7 Sheets--Sheet 1.

E. D. LEAVITT, Jr.

Improvement in Steam-Pumping Engines.

No. 129,240. Patented July 16, 1872.

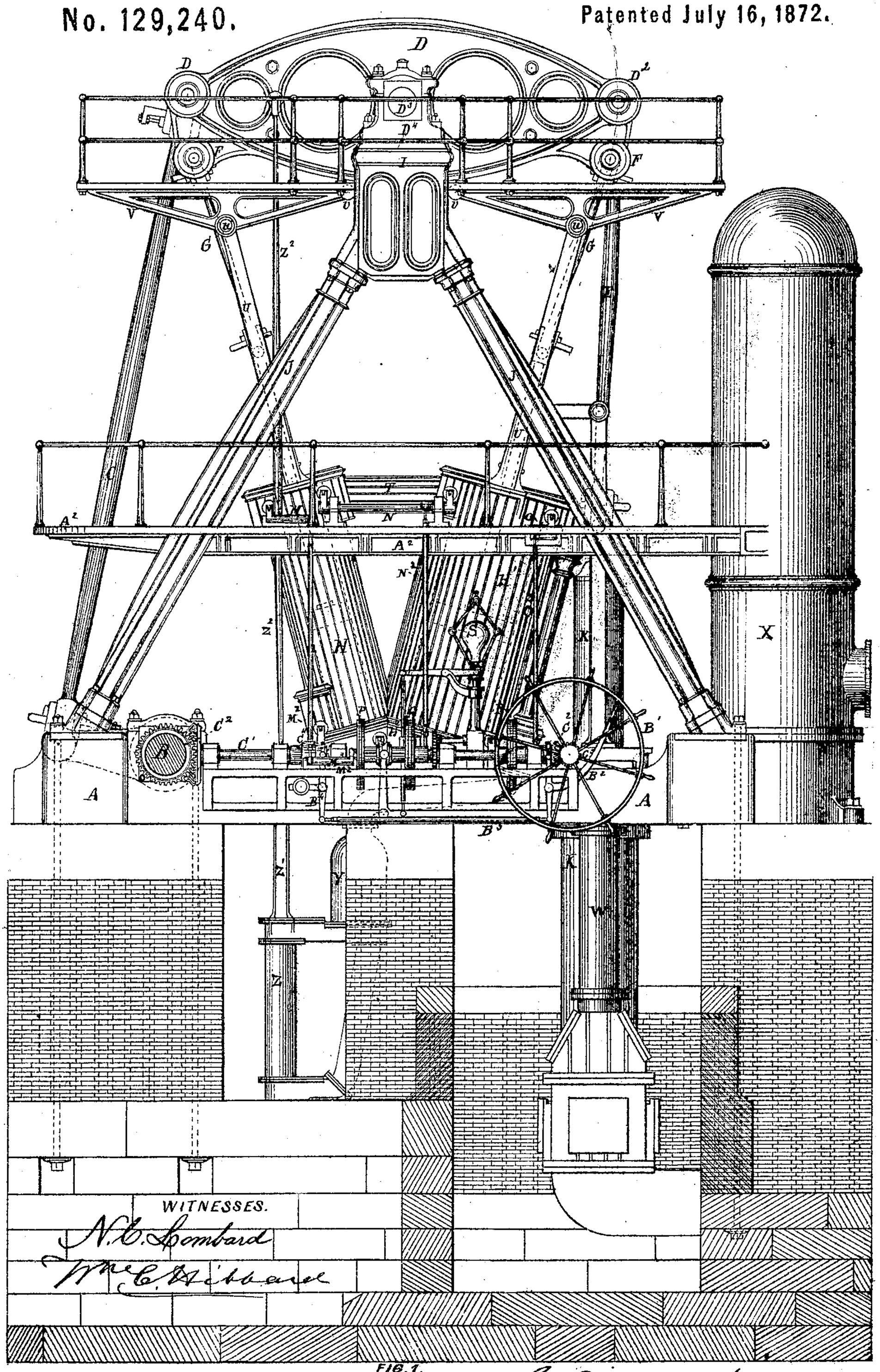

FIG. 1.

