No. 625,868. Patented May 30, 1899.

R. E. BRADFORD.

COMPOUND ENGINE.

(Application filed May 14, 1897.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 11.

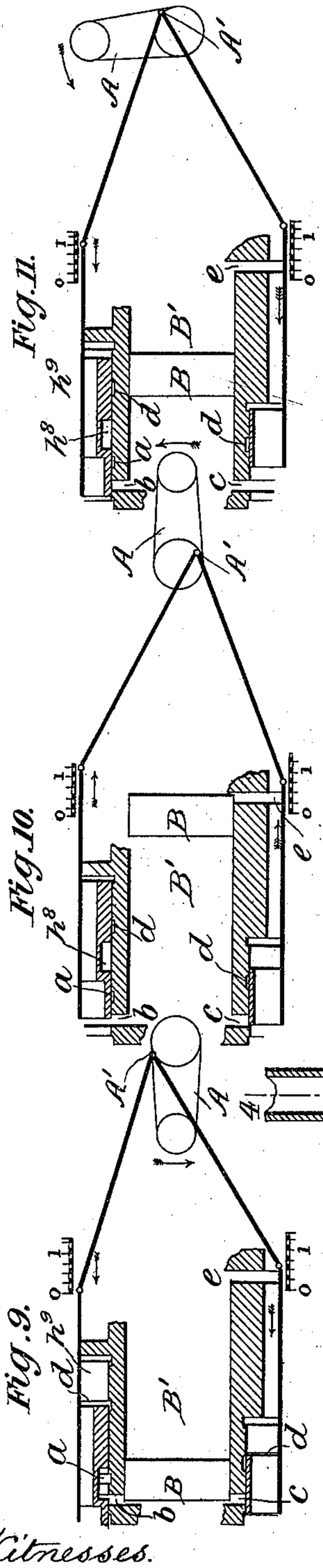
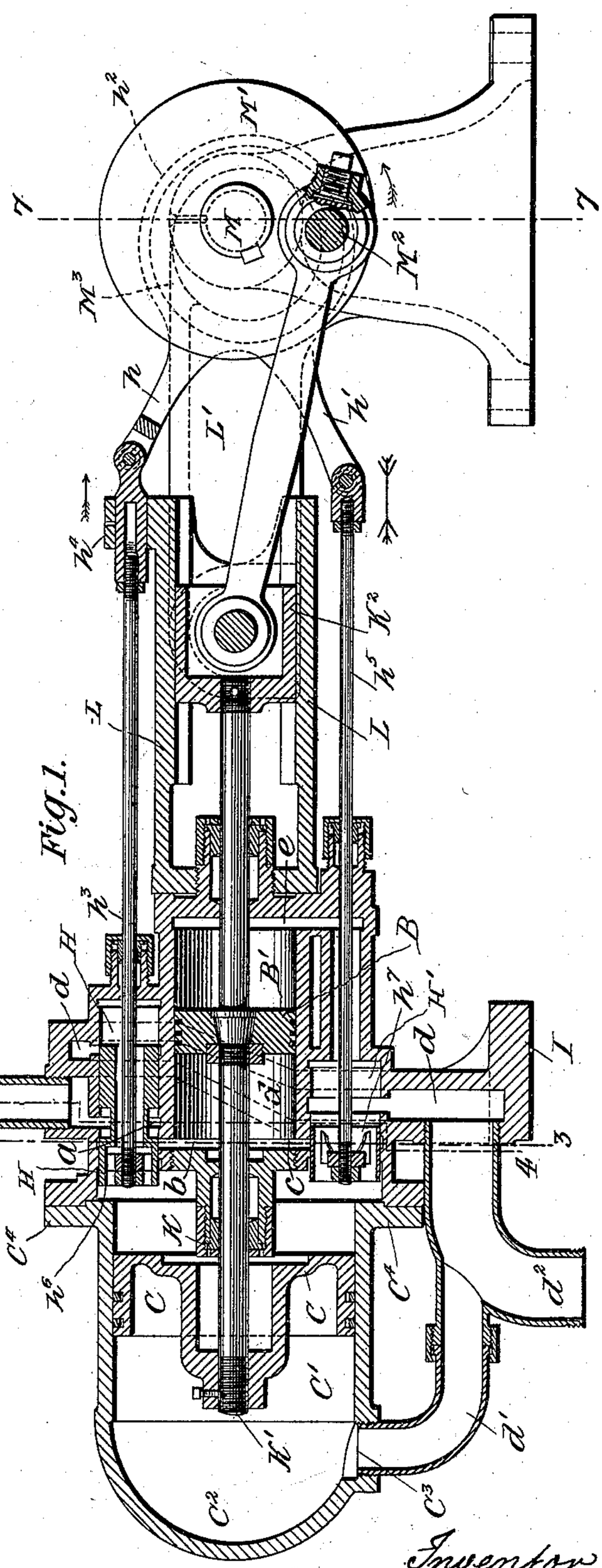


