(No Model.) 3 Sheets—Sheet 1.

C. A. HAGUE.

PUMPING ENGINE.

No. 356,119. Patented Jan. 18, 1887.

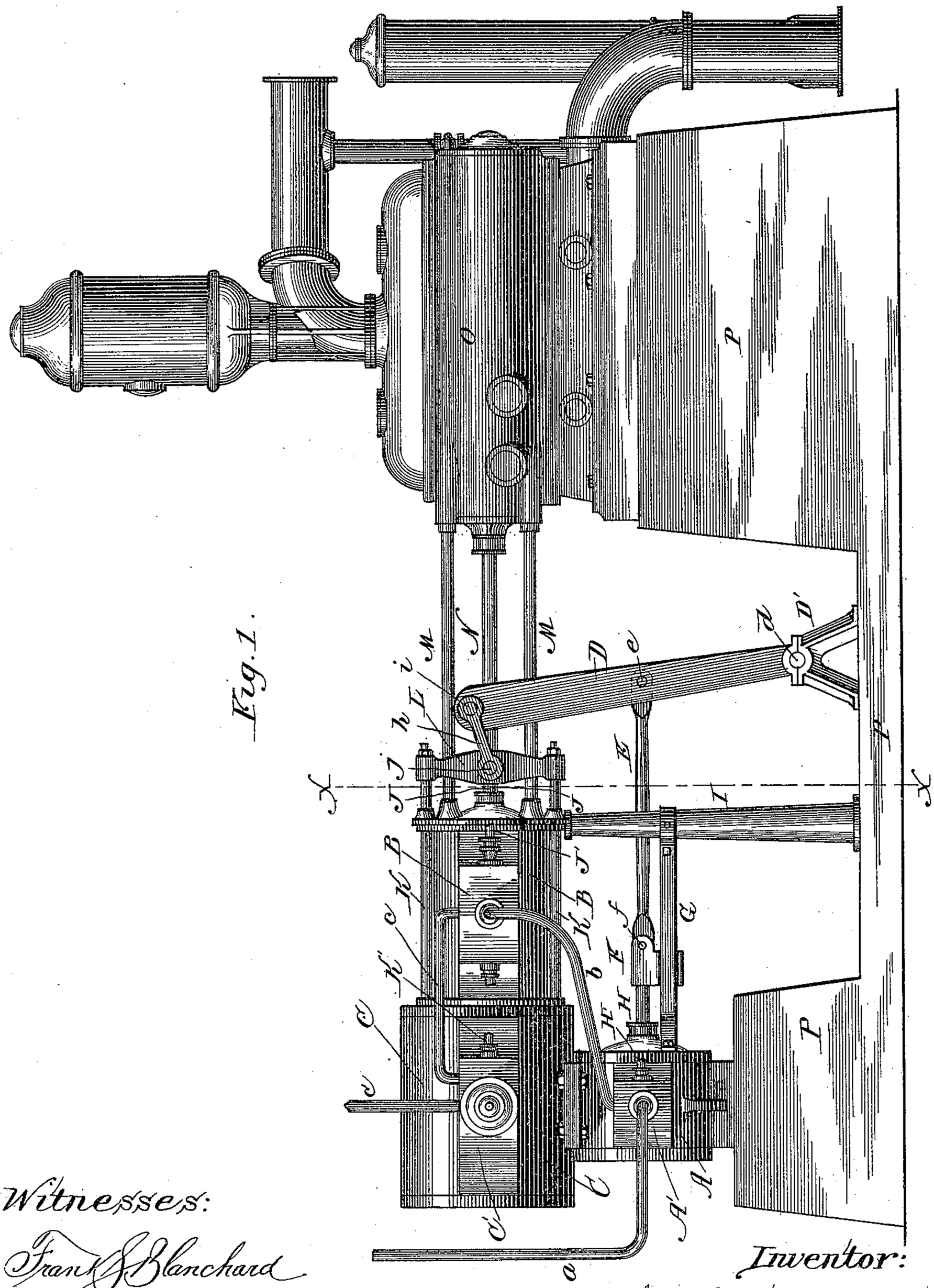

Fig. 1.

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(No Model.) 3 Sheets—Sheet 2.

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Fig. 2.