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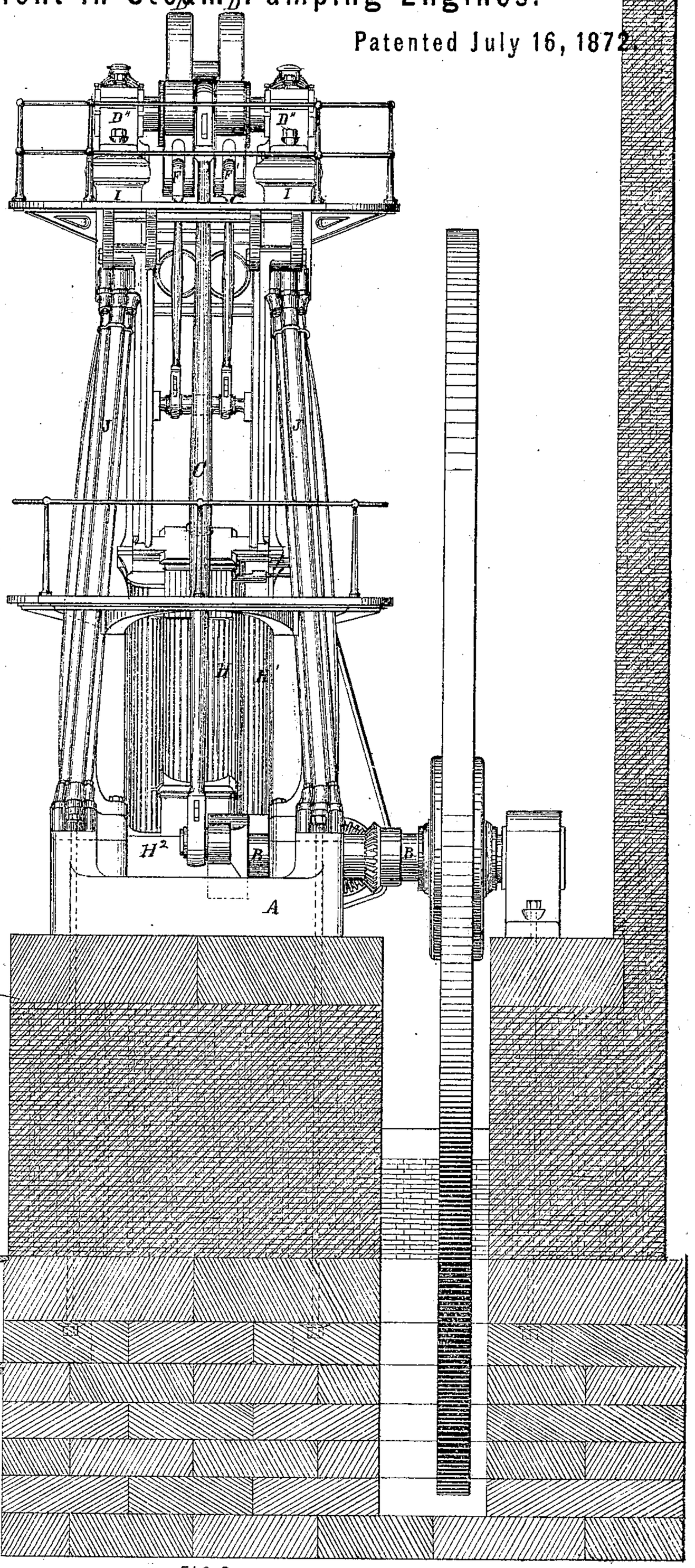

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FIG. 2.

