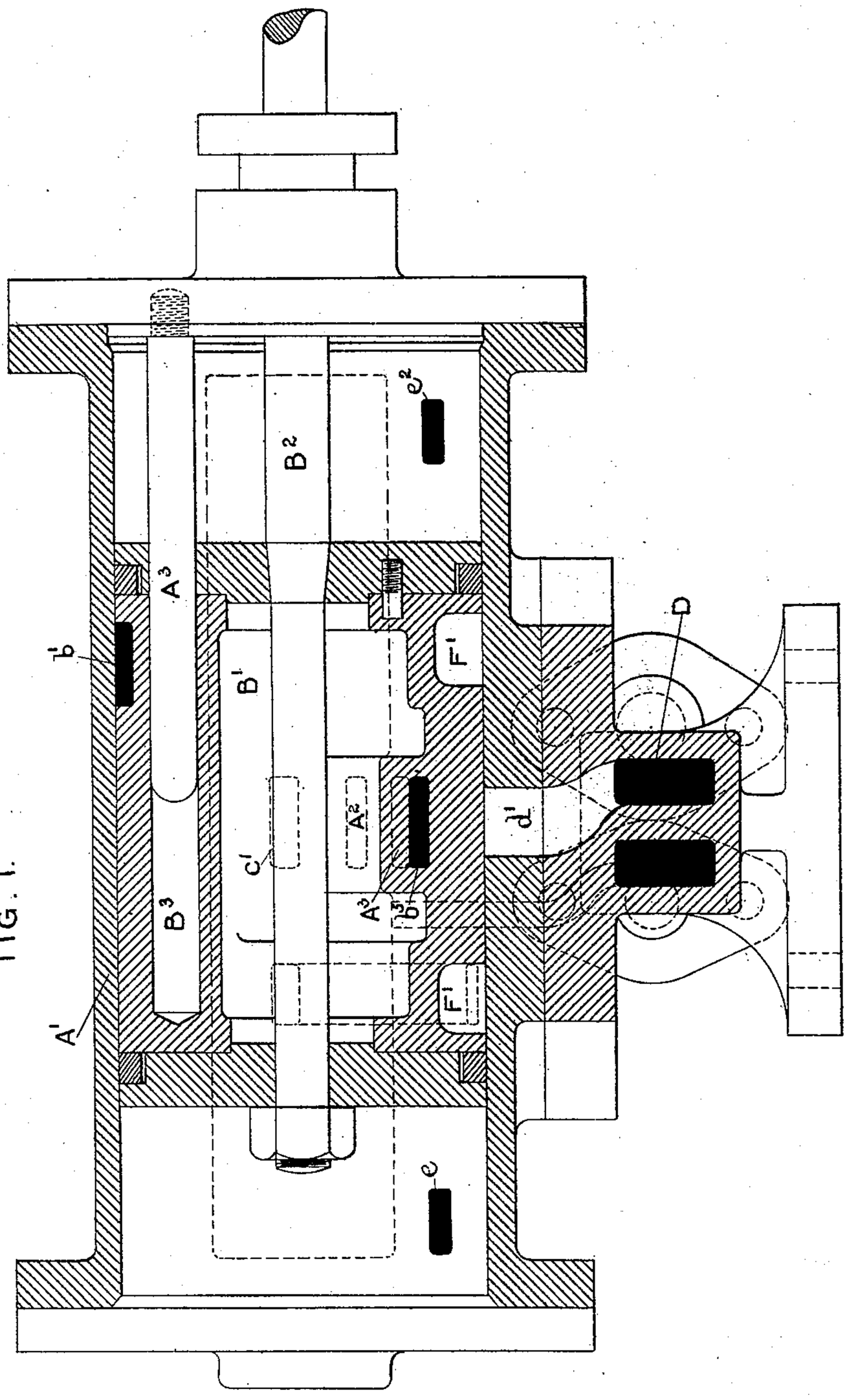
(No Model.) 5 Sheets—Sheet 1.

A. G. MUMFORD & A. ANTHONY.

DIRECT ACTING STEAM PUMPING ENGINE.

No. 454,059. Patented June 16, 1891.

FIG. 1.



WITNESSES:

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Robt. Ed. Phillips.

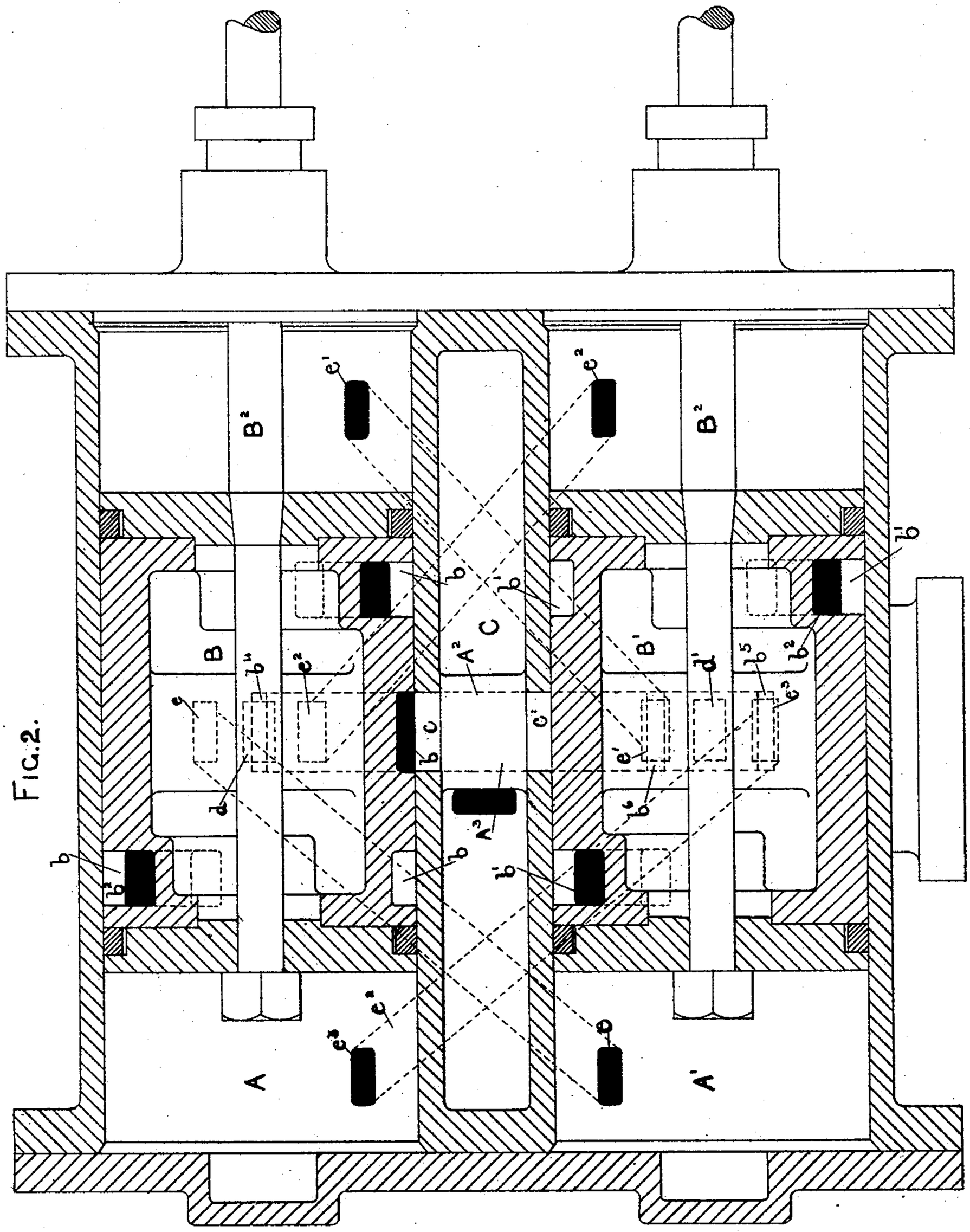
(No Model.) 5 Sheets—Sheet 2.

