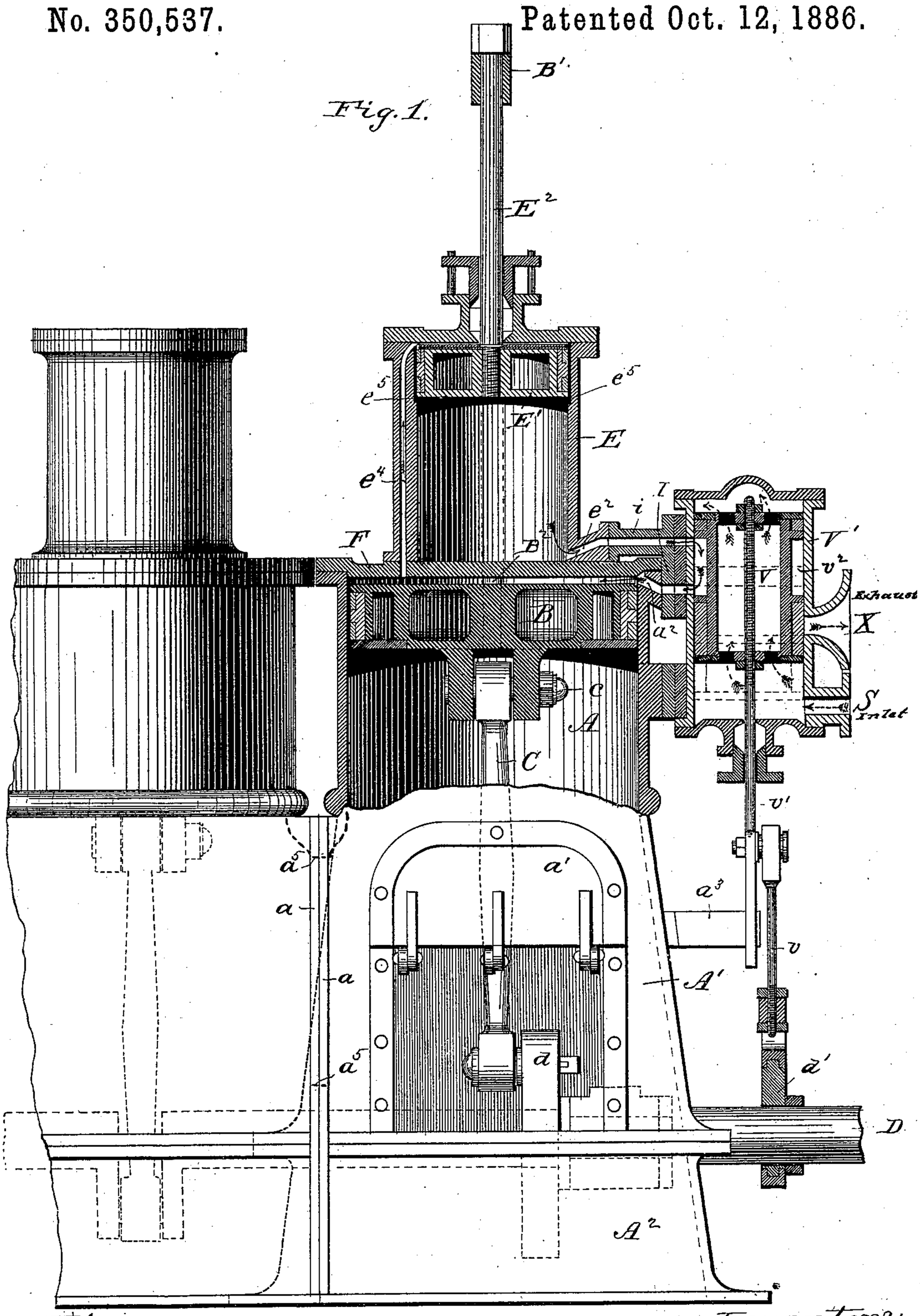
(No Model.) 2 Sheets—Sheet 1.

G. C. KIDDER & W. M. FERRY.

COMPOUND STEAM ENGINE.

No. 350,537. Patented Oct. 12, 1886.

Fig. 1.



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(No Model.) 2 Sheets—Sheet 2.