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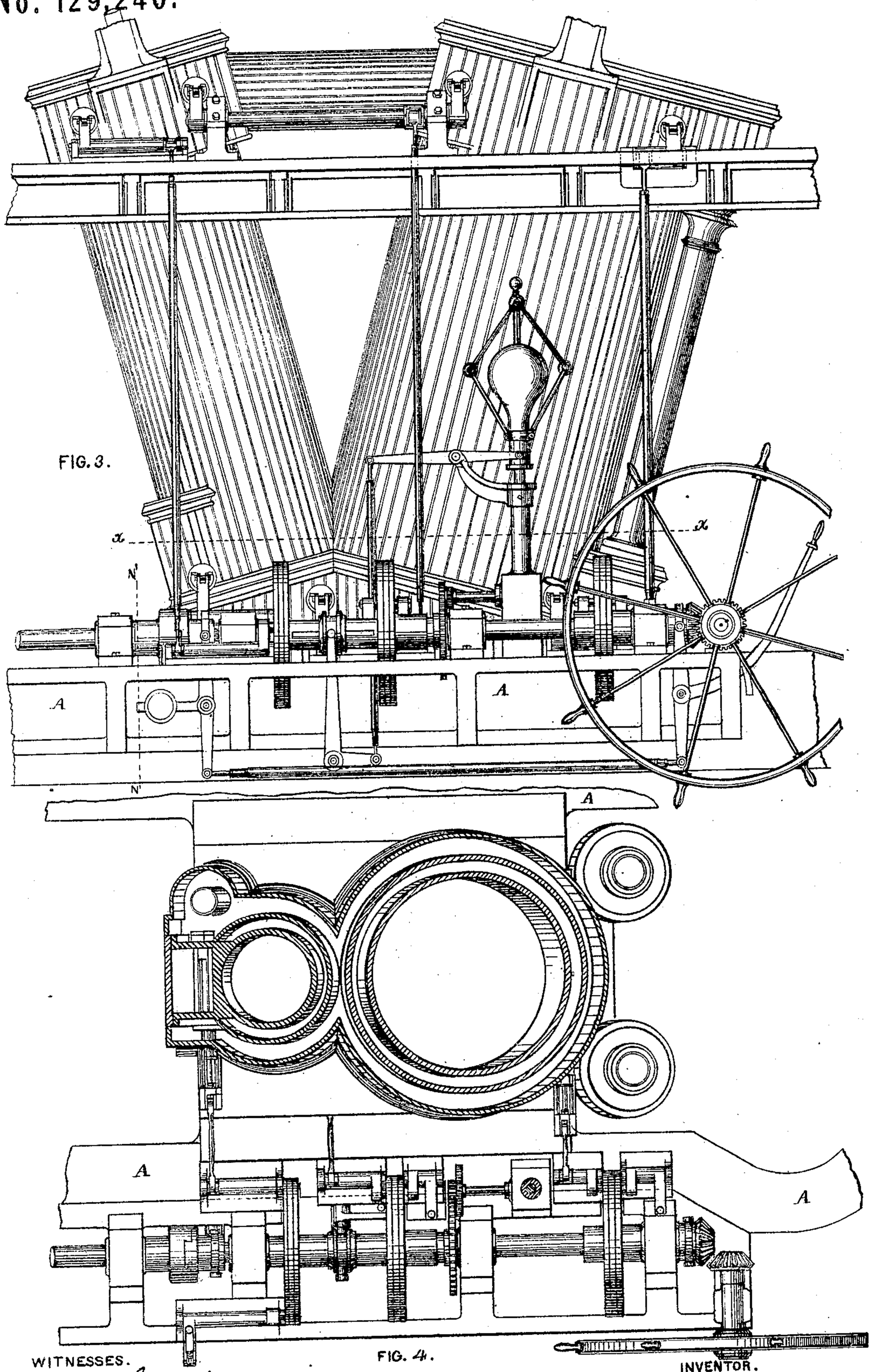

FIG. 3.