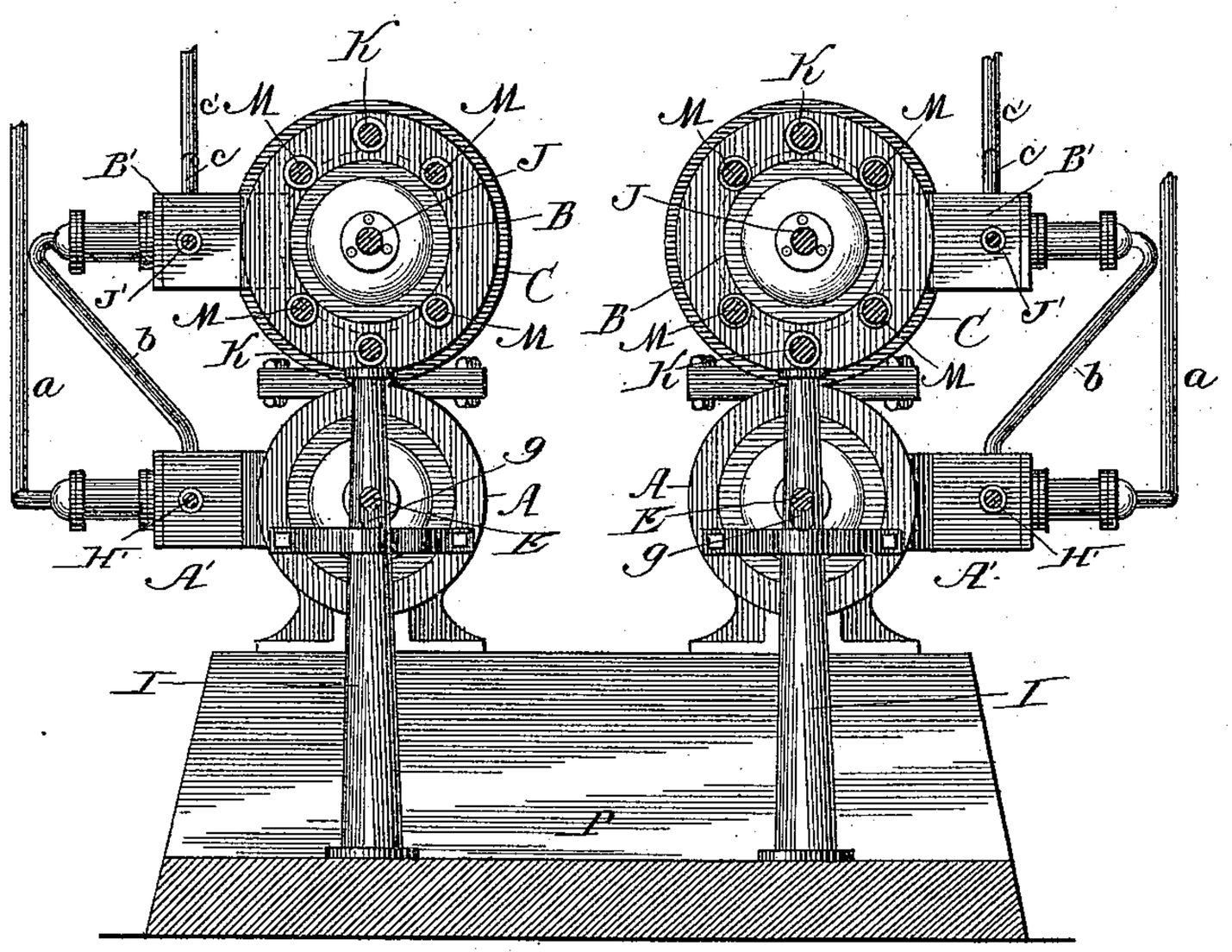
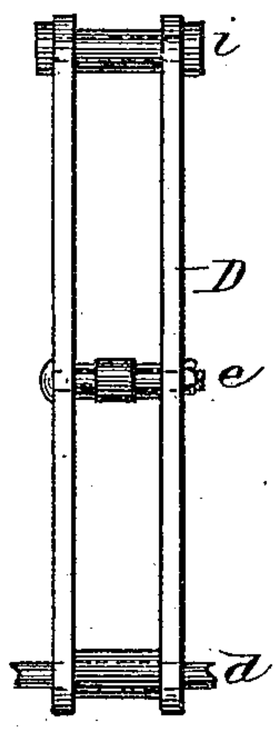


Fig. 3.