A. G. MUMFORD & A. ANTHONY.

DIRECT ACTING STEAM PUMPING ENGINE.

No. 454,059. Patented June 16, 1891.

FIG. 2.



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Attorney

(No Model.) 5 Sheets—Sheet 3.

A. G. MUMFORD & A. ANTHONY.

DIRECT ACTING STEAM PUMPING ENGINE.

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FIG. 3.

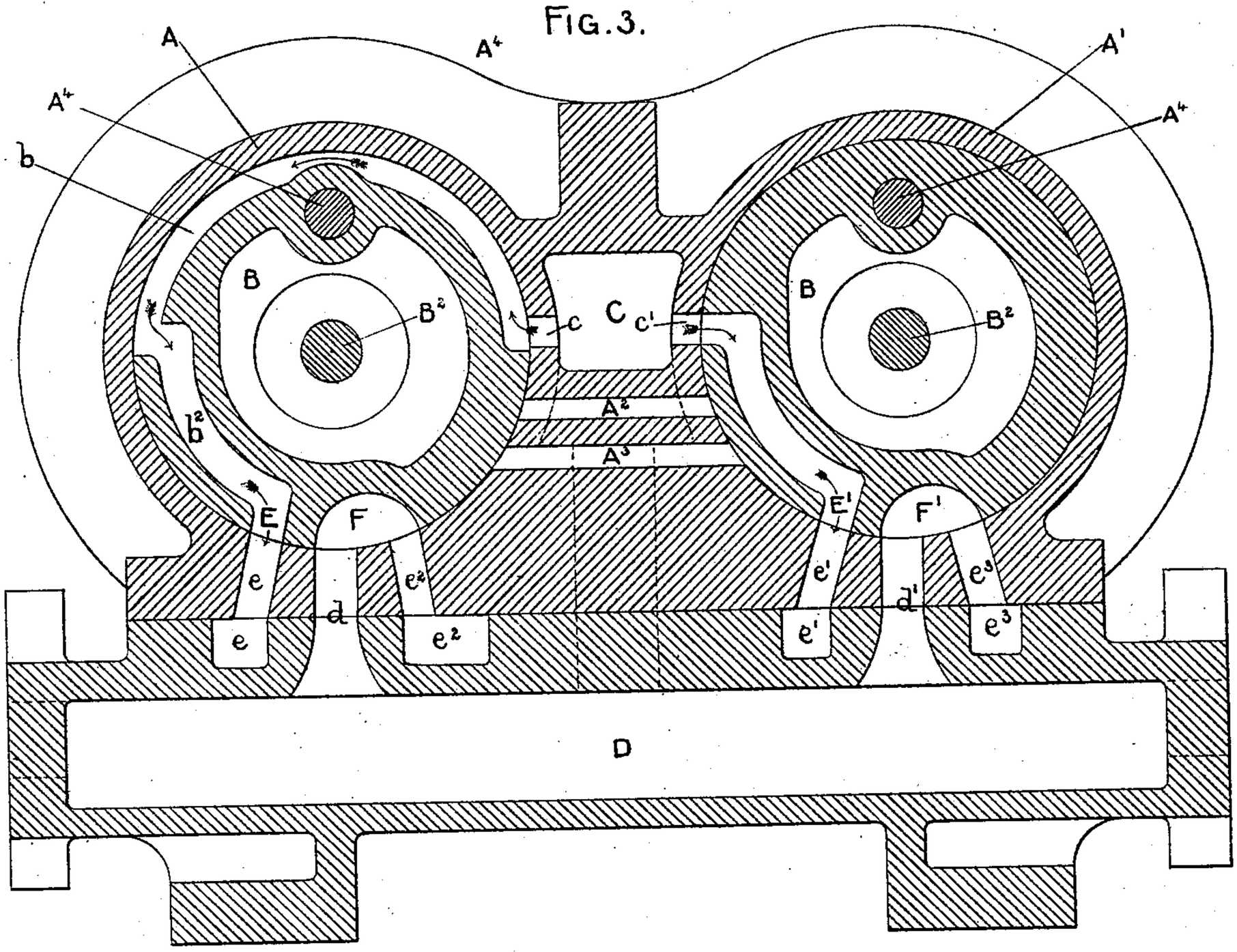
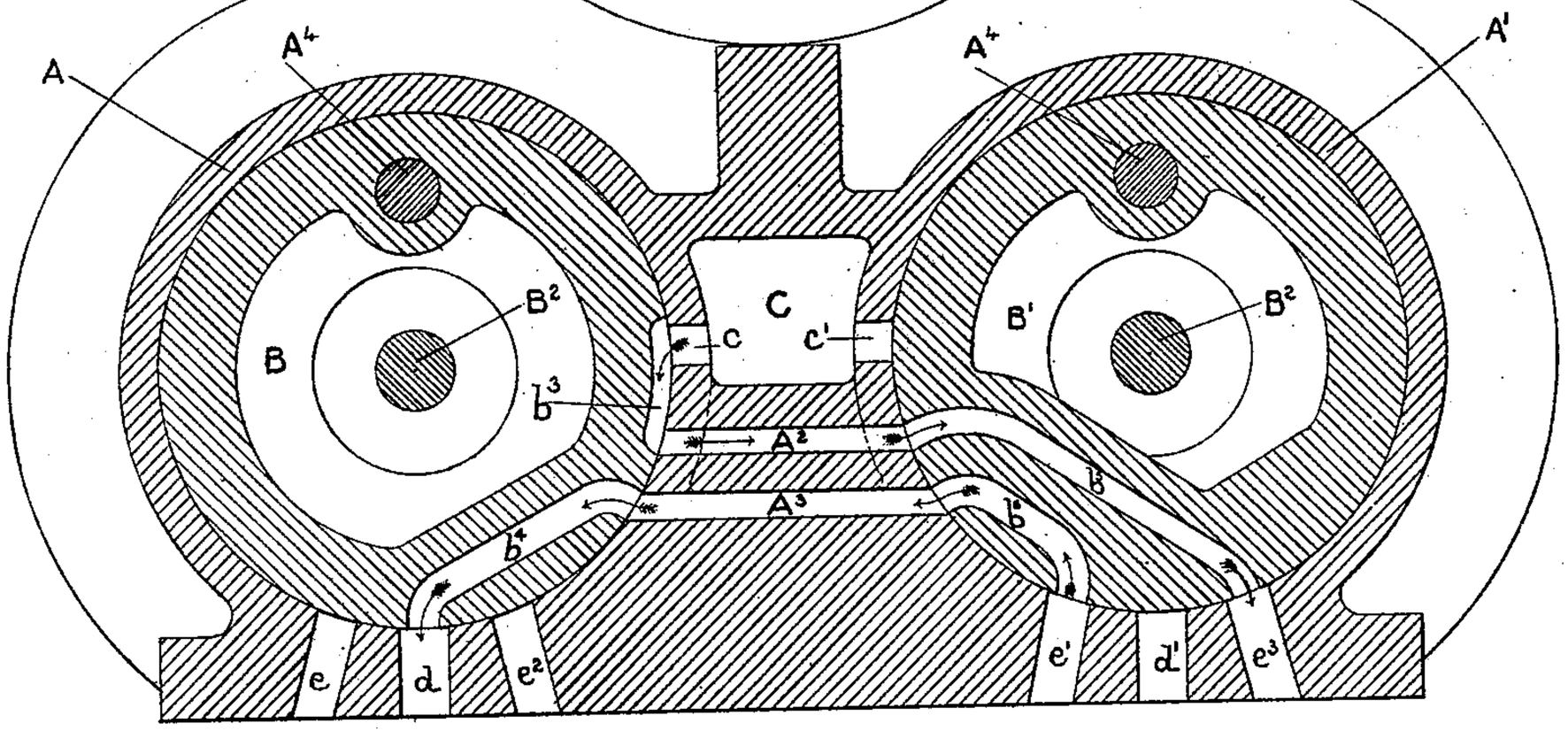