FIG. 4.

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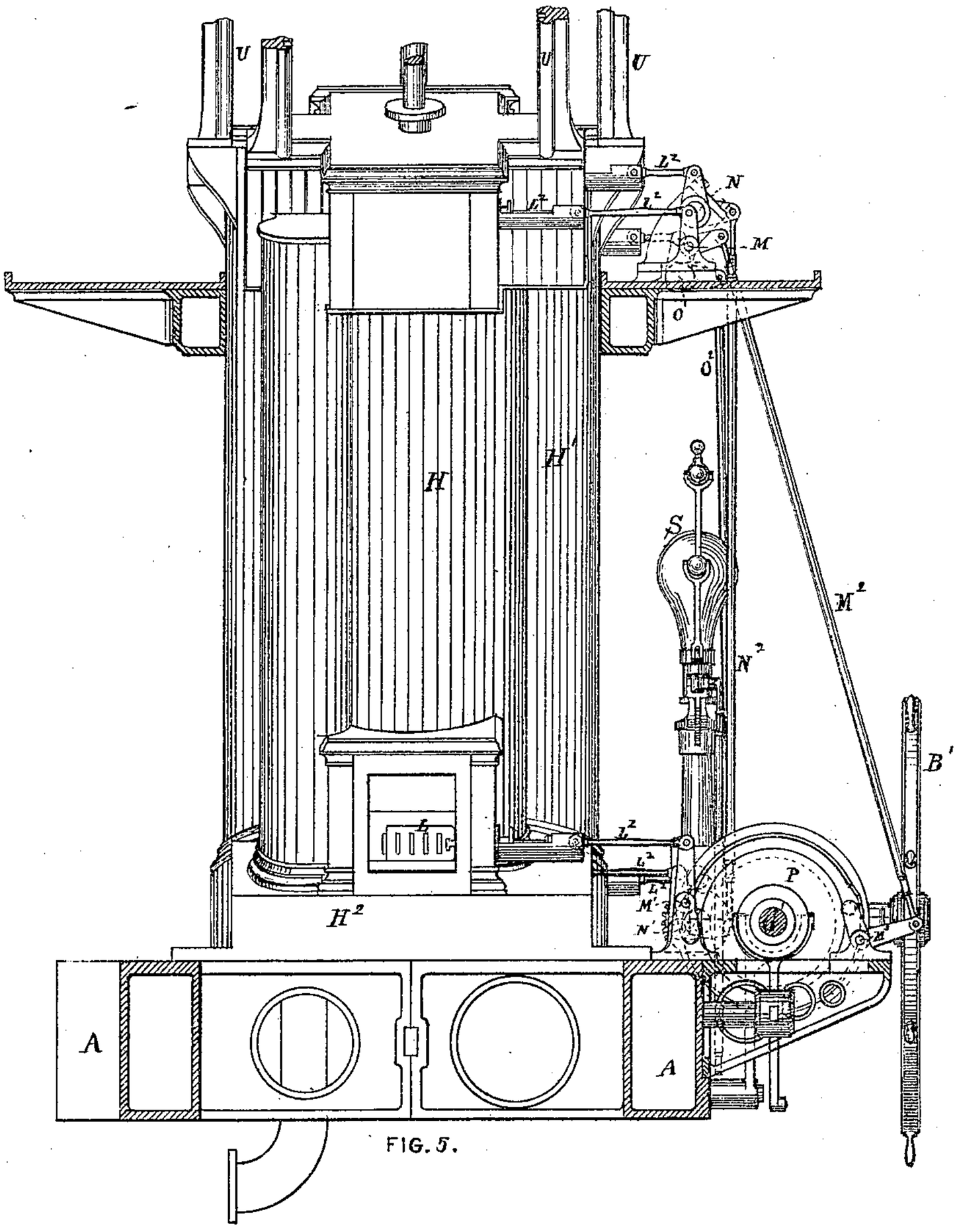

FIG. 5.