Witnesses:

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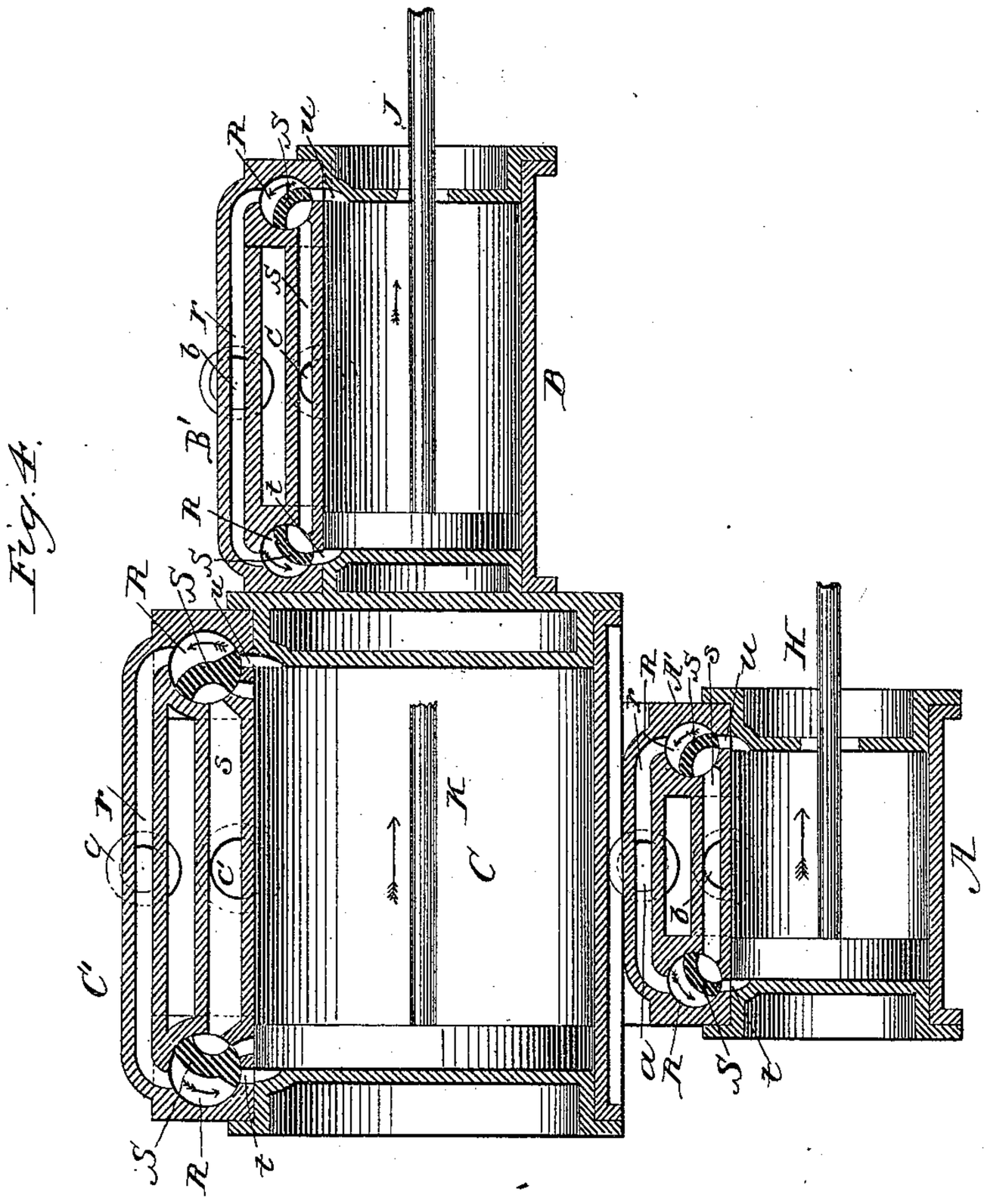

WITNESSES:

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INVENTOR

Chas A Hague.

UNITED STATES PATENT OFFICE.

CHARLES A. HAGUE, OF HACKENSACK, NEW JERSEY.

PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 356,119, dated January 18, 1887.

Application filed July 3, 1886. Serial No. 207,013. (No model.)

To all whom it may concern:

Be it known that I, CHARLES A. HAGUE, residing at Hackensack, in the county of Bergen and State of New Jersey, and a citizen of the United States, have invented a new and useful Improvement in Pumping-Engines, of which the following is a full description, reference being had to the accompanying drawings, in which—

Figure 1 is a side elevation; Fig. 2, a section on line *x x* of Fig. 1, and Fig. 3 a detail of the vibrating arm; Fig. 4, a sectional elevation of the cylinders, showing the steam-chests on top of the respective cylinders.