FIG. 4.



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(No Model.) 5 Sheets—Sheet 4.

A. G. MUMFORD & A. ANTHONY.

DIRECT ACTING STEAM PUMPING ENGINE.

No. 454,059. Patented June 16, 1891.

FIG. 5.

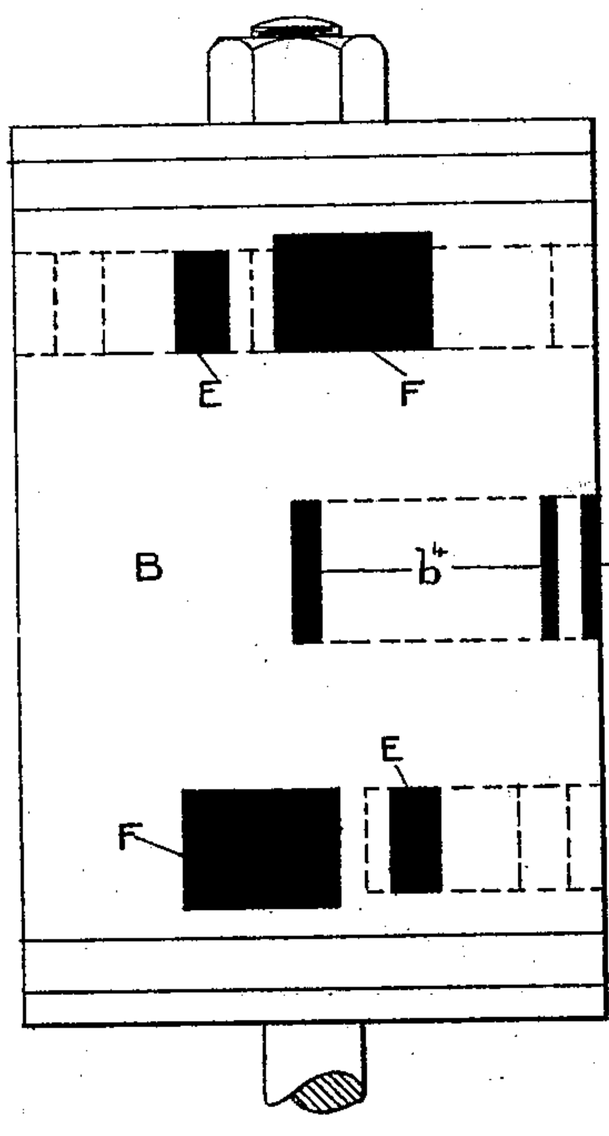


FIG. 6.