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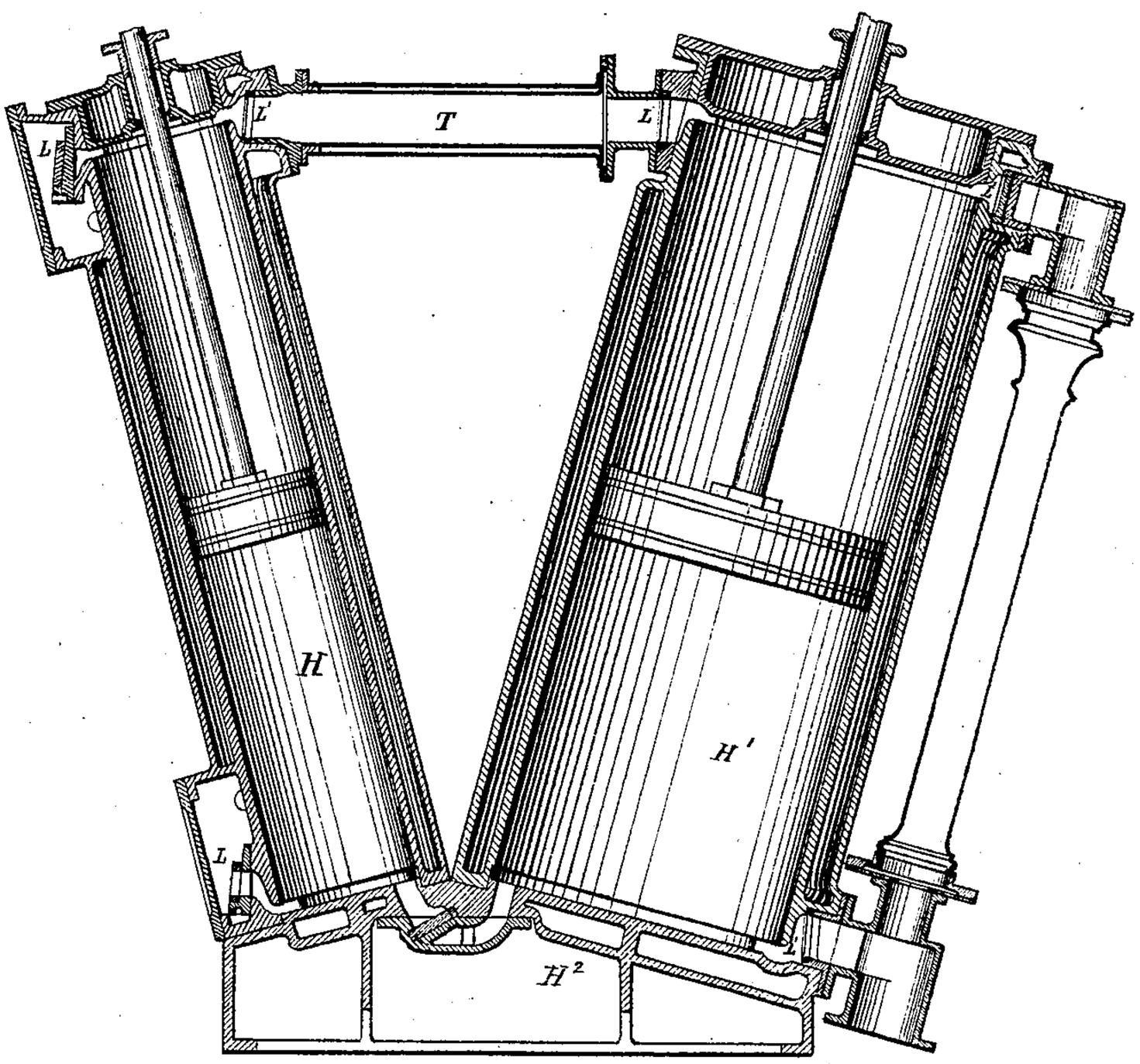

FIG. 6.

