passages f f' when the valve is operated.

The cylinder-valve e^5 is provided with a valve-stem h, secured by nuts to a web formed near the middle of said cylinder. The valve proper is provided with a valve-stem h', which is secured into a portion of the casing e. Both of the valve-stems pass through suitable packing-glands in the wall of the steam-chest and are connected, respectively, to eccentrics by which they are operated, said eccentrics being connected to the movable parts of the engine, whereby said valves are operated at the proper time.

The operation of the engine is as follows: The steam first enters, as shown in Fig. 3, through the passages e^8 and f' and forces the high-pressure piston C′ forward. Before the said piston reaches the end of its stroke the cut-off valve e^5 is moved backward and covers the inlet to the passage e^8, thus shutting off the steam toward the end of the stroke, as is usual in such cut-off valves. When the said piston reaches the end of its stroke, the valve E is operated, which brings the port e^9 over the passage f and the port e^4 over the passage f'. The steam enters the passage f and forces the piston C′ backward, the cut-off valve acting as before to cut off the steam near the end of the stroke. As the piston C′ moves in this direction it drives the steam in front of it through the passage f', port e^4, and passages e^3 and f^3 into the low-pressure cylinder, and thus the pistons in both cylinders are forced in the same direction at the same time. As the low-pressure piston moves in the direction just described the steam in front of it is forced through the passage f^4 and the recess e' into the exhaust-passage f^6. The operation is then repeated on the next stroke.

It will be noticed that the exhaust from the high-pressure cylinder is reheated before passing to the low-pressure cylinder by passing through the highly-heated valve E in the steam-chest. It will also be noticed that I provide fully for the expansion of the high-pressure cylinder because of the heat it is subjected to by the steam which surrounds it both internally and externally.

By my construction of the high-pressure cylinder its cost is greatly reduced and its construction simplified, as it consists of a plain cylinder with a flange at one end, no holes or steam-ports being made in the same.

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

1. A compound expansion steam-engine comprising a low-pressure cylinder, a high-pressure cylinder within the same, a head for said low-pressure cylinder provided with an annular groove in which one end of the high-pressure cylinder is secured and having suitable steam-ports, another head for said low-pressure cylinder provided with steam-ports and an annular channel having communication with said latter steam-ports, and a packing in said latter annular channel; the construction being such that the free end of the inner cylinder fits within the said latter channel and the packing is pressed firmly against the same by the steam behind it, substantially as described.

2. A compound expansion steam-engine comprising high and low pressure cylinders one within the other, cylinder-heads for joining said cylinders; one of said heads having an annular steam-channel to receive the end of the inner cylinder, a packing in said channel adapted to be pressed by the steam against the head of the cylinder, a valve-seat having an exhaust-port, two ports for the high-pressure cylinder and two for the low-pressure cylinder, a valve having a recess for connecting the low-pressure cylinder-ports alternately with the exhaust-port, two ports adapted to be brought alternately into communication with the low-pressure cylinder-ports and communicating with each other through the body of the valve, and a port adapted to be brought alternately into communication with the ports of the high-pressure cylinder and communicating through the body of the valve with the before-mentioned communicating ports, substantially as described.

In testimony whereof I hereunto affix my signature in presence of two witnesses.

ANDREW M. HALEY.

Witnesses:
J. J. JORDAN,
EDITH PERRY.