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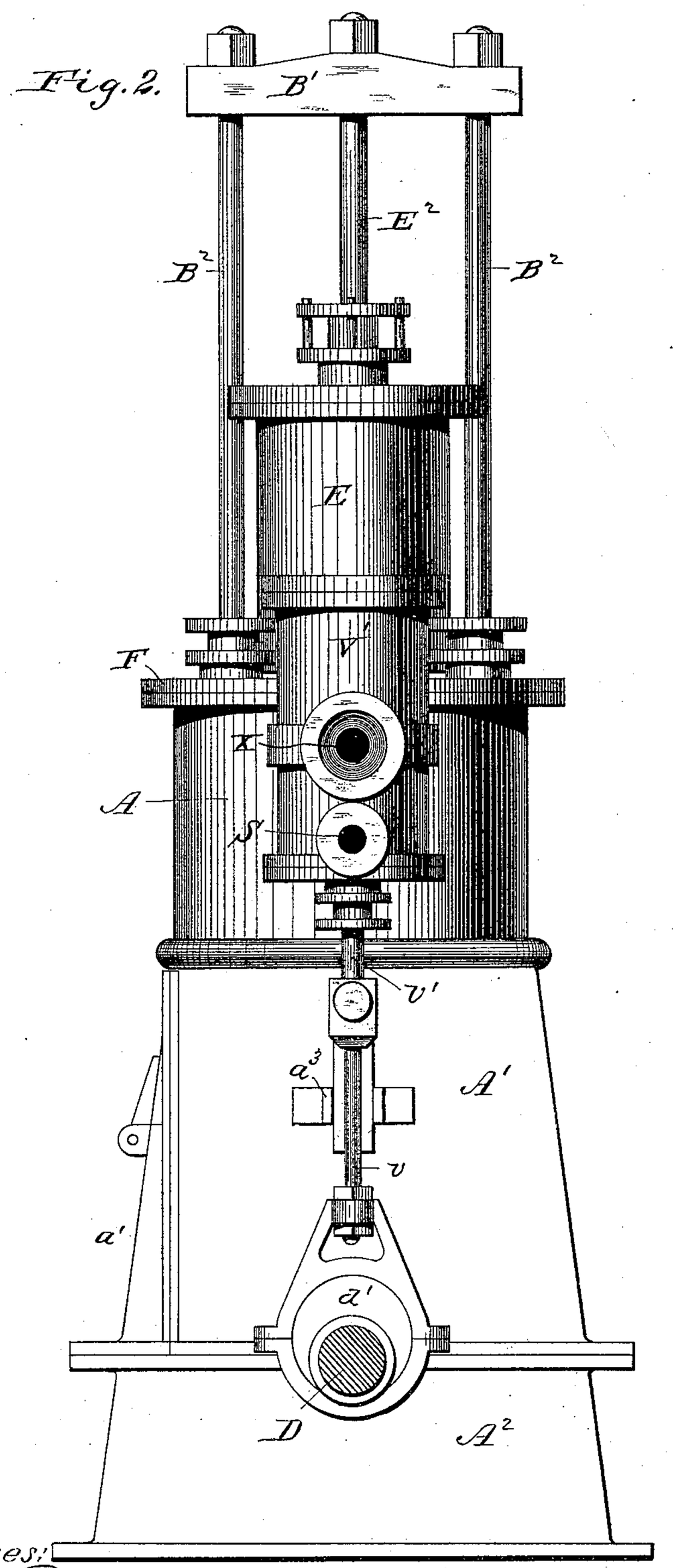
Fig. 2.



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UNITED STATES PATENT OFFICE.

GEORGE CHANDLER KIDDER AND WILLIAM MONTAGUE FERRY, OF PARK CITY, UTAH TERRITORY.

COMPOUND STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 350,537, dated October 12, 1886.

Application filed March 6, 1886. Serial No. 194,348. (No model.)

To all whom it may concern:

Be it known that we, GEORGE CHANDLER KIDDER and WILLIAM MONTAGUE FERRY, citizens of the United States, residing at Park City, in the county of Summit and Territory of Utah, have invented certain new and useful Improvements in Compound Steam-Engines; and we do 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, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

The object of our invention is to provide a compound steam-engine of strong, simple, and cheap construction, and which shall be economical of steam and effective in operation.