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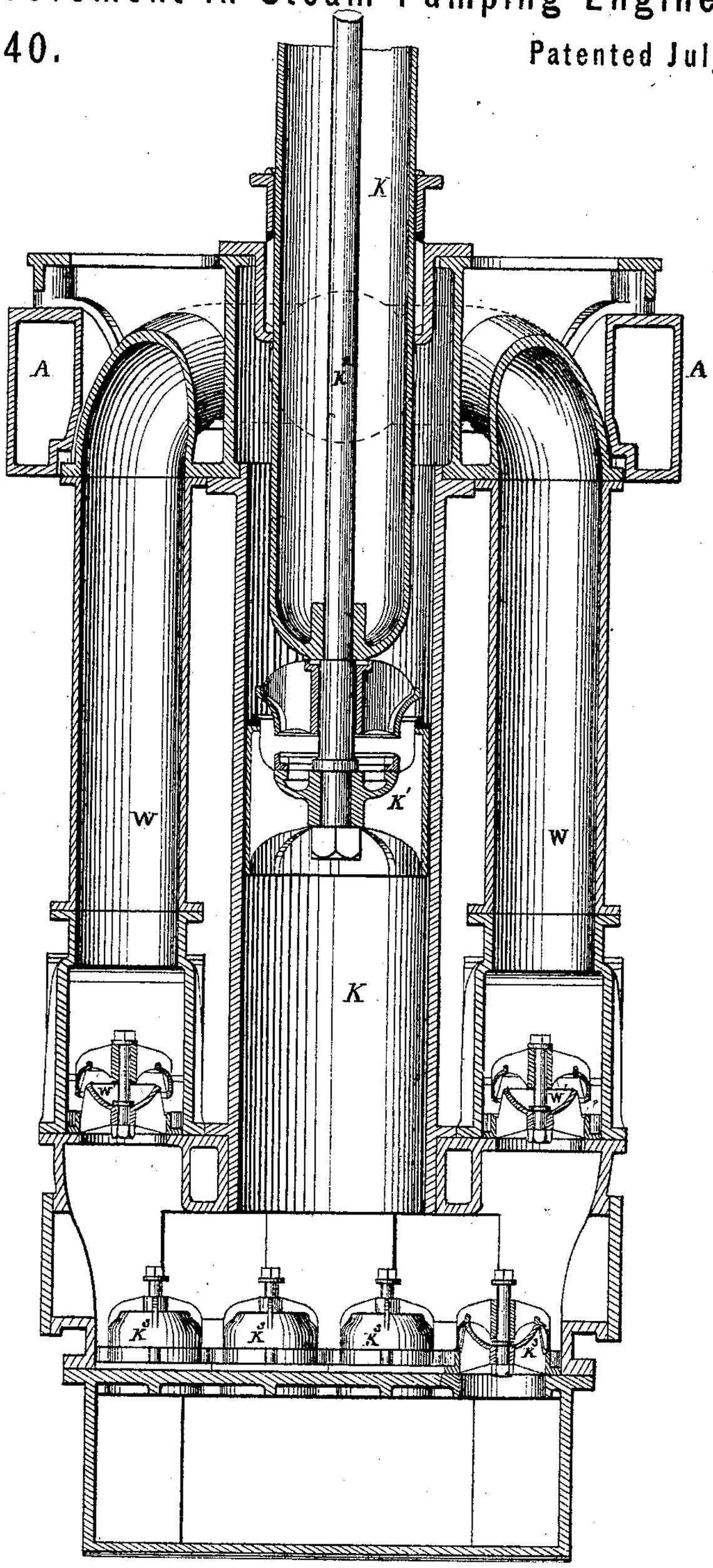

FIG. 7.