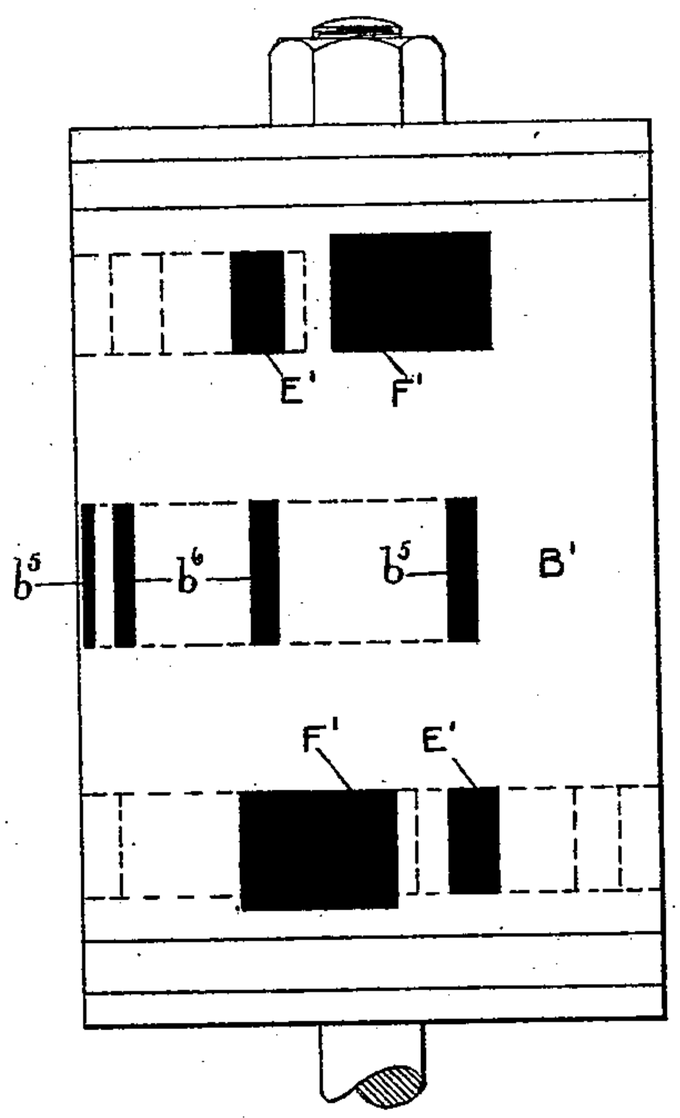


FIG. 7.

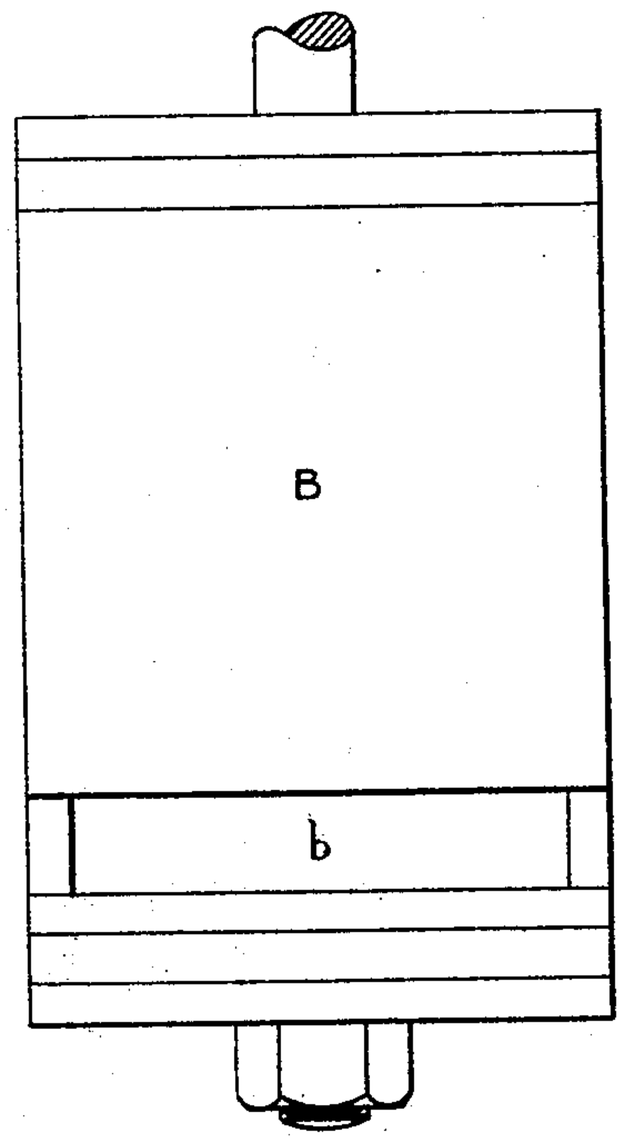
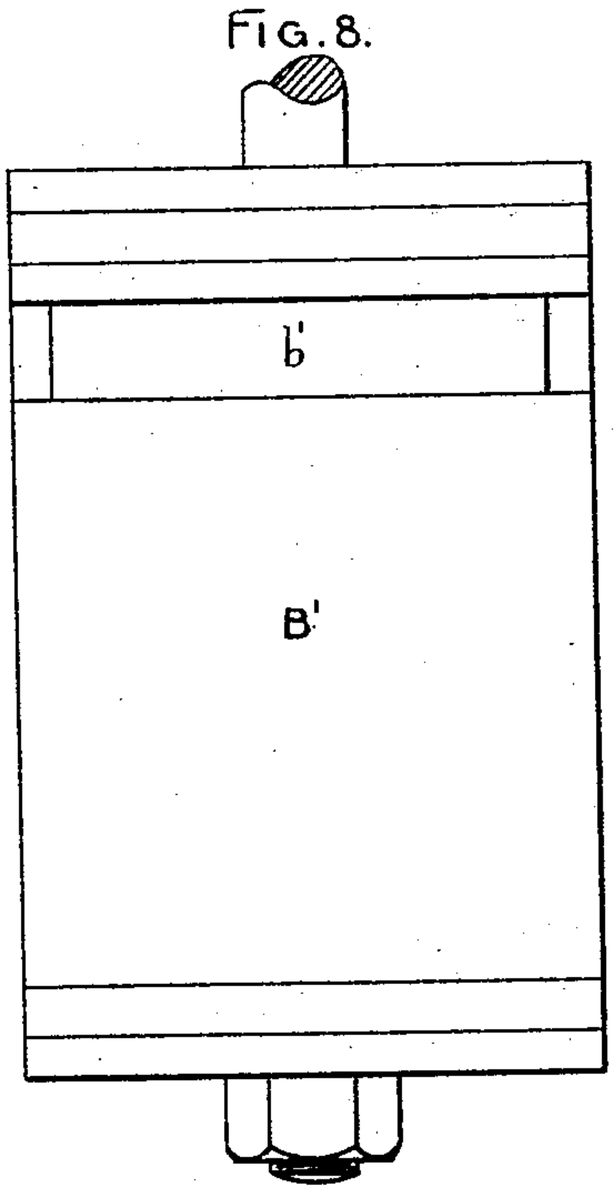


FIG. 8.