This invention relates to that class of steam pumping-engines termed "non-rotative," and in which duplex pumping-engines are used, the steam-valves of one set of cylinders being operated by motion derived from the opposite cylinders, and in this class of engines an objection arises by reason of the limited range of steam expansion, which produced a consequent limited range in economic duty.

The object of this invention is to enable duplex pumping-engines of the non-rotative type to be as economic in duty and have as great a range of steam expansion as with steam-engines which are controlled by a crank and fly-wheel, and also to increase the duty performed by the engine from the consumption of a certain amount of steam; and these objects are accomplished by the devices and combinations of devices hereinafter described, and pointed out in the claims as new.

In the drawings, A represents the cylinder, having connected therewith a steam-chest, A′, and into which the steam is first admitted, so that this cylinder may be termed the "initial cylinder," and the steam is supplied to the steam-chest A′ from a boiler or other source of supply by a steam-pipe, *a*.

B is a cylinder, having connected therewith a steam-chest, B′, to which steam is supplied by a pipe, *b*, from the steam-chest A′ under pressure, making the cylinder B a high-pressure cylinder.

C is a cylinder, having connected therewith a steam-chest, C′, to which steam is supplied by a pipe, *c*, from the steam-chest B′, and as the steam has been worked in the cylinder B before passing to the cylinder C, this cylinder C would be a low-pressure cylinder, and the steam, after working in the cylinder C, is exhausted therefrom through a pipe, *c′*, in any usual and well-known manner. The cylinders A B C may be of any of the usual and well-known forms of construction, having their steam-chests provided with valves and cut-offs, as usual; and, as shown, the cylinders B C are located in parallel planes—one in advance of the other—and the cylinder A is located in a plane below the cylinders B C.

D is an arm, formed, as shown in Fig. 3, of two side bars connected together at the top and bottom, and pivoted by the lower connection, *d*, to a support, D′, on the base or foundation which supports the engine as a whole. This arm is made heavier at its upper end than at its lower, to steady the stroke or movement of the pistons and plungers through the inertia or momemtum arising from the weight of such top or free end of the arm.

E is a connecting-rod, one end of which is connected by a suitable pin or pivot, *e*, to the vibrating arm D.

F is a slide, to which is pivotally connected by a suitable pin or pivot, *f*, the end of the connecting-rod E.

G is a track or guideway supporting the slide F, the slide being mounted on the track so as to be maintained in a direct line of motion.

H represents the piston-rod for the cylinder A, one end of which is attached to the slide F.

I is a post, the lower end of which rests on the base or foundation supporting the engine, and the upper end of which receives and supports the cylinder B at one end, the other end of the cylinder being attached to the cylinder C, and the cylinder C, as shown, is supported on the cylinder A, and the cylinder A is supported on the base or foundation. The post I is provided with a slot, *g*, in line with the connecting-rod E, to allow the rod to reciprocate from the movements of the vibrating arm D in the form of construction shown.

J represents the piston-rod for the cylinder B.

K represents the piston-rods for the cylinder C, the rods being located in line one with the other on opposite sides of the cylinder B and just outside of the periphery of such cyl-

inder in the construction shown. The steam-chest A′ has its valves operated by a connecting-rod, H′, and the steam-chests B′ C′ have their respective valves operated by connecting-rods J′ K′, and these rods H′ J′ K′ operate their respective valves in the usual manner.

L is a head, to which is connected the ends of the piston-rods J K, which head has a reciprocating movement from the vibrations of the arm D, to the upper end of which the head is connected by links *h*, the link at one end being pivoted to the arm D by a pin or pivot, *i*, and at the other end to the head L by a pin or pivot, *j*.

M represents tie-rods connecting the cylinder B with the pump-cylinder.

N represents the piston-rod for the pump.

O represents the pump-cylinder.

P represents the foundation supporting the cylinders.

The pump-cylinder and devices pertaining thereto are not carried out in detail, and are only represented for the purpose of showing a relative arrangement of the steam-cylinders with the pump; but such pump may be of any of the usual and well-known forms of construction, and need not therefore be here specifically described, as the present invention pertains to the working of the steam in the steam-cylinders.