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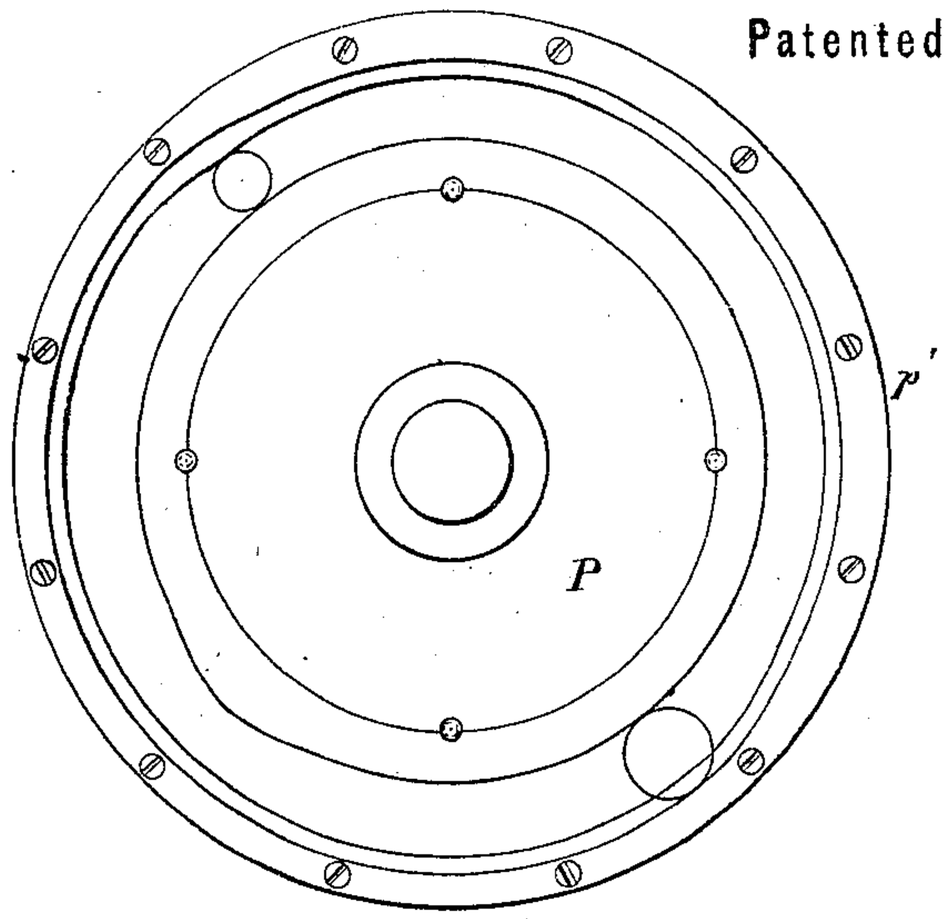

FIG. 8.

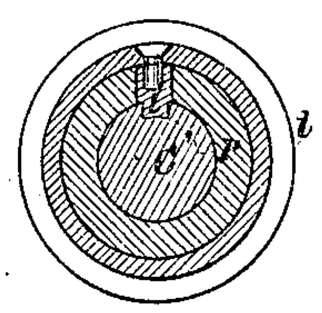

FIG. 10.