Fig. 10.

Fig. 9.

Fig. 1.



Witnesses.
Nellie Callahan.
E. A. Fincke.

Inventor.
Richard Ernest Bradford.
by Wm. F. Fincke. Atty.

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Fig. 7.

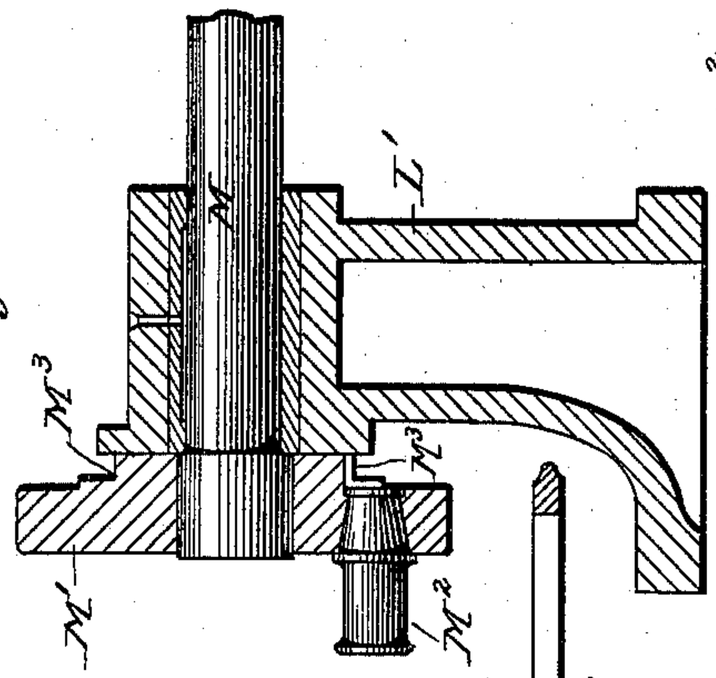


Fig. 6.

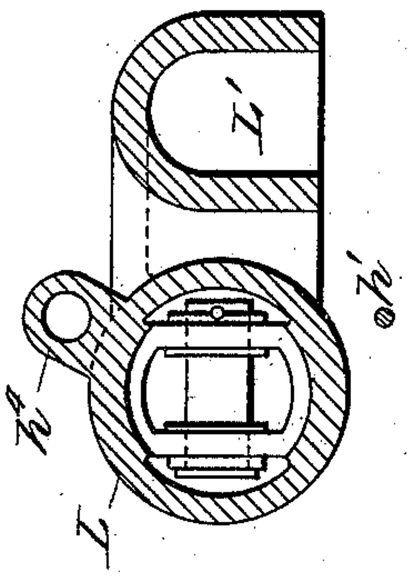


Fig. 8.

Fig. 5.