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(No Model.) 5 Sheets—Sheet 5.

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FIG. 9.

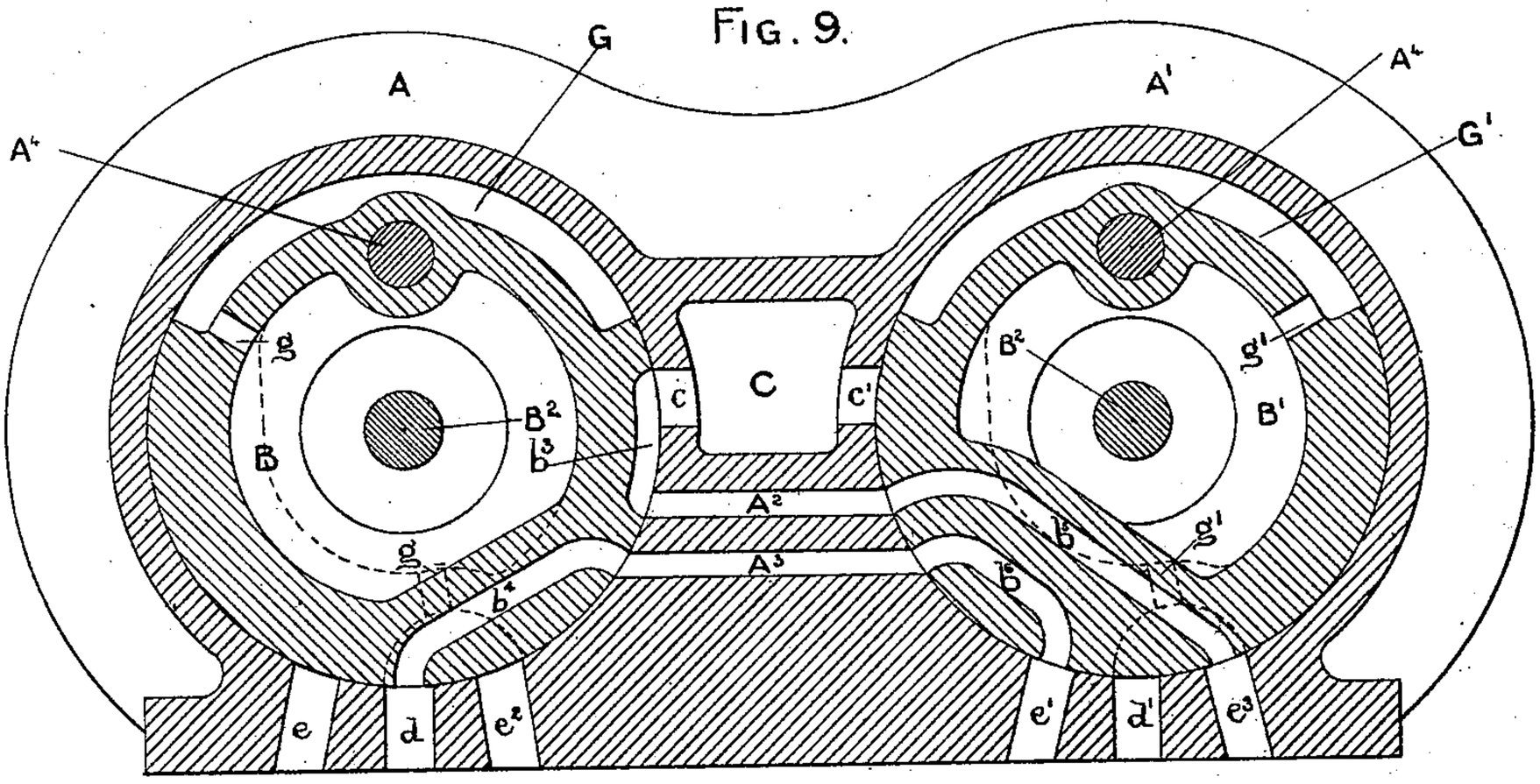


FIG. 10.