Our improvements relate more particularly to the construction of the supporting-frame of the engine, to making the whole mechanism in as few parts as possible, to so shaping and arranging the parts that most of them may be fitted by the lathe, to the means for applying the steam to the pistons, and to other features hereinafter described.

Our invention can best be understood by reference to the accompanying drawings, in which we have shown a means for carrying it into effect.

Figure 1 is a vertical section of a single-acting compound steam-engine embodying our invention. Fig. 2 is a side elevation of the same.

Referring to the drawings, A indicates a low-pressure steam-engine cylinder, of which B is the piston. A connecting-rod, C, pivoted to the center of the piston by a wrist-pin, *c*, actuates the crank *d* of the engine-shaft D.

The supporting-frame of the cylinder A is preferably made integral and continuous therewith, and in the construction shown consists of a hollow portion, A′ A², into which the cylinder A opens, and which is of such shape as to give the necessary stability. The frame A′ A² is, for convenience, made in two parts, as shown, between which are formed bearings for the shaft D. The frame A′ A² may be formed on one side for convenient attachment to the corresponding frame of a similar engine, as by the flanges *a*. By so combining two upright engines of the character shown, and by placing the cranks of the engine-shaft opposite to each other, the weights of the pistons and other moving parts will be perfectly balanced and the whole mechanism have great stability.

The hollow supporting-frame is furnished with a door, *a′*, which allows access to the moving parts for adjusting, cleaning, and oiling. Some steam, however, will necessarily escape from the cylinder A into the interior of the supporting-frame, and the door *a′* is made steam-tight, to prevent any exit of steam at that point. A drain-pipe for condensation, with a check-valve which will be opened by a certain pressure from within to allow egress of water or steam, may be applied to the base of the frame. When two engines are combined, an opening (indicated by the dotted lines a^5 in Fig. 1) from one hollow frame into the other will be provided, through which the air or steam contained in the base-frame will circulate freely.

On the end of and in line with the cylinder A is situated a high-pressure cylinder, E, of which E′ is the piston and E² the piston-rod, with which latter duplicate piston-rods B² B² from the piston B connect by a cross-head, B′. The rods B² B² are outside of the cylinder E, and are arranged in the plane of the connecting-rod C and crank *d*, in order to stiffen the piston B against the rocking tendency caused by the throw of the crank. The cylinders A and E have the head F in common. Steam passes to and from the cylinders A and E through ports a^2 e^2, the ingress and egress of the steam being regulated by a reciprocating valve, V, whose case V′ is supported by the lower cylinder. The valve is actuated in the usual manner from an eccentric, *d′*, upon the engine-shaft through a pitman, *v*, and stem *v′*, the latter being guided by a bracket, a^3, upon the supporting-frame. The steam-inlet to the valve is indicated at S and the exhaust to the condenser at X. The course of the steam, when the valve is in the position shown, is indicated by the full-line arrows. When the pistons are in their lowermost positions, the valve, also, is in such position, as indicated by dotted lines. The upper cyl-

inder is then placed in communication with the steam-inlet S, the steam passing through the heads of valve and around its upper end to the port e^2, while the lower cylinder communicates with the exhaust X by the annular passage v^2 around the valve. This pressure upon the upper piston raises the pistons of both cylinders, the exhaust from the upper taking place through a passage, e^4, into the lower cylinder, and thence through the port a^2. The upstroke having been completed, the valve V is shifted to the position shown in full lines, placing the lower end of the upper cylinder in communication with the upper end of the lower cylinder, and cutting off the exhaust X. By reason of this last-mentioned communication alone the expansion of the steam in the high-pressure cylinder acting upon both pistons would force down the lower piston by reason of its greater area. In such case the effective expansive force of the steam would be measured by the excess of area of the lower over the upper piston; but by reason of the additional communication between the cylinders already referred to—namely, by the duct e^4—the piston of the upper cylinder is balanced in the expanding steam. The steam has therefore no tendency to force the upper piston upward, and its pressure upon the lower piston being unopposed by any contrary pressure upon the upper piston becomes all effective for work. As the pistons descend, steam passing up through the duct e^4 fills the cylinder E behind its piston. The end of the downward stroke having been reached, the valve V places the lower cylinder, and, by the duct e^4, the upper cylinder above its piston, also, in communication with the condenser or with the open air. In the former case a more or less perfect vacuum is formed above the pistons. The last-mentioned movement of the valve also admits high-pressure steam to the upper cylinder beneath its piston, and the above-described operation of the engine is repeated.