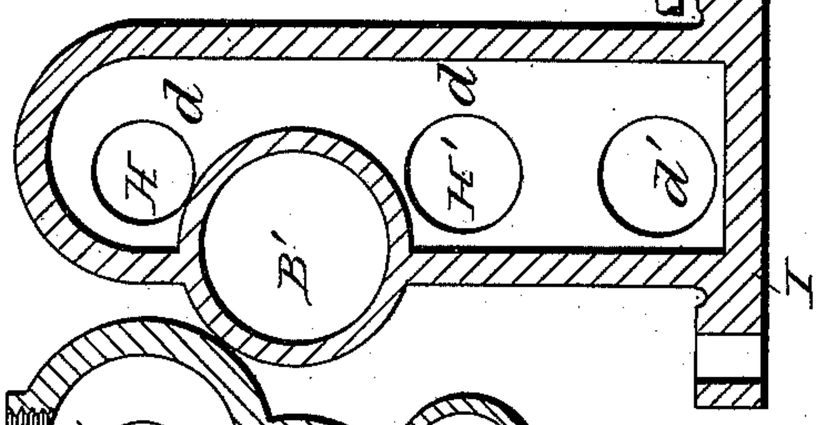


Fig. 4.

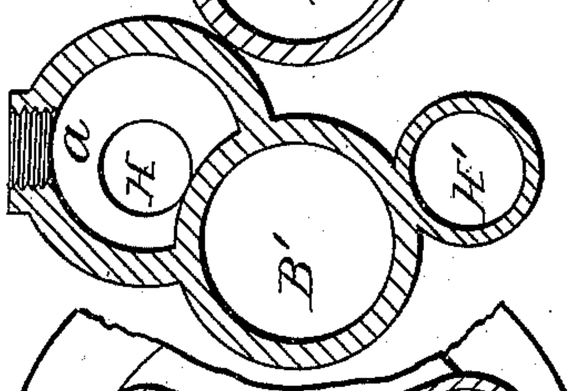
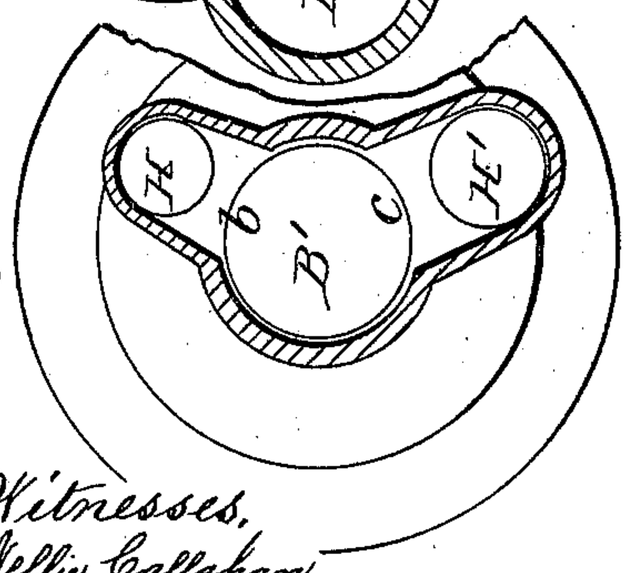


Fig. 3.



Witnesses,
Nellie Callahan.
E. A. Finnerel.

Fig. 1.