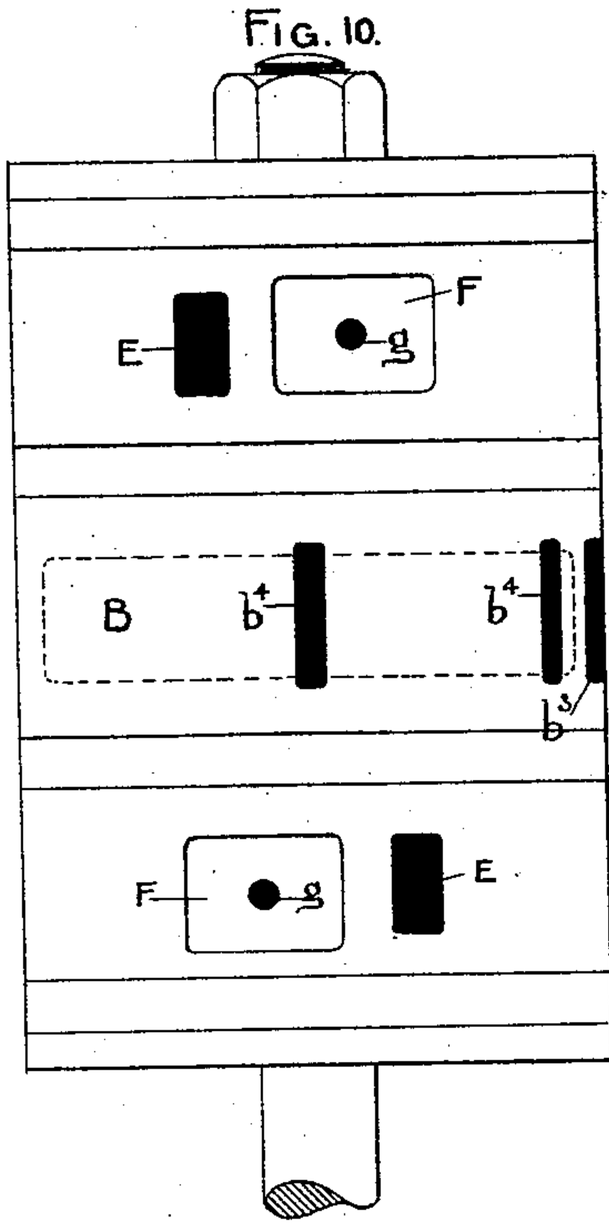


FIG. 11

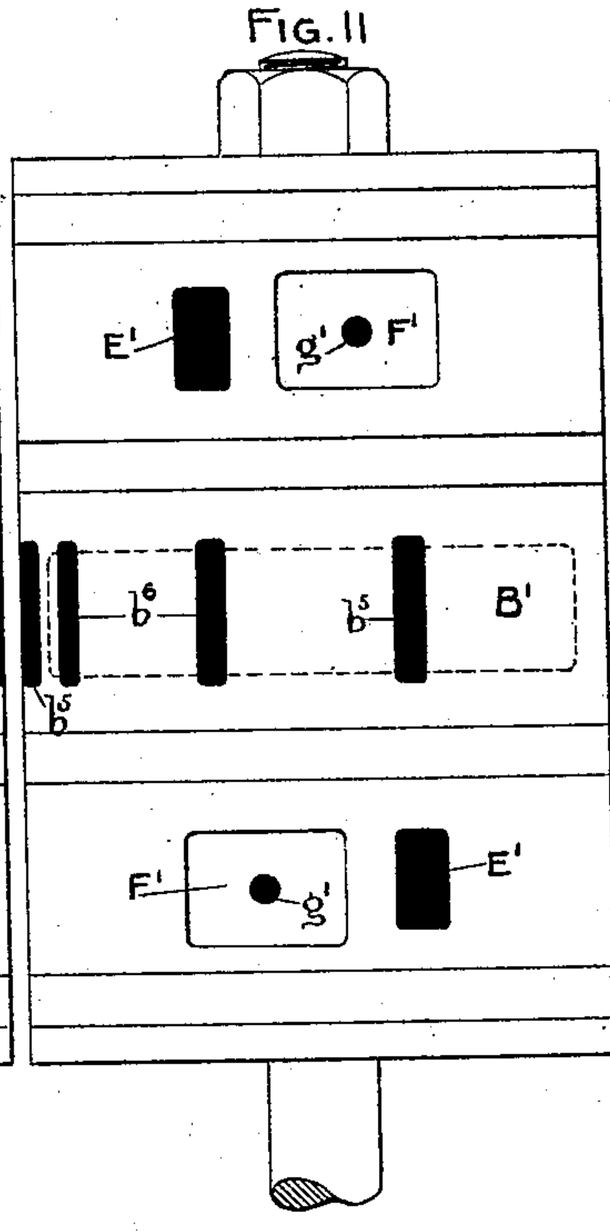
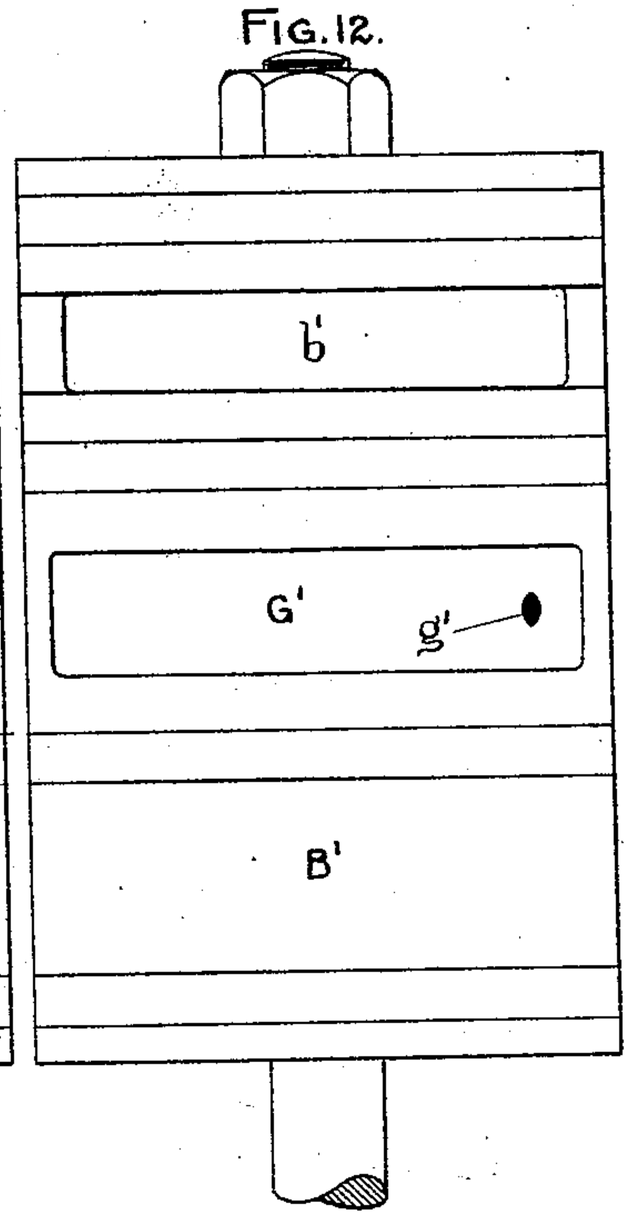


FIG. 12.



WITNESSES:
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By their Attorney.
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UNITED STATES PATENT OFFICE.

ARTHUR GEORGE MUMFORD AND ALFRED ANTHONY, OF COLCHESTER, ENGLAND.

DIRECT-ACTING STEAM PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 454,059, dated June 16, 1891.

Application filed December 17, 1890. Serial No. 375,053. (No model.) Patented in England November 6, 1888, No. 16,015, and October 11, 1890, No. 16,281.

To all whom it may concern:

Be it known that we, ARTHUR GEORGE MUMFORD and ALFRED ANTHONY, both subjects of the Queen of Great Britain, residing at Colchester, in the county of Essex, England, have invented certain new and useful Improvements in Direct-Acting Steam or other Fluid Pumping-Engines, (for which we have obtained Letters Patent in Great Britain numbered 16,015, bearing date November 6, 1888, and 16,281, bearing date October 11, 1890,) of which the following is a specification.

Our invention relates to improvements in direct-acting steam or other fluid pumping-engines having duplex cylinders, the pistons of which act as distributing-valves to the respective other cylinders; and the objects of our improvements are, first, to enable one of the pistons to start should they both be at a state of rest at or about the center of the length of their stroke—*i. e.*, at or about the center of the lengths of the cylinders; second, to balance the pressure on the pistons when steam at a very high pressure is used; third, to prevent the rotation of the pistons in their cylinders, and, lastly, to generally render this type of pumping-engine more efficient.