The operation is as follows: The steam from the boiler or other source of supply is supplied to the steam-chest A′ of the cylinder A, and is admitted to the initial cylinder A, driving the piston therein to the end of its stroke in either direction, according to the admission of the steam, the steam being controlled by the valves in the steam-chest, as usual, to drive the piston, and at the end of the piston-stroke the steam is released and admitted to the high-pressure cylinder B through the connecting-pipe *b*, and drives the piston in the cylinder B to the end of its stroke in either direction, accordingly as the steam is admitted to the cylinder, the admission of the steam being controlled by the valves in the steam-chest B′, as usual, and after the steam has driven the piston to the end of its stroke it is released and admitted into the low-pressure cylinder C through the pipe *c*, and after operating the piston of that cylinder in the usual manner is released and passes off through the exhaust-pipe *c′*. It will thus be seen that the steam in the initial cylinder A works under its full head on the piston of that cylinder, and is then released and passes under a high pressure to the cylinder B, and operates the piston of such cylinder, and is then released and passes under a decreased pressure to the low-pressure cylinder C, to operate the piston of that cylinder, thus enabling the practicable limit which has heretofore been employed with two cylinders to be greatly exceeded without any waste of the pressure of the steam, thus effecting great economy in the use of steam in engines of this class, and at the same time a higher duty is had by reason of the greatly-increased expansion of the steam through the addition of the initial cylinder A, which avoids the extreme difference between initial and terminal pressures that would follow the same ratio of expansion if only a single cylinder or two cylinders were used.

The initial pressure of steam is greater in the cylinder A than the back-pressure, because the length of the cylinder B is double that of the cylinder A, leaving double the amount of space for the diffusion of the steam in the cylinder B, so that as the piston in the cylinder A commences a return stroke in either direction the back-pressure is carried into the cylinder B and diffused over the receiving-space of such cylinder, giving the initial pressure in the cylinder A the benefit where such pressure will be double, or nearly so, of that of the back-pressure.

The arm D being of greater weight at its upper end than at its lower end gives the balance of power to such upper end, producing an inertia and momentum by which the strokes of the pistons and plungers are steadied, thereby producing a uniform impulse through the absorption and distribution of the surplus energy above that required for the work done throughout the stroke in either direction, thus keeping the stroke in either direction a uniform one, and adding greatly to the working capacity of the pump.

An arrangement of valves to be used in carrying out this invention is shown in Fig. 4, in which figure the steam-chests are located on top of the respective cylinders, instead of on the side, as shown in Figs. 1 and 2. Each steam-chest at each end has a passage, R, in which is located a circular slide-valve, S, which valve has a semi-rotation, so as to open and close the ports leading to the supply and exhaust passages for the steam. As shown in Fig. 4, each piston has made a complete movement and is about to return in the direction indicated by the arrow, and on such return movement the valve S will be rotated so as to open the ports leading to the cylinder and allow the steam to enter back of the piston and pass out in front of the cylinder. The steam from the supply-pipe A enters the passage *r* of the steam-chest A′ to enter the valve-passages at either end, accordingly as the valve S is turned to open one passage or close the other, and from the valve-passage, with the piston moving in the direction of the arrow of the cylinder A, the steam passes through the port *t* back of the piston to drive the piston forward, and the steam in the cylinder in front of the piston passes out through the port *u*, the valve S for such port being turned to open the port for the steam to pass into the passage R and enter the passage *s* and pass into the pipe *b*, and from thence to the passages *r* of the steam-chest B′, to pass the supply-valve S of that steam-chest and enter the port *t*, for the steam to pass back of the piston of the cylinder B, the steam in front of such

piston passing out through the port *u*, the valve S of such port being turned to allow the steam to enter the passages R and *s* and pass into the pipe C to the passage *r* of the steam-chest C′, and enter the passage R and pass the valve S to enter the port *t* of the cylinder C and advance its piston, the steam in front of the piston of such cylinder passing out through the port *u* and entering the passages R and *s*, to pass out through the exhaust-pipe *c*′. A movement of the pistons in the opposite direction to the position shown in the figure is had by a reverse movement of the steam, by which the live steam enters the port *u* and the secondary steam passes out through the ports *t*, the valves S being automatically operated to open and close the ports *t u*, as required, for supplying or exhausting the steam from the respective cylinders from the movement of the companion set of cylinders of a duplex engine.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination, with the cylinders A, B, and C and their piston-rods, of a vibrating lever, D, pivoted at its lower end to a stationary support and of a greater weight at its upper than at its lower end, and link-connections between the lever and the piston-rods of the cylinders, substantially as described.

2. The combination, with the initial cylinder A and the high and low pressure cylinders B C, of a vibrating arm or lever, D, for absorbing and distributing the surplus energy and maintaining a steady stroke for the pistons and plungers, substantially as specified.

3. The combination, with the initial cylinder A, high-pressure cylinder B, and low-pressure cylinder C, of the arm D, connecting-rod E, slide F, piston-rod H, head L, links *h*, and piston-rods J K, substantially as and for the purpose specified.

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