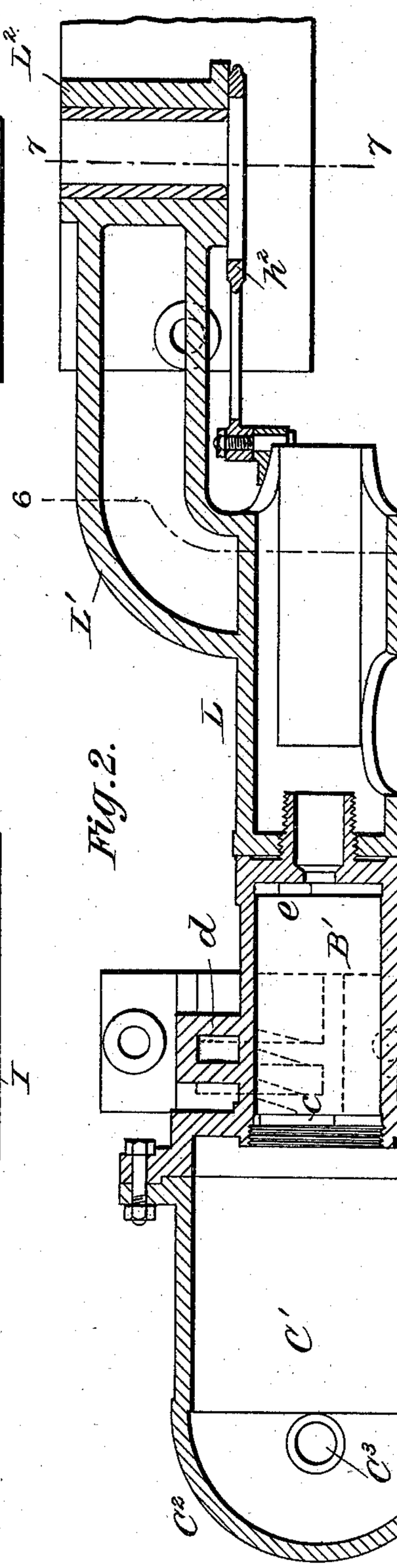


Fig. 2.

Inventor,
Richard Ernest Bradford.
by Wm. T. Finnerel, Atty.

UNITED STATES PATENT OFFICE.

RICHARD E. BRADFORD, OF LONDON, ENGLAND.

COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 625,868, dated May 30, 1899.

Application filed May 14, 1897. Serial No. 636,453. (No model.)

To all whom it may concern:

Be it known that I, RICHARD ERNEST BRADFORD, a subject of the Queen of Great Britain, residing at London, England, have invented certain new and useful Improvements in Compounding Fluid-Pressure Motive-Power Engines, (which was patented in Germany under date of May 12, 1897, No. 97,908,) of which the following is a full, clear, and exact description.

My invention relates to an improved form of engine in which the steam is allowed to expand to the full capacity of both the cylinders employed. The practical result is an increased capacity for work with an increased economy in the steam used.

I will describe my invention by the aid of the accompanying drawings, in which—

Figure 1 is a vertical section of a two-cylinder compounding-engine with the pistons arranged tandem and all the parts shown in one plane for the sake of clearness. Fig. 2 is a horizontal section, leaving out the moving parts; Fig. 3, a transverse section through ports *b* and *c*, as shown by the dotted line 3 3, Fig. 1; Fig. 4, a transverse section through port *a*, as shown by the dotted line 4 4, Fig. 1; Fig. 5, a transverse section through port *d d* on line 5 5, Fig. 1. Figs. 3, 4, and 5 are various sections of one casting; Fig. 6, a transverse section through guide and other parts on line 6 6 of Fig. 2; Fig. 7, a transverse section through main bearing on line 7 7, Fig. 2. Fig. 8 shows the valve-gear. Figs. 9, 10, and 11 are diagrams representing various positions of the valves.

The drawings show the invention applied to an engine with pistons tandem and each cylinder single-acting.

The engine consists, essentially, of three castings. The first contains the low-pressure cylinder C′ and spherical end C^2, having an opening C^3 communicating by means of the pipe *d′* with the atmosphere or exhaust. This casting is provided with a flange C^4, by which it is connected to the second or middle casting.

The second or middle casting contains the high-pressure cylinder B′, the two valve-chambers H and H′, and the hollow foot I, containing the exhaust-passage *d*. The valve-chambers H and H′ are open at their ends to the low-pressure cylinder C′. The stuffing-box K, through which the rod K′, connecting the pistons B and C, passes, is screwed into the rear of the high-pressure cylinder B′, and the piston C is bell-shaped to enable it to pass over the said stuffing-box K, and thus move throughout the entire length of the low-pressure cylinder C′.

The third or end casting forms the guide L for the cross-head K^2. This casting has a curved arm L′, connecting the guide L with the plumber-block L^2, supporting the main bearing, in which is mounted the shaft M, having a disk M′ and crank-pin M^2. The disk M′ is formed with an eccentric M^3, upon which works the eccentric-strap h^2.

In Figs. 9, 10, and 11 I have merely shown a crank (marked A) instead of a disk M′ and crank-pin M^2, and the eccentric has been indicated by means of a center A′.