It is well known that in the type of pumping-engine forming the subject of our invention it is necessary, if the pump has to work against a heavy pressure, that the plungers of the pump should make a distinct pause at the ends of their strokes—that is, they should remain at rest a period more or less prolonged before reversing their motion. To insure this action it is essential that there should be a certain amount of lap on the parts of each piston which give steam to the other cylinder—that is to say, each piston should travel a certain distance about the middle of the length of its cylinder without admitting steam to or exhausting from either end of the other cylinder, so as not to reverse the motion of the other piston too quickly. The result of this is that it is possible for both pistons to get in such a position at or about the center of the length of the cylinders that neither can give steam to or exhaust from either end of the other cylinder, and consequently the engine comes to a state of rest from which it cannot be started. To overcome this difficulty we form supplemental ports between the bores of the cylinders and we form supplemental ports in the pistons, so that should both pistons be at a state of rest at or about the center of the length of their cylinders both ends of either one cylinder or the other, on each side of the piston, are in communication with the steam-chamber and exhaust-chamber, respectively, thereby allowing the piston of the said cylinder to move either forward or backward and so start or restart the engine. It is also well known that if steam at a high pressure is used with this type of pumping-engine the pistons will not work smoothly unless the exhaust-recesses in the pistons are reduced to the smallest possible area, which cannot be done without impairing the action of the engine. We therefore overcome this difficulty by balancing each piston by forming suitably-proportioned recesses in them and by connecting the said recesses by suitable passages with the exhaust-recesses, thereby equalizing the pressure on the top and bottom of the piston.

We attain the objects of our invention by the mechanism illustrated in the accompanying drawings, in which—

Figure 1, Sheet No. 1, is a view in sectional side elevation through one of the cylinders. Fig. 2, Sheet No. 2, is a view in sectional plan through the center of the cylinders. Fig. 3, Sheet No. 3, is a view in transverse section through the central ports of the cylinders and through the end ports at the back of each piston, the pistons being both at the front or stuffing-box end of the cylinders. Fig. 4, Sheet No. 3, is a transverse section through the central ports in the cylinders and through the central ports in both pistons, the pistons being both in the middle of their stroke. Figs. 5 and 6, Sheet No. 4, are views of the bottom sides of the pistons, showing their end and central ports. Figs. 7 and 8, Sheet No. 4, are views of the top sides of the pistons, showing the annular steam-passages; and Fig. 9, Sheet No. 5, is a view in transverse section through the central ports of the cylinders and pistons.

Figs. 10 and 11, Sheet No. 5, are views of the bottom sides of both pistons; and Fig. 12, Sheet No. 5, is a view of the top of one piston, all showing the arrangement for balancing the pistons.

Throughout the views similar parts are marked with like letters of reference.

Referring to the several figures of the drawings A and A′ designate the cylinders, preferably placed side by side and in close proximity to one another, as shown by the accompanying drawings.

B and B′ designate the pistons, which are made of a length greater than half the length of the cylinders and either hollow to receive the steam within them or practically solid with annular steam-spaces *b* round them, as shown. These pistons are fitted with piston-rods B^2 B^2, adapted to be coupled direct onto the plungers or plunger-rods of the pumps.

C designates the steam-chamber common to both cylinders A and A′ and communicating therewith by the holes or passages *c* and *c′*.

D designates the exhaust-chamber common to both cylinders and in communication therewith by the ports *d* and *d′*.

E and E designate the steam slots or ports in the piston B, which are connected with the steam-chamber C by means of suitable passages b^2 b^2, the steam-slot at the front end of the piston direct and the one at the rear end thereof through the annular recess *b*.

E′ and E′ designate the steam slots or ports in the piston B′, which are connected with the steam-chamber C by a suitable passage b^{2*} b^{2*}, the steam-slot at the front end of the piston through the annular recess *b′* and the one at the rear end thereof direct.

F and F designate the exhaust-recesses in the piston B, and F′ and F′ designate those in the piston B′.

e designates the steam-port between the center of the cylinder A and the rear end of the cylinder A′.

e^2 designates the steam-port between the center of the cylinder A and the front end of the cylinder A′.

e′ designates the steam-port between the center of the cylinder A′ and the front end of the cylinder A, and e^3 designates the steam-port between the center of the cylinder A′ and the rear end of the cylinder A. *d* and *d′* designate the exhaust-ports in the center of the cylinders A and A′, respectively.

So far the construction of the pumping-engine presents no novel features, being already well known, and we will now proceed to describe the novel parts constituting our invention.

At the center of the length of each cylinder are formed two supplemental ports A^2 and A^3, connecting the bores of the two cylinders together, and preferably placed below the center of the cylinders and one above the other, as shown in the accompanying drawings. At the center of the length of the piston B are formed two supplemental ports b^3 and b^4, coinciding when the piston is at or about the center of its stroke with the supplemental ports A^2 and A^3 and putting them respectively into communication with the steam and exhaust of the cylinder A through the ports *c* and *d*, respectively. At the center of the length of the piston B′ are two supplemental ports b^5 and b^6, coinciding when the piston is at or about the center of its stroke with the supplemental ports A^2 and A^3, putting them in communication with the rear and front ends of the cylinder A by means of the ports *e′* and e^3, thereby admitting steam from the steam-chamber C to the rear end of the cylinder A, behind the piston B, through the ports and passages *c*, b^3, A^2, b^5, and e^3, and opening the forward end of the cylinder A in front of the piston B to the exhaust-chamber D through the ports and passages *e′*, b^6, A^3, b^4, and *d*, as shown by Fig. 4, Sheet No. 3, and Fig. 9, Sheet No. 5. The lengths of these supplemental steam-ports are so proportioned that they begin to open to one another at the same moment that each piston respectively closes the end ports of its cylinder on the one side, and remain open till the piston has opened the end ports of its cylinder on the other side.