To give the lead which is desirable when the pistons are near the end of their upstroke, passages are provided by which some of the high-pressure steam below the piston E′ may be enabled to act against the upper face of one or both of the pistons just before the completion of said stroke. A convenient means of effecting this is by grooving the bore of the cylinder E′ longitudinally for a distance somewhat greater than the thickness of its piston, as shown at e^5. These passages, which we term "relief-grooves," will be uncovered by the upward movement of piston E′ in time to transfer the action of a part of the steam from the under side of the said piston to the upper sides of both pistons before the upstroke is quite completed. These passages, as well as the duct e^4, may be made in various ways, and we do not restrict ourselves to the arrangement shown.

In fitting the valve-case V′ to the two cylinders, we prefer to employ an intermediate piece, I, which materially facilitates the fitting. Said piece is provided with ports corresponding in position to the ports of the two cylinders and of the valve-case, and is held between said case and the larger cylinder. A thicker or longer portion, *i*, extends toward the smaller cylinder, to which it is clamped or bolted. In fitting the parts the two cylinders are bored, faced, and bolted together. The valve-case is then applied to the larger cylinder, and the necessary length of the portion *i* is determined. The piece I *i* is then made of the ascertained dimension, and secured in place.

For marine use the cranks of a pair of the above-described engines would not be placed opposite to each other, as shown in dotted lines in Fig. 1, but in the usual manner to avoid a dead-center.

Having thus described our invention, what we claim, and desire to secure by Letters Patent of the United States, is—

1. The combination of two upright engines, each having a frame and high and low pressure cylinders, as described, said frames being united laterally, steam-tight, and provided with a communicating opening, and the engines being connected within said frame to a common shaft by diametrically-opposite cranks, substantially as set forth.

2. The combination of a high-pressure cylinder and piston, a low-pressure cylinder and piston, and a valve-case and a single hollow cylindrical balanced steam-valve for controlling the admission and exhaust of steam to both cylinders, having ports, as described, whereby the live steam is cut off from both cylinders, while the steam-charged end of the high-pressure cylinder is placed in communication with the other cylinder, substantially as set forth.

3. The combination of a high-pressure cylinder and piston and a low-pressure cylinder and piston, said pistons working together, a steam-duct connecting the low-pressure cylinder with the outer end of the high-pressure cylinder, a duct between the low-pressure cylinder and the inner end of the high-pressure cylinder, and a valve for opening and closing the latter duct, substantially as set forth.

4. The combination of a high-pressure cylinder and piston and a low-pressure cylinder and piston, said pistons working together, and a steam-duct connecting the low-pressure cylinder with the high-pressure cylinder on the corresponding side of the piston, the high-pressure cylinder also having relief-passages from the high-pressure side of its piston to the side with which the said duct communicates, which passages are opened when the piston is near the end of its stroke, substantially as set forth.

5. The combination of two cylinders and pistons, connected and working together, and a steam-duct, whereby the high-pressure cylinder is provided with an exhaust into the

low-pressure cylinder and its piston is balanced in the body of steam which operates upon the low-pressure piston, substantially as set forth.

6. The combination, with the two cylinders and the pistons of unequal area, connected and working together, one of the pistons being balanced in the low-pressure steam, while the latter acts upon the low-pressure piston, of an exhaust-steam duct, steam-ports, and a valve, all substantially as described, to act alternately by high and low pressure, as set forth.

7. The combination, with the two cylinders, connected as shown, of the valve-case and the interposed fitting I *i*, as and for the purposes described.

In testimony whereof we affix our signatures in presence of two witnesses.

GEORGE CHANDLER KIDDER.
WILLIAM MONTAGUE FERRY.

Witnesses:
JAMES MOFFAT,
A. D. GANIS.