Fig. 1 and the accompanying valve diagrams, Figs. 9, 10, and 11, show an engine whose parts are moving in the direction indicated by the respective arrows. The cycle commences with diagram Fig. 9. The crank A is on the top or back end, and steam admission is opening to work side of high-pressure piston B, and the other side of high-pressure piston B and the work side of low-pressure piston C are opening to exhaust *d*, the other side of low-pressure piston C being always open to atmosphere or condenser through the pipes *d′* d^2.

In Fig. 1 the engine is at half-stroke, the steam-admission port *b* is just closed, and all the rest of the engine is full open to exhaust *d*. The low-pressure piston C is thus *in equilibrio*.

In diagram Fig. 10 the engine is at full stroke. The port *b* is now open to act as an intermediate passage, the intermediate port *c* being in the act of opening. The port *e* always remains open. There is thus communication between both sides of the high-pressure piston B and the crank side of the low-pressure piston C. The high-pressure piston B is thus *in equilibrio*.

In diagram Fig. 11 the engine is shown half-stroke back. The port *b* has closed. The intermediate port *c* is, however, open to its full extent.

Between the position of the parts indicated

in Figs. 11 and 9 the valves are moving in the direction indicated by the arrows in these figures, and first the intermediate passage *c* is closed for cushioning the returning high-pressure piston B. Then the steam is admitted to the high-pressure cylinder B′ through the cavity h^8 of the valve h^6, and simultaneously the end h^9 of the valve h^6 opens communication between the work side of the low-pressure cylinder C′ and the exhaust *d*. In Fig. 9 the crank A is shown about to commence a new stroke and the valve h^7 is about to open communication between the work side of the low-pressure cylinder C′ and the exhaust *d*. It is thus obvious, first, that both pistons are in equilibrio respectively during their return stroke; second, all back pressure is avoided; third, the steam expands to the capacity of the high-pressure cylinder plus the capacity of the low-pressure cylinder; fourth, the steam being cut off at half-stroke of high-pressure piston and the cylinder being as one to four the expansion equals ten.

The details of this engine will be readily understood by reference to Fig. 1. The sections, Figs. 3, 4, and 5, show the actual shape and position of some of the parts of the central casting, these having been all represented in one plane at Fig. 1, as before stated.

There are two arms *h h′* on the eccentric-strap h^2, each of which is connected to a valve-rod, one of the valve-rods h^3 having a guide h^4. The other valve-rod h^5 derives a parallel motion and a later period of action. The first valve h^6 thus facilitates a rapid opening for admission to both cylinders B′ C′ and the second valve h^7 a sudden closing for cushioning to both cylinders B′ C′, thus doing the work of the ordinary expansion-gear combination.

In applying my invention to single-acting compound engines having one crank, as above described, the high and low pressure pistons are connected together on the same piston-rod, and in applying my invention to single-acting compound engines having two cranks opposite to one another the high-pressure valve arrangement is the same as hereinbefore described.

What I claim is—

1. In a compounding fluid-pressure motive-power engine having a high and a low pressure cylinder, each cylinder having a piston connected to a single-crank shaft by means of a piston-rod and connecting-rod, the combination of an eccentric mounted on the crank-shaft, said eccentric having two arms, the one actuating the valve for admitting steam to the high-pressure cylinder, cutting off the steam, opening communication between the high-pressure cylinder and the low-pressure cylinder, and finally opening communication between the low-pressure cylinder and the exhaust, the other valve first opening communication between the work side of the high-pressure piston and the other side of the same, and at the same moment opening communication between the work side of the high-pressure piston and the work side of the low-pressure piston, and finally opening communication with the exhaust, substantially as set forth.

2. In a compounding fluid-pressure motive engine, the combination of a high-pressure cylinder and a low-pressure cylinder, each having a piston mounted on the same piston-rod, and a pair of valves operated by rods connected to two arms of an eccentric mounted on the crank-shaft, one of said valves communicating with the source of fluid-pressure, then opening communication between the cylinders, and finally with the exhaust, the other valve placing the high-pressure piston in equilibrio and opening communication with the low-pressure cylinder, and finally with the exhaust, substantially as set forth.

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

RICHD. E. BRADFORD.

Witnesses:
B. J. B. MILLS,
CLAUDE K. MILLS.