The action of the supplemental ports is as follows: When both pistons are in such a position that neither can give steam to the other by the end ports, communication is opened through all the supplemental ports in both cylinders and pistons, as shown in Fig. 4, Sheet No. 3, and Fig. 9, Sheet No. 5, of the accompanying drawings. Steam then passes by the port b^3 in the piston B through the port A^2, and thence by the port b^5 in the piston B′ to the steam-port e^3 in cylinder A′, and thence to the back of the piston B. At the same time the exhaust-steam from the other end of the piston B passes by the port *e′* and supplemental port *b* in piston B′ to the supplemental port A^3, thence by the port b^4 in the piston B and the exhaust-port *d* to exhaust-chamber D, as shown by the arrows in Fig. 2, Sheet No. 2, and Fig. 4, Sheet No. 3, of the accompanying drawings. This causes the piston B to make a stroke toward the forward—that is, the stuffing-box—end of the cylinder A, and gives steam by the port e^2 to the piston B′, which then makes a stroke, giving steam to the piston B, when the pistons continue working in the usual manner.

It will be obvious that it is immaterial to which end of the cylinder the steam is admitted by the supplemental ports, or which piston is adapted to be first set in motion, as the supplemental ports can be so arranged as to admit steam to either end of either cylinder and to open the other end of the said cylinder to the exhaust.

In ordinary working the supplemental ports in the one piston have already passed the supplemental ports in the cylinder before the same ports in the other piston have arrived at them, so that the communication, as shown

in Fig. 4, Sheet No. 3, is never established unless one of the pistons is out of its proper position with respect to the other, and both positions are so placed that neither can give steam to the other by the end ports.

When it becomes necessary to balance the pistons, owing either to the size of the exhaust-recesses or to the high pressure of the steam used, we effect this object in the manner shown by Figs. 9, 10, 11, and 12, Sheet No. 5, of the accompanying drawings. We form on the top side of each piston an annular recess of an area equal to the areas of the two exhaust-recesses.. We designate these recesses "balancing-recesses," and they are marked G and G′ on the drawings. These balancing-recesses are each put in communication with the two exhaust-recesses in each piston by any suitable passages, so that the exhaust-steam can gain access thereto.

In the construction of piston illustrated by Figs. 9, 10, 11, and 12, Sheet No. 5, of the accompanying drawings, we simply drill or form holes *g g*, &c., and *g′ g′*, &c., between the exhaust-recesses and the interior of each piston and from the interior of each piston to the balancing-recesses, but the communication may be made in any other suitable and convenient manner. When we use balancing-recesses, we prefer to use two extra sets of piston-rings in each piston, as shown by Figs. 10, 11, and 12, Sheet No. 5, of the accompanying drawings, to prevent the leakage of steam through the balancing-recesses.

To prevent the rotation of the pistons in their cylinders, we use in each cylinder a stud or guide A^4, screwed or otherwise fixed to the cylinder-cover. These studs or guides are adapted to slide in longitudinal recesses B^3 in the pistons, as shown by Figs. 1, Sheet No. 1, Figs. 3 and 4, Sheet No. 3, and Fig. 9, Sheet No. 5. By this arrangement we are enabled to use any type of piston and any arrangement of main induction and eduction ports, as found most convenient.

We wish it to be particularly understood that we do not limit ourselves to the precise details of construction hereinbefore described, and illustrated by the accompanying drawings, but hold ourselves at liberty to make such changes and alterations as fairly fall within the spirit and scope of our invention.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is—

1. In a steam pumping-engine having duplex cylinders the pistons of which act as distributing-valves to the said cylinders, the supplemental ports located centrally in the cylinders and pistons and adapted, when both pistons are in such a position that neither can give steam to or exhaust from either end of the cylinder containing the other by the usual means, to put the one end of one cylinder in communication with the steam and the other end thereof in communication with the exhaust, as and for the purpose set forth.

2. In a pumping-engine having duplex cylinders the pistons of which act as distributing-valves to the said cylinders, the combination, with the said cylinders and pistons having suitable induction and eduction ports, of the supplemental ports located centrally in the cylinders and their pistons and adapted to enable the engine to start or restart should both pistons be at a state of rest at or about the center of their strokes, and the balancing-recesses in the pistons, located on opposite sides of the pistons to the exhaust-recesses and adapted to equalize or balance the pressure on both sides of the said pistons, all combined, arranged, and operating as set forth.

3. In a pumping-engine having duplex cylinders the pistons of which act as distributing-valves to the said cylinders, the combination, with the said cylinders and pistons having suitable induction and eduction ports, of the supplemental ports located centrally in the cylinders and pistons and adapted to enable the engine to start or restart should both pistons be at a state of rest at or about the center of their strokes, the balancing-recesses in the pistons, located in the opposite sides of the said pistons to the exhaust-recesses therein and adapted to equalize or balance the pressure on both sides of the pistons, and the piston-rings in the pistons, located between the balancing and exhaust recesses of the said pistons, all combined, arranged, and operating as set forth.

4. In a pumping-engine having duplex cylinders the pistons of which act as distributing-valves to the said cylinders, the combination, with the said cylinders and pistons having suitable induction and eduction ports, of the supplemental ports located centrally in the cylinders and their pistons and adapted to enable the engine to start or restart should both pistons be at a state of rest at or about the center of their strokes, the balancing-recesses in the pistons, located on the opposite sides of the said pistons to the exhaust-recesses therein and adapted to equalize or balance the pressure on both sides of the pistons, the piston-rings in each piston, located between the balancing and exhaust recesses therein and adapted to cut off the passage of steam between the said recesses, and the longitudinal recesses in the pistons, adapted to receive studs or their equivalents fixed to the cylinder-covers to prevent the rotation of the pistons in the cylinders, all combined, arranged, and operating as set forth.

5. In a pumping-engine having duplex cylinders the pistons of which each act as a distributing-valve to the other cylinder, the combination of the two supplemental ports A^2 and A^3, connecting the bores of the two cylinders A and A′, the two supplemental ports b^3 and b^4 in the piston B, the former adapted to

put the supplemental port A^2 in communication with the steam-chest C and the latter adapted to put the supplemental port A^3 in communication with the exhaust-port *d* of the cylinder A, the two supplemental ports b^5 and b^6 in the piston B′, the former adapted to put the supplemental ports A^2 and A^3 in communication with the rear and front ends of the cylinder A by the steam-ports *e e*, respectively, and the studs or their equivalents A^4 A^4, fixed to the covers of the cylinders and engaging with the longitudinal recesses B^3 B^3 in the pistons to prevent their rotation, all combined, arranged, and operating as set forth.

In witness whereof we have hereunto signed our names in the presence of two subscribing witnesses.

ARTHUR GEORGE MUMFORD.
ALFRED ANTHONY.

Witnesses:
A. H. WYATT,
F. H. NOBLE,
Both of Colchester.