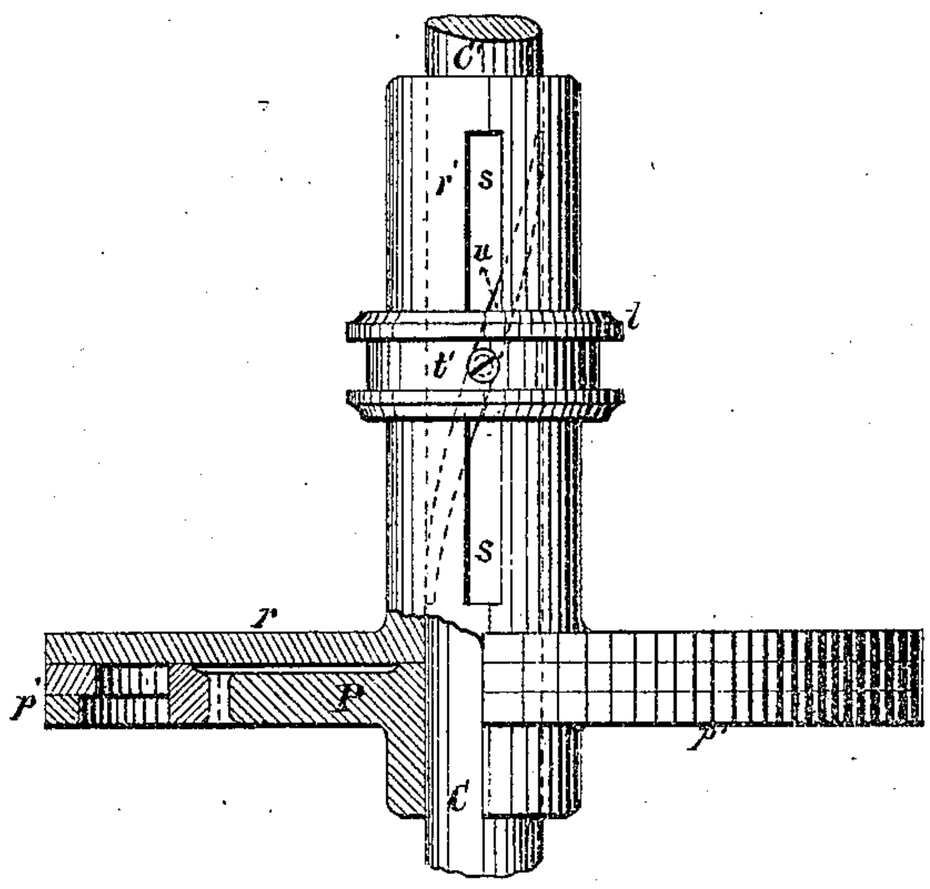

FIG. 9.

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UNITED STATES PATENT OFFICE.

ERASMUS D. LEAVITT, JR., OF CAMBRIDGE, MASSACHUSETTS.

IMPROVEMENT IN STEAM PUMPING-ENGINES.

Specification forming part of Letters Patent No. 129,240, dated July 16, 1872.

To all whom it may concern:

Be it known that I, ERASMUS DARWIN LEAVITT, Jr., of Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Steam-Engines, of which the following is a specification:

My invention consists of certain improvements in pumping-engines, so called, several of which improvements may, however, be advantageously applied to engines used for operating steam-vessels and for other purposes.

The first improvement relates to the construction and arrangement of the steam-cylinders in compound or double-cylinder engines, having a high and a low-pressure cylinder; and consists in placing the said cylinders under the main center of the beam, with their axes radiating from a point in a line below the main center to suitable points of connection at the ends of the beam, the piston of the smaller or high-pressure cylinder being connected to one end of the beam, and that of the other or low-pressure cylinder to the opposite end of the same, or the several parts may be placed in other positions while they preserve the same relations to each other. By this arrangement the cylinders can be brought near to each other so that the steam passages between them will be short, and the pistons will move in opposite directions, so that the steam from each end of the high-pressure cylinder will be discharged into the contiguous end of the low-pressure cylinder, making the steam-passages short and direct, and equilibriating the strains upon the beam and framing. This arrangement also enables the connecting-rod that leads to the crank, and the connecting-rod that leads to the pump, to be worked from the ends of the beam without interference with the cylinders, and allows free space for the main connecting-rod to vibrate, and also for the pump, so that all its parts are accessible, and also permits the cylinders to have as long a stroke as the pump.

The second improvement relates to the valves and valve-gear, and its object is to economize fuel by affording the best distribution and expansion of the steam, and particularly by reducing the clearance in the ports and passages. To accomplish these results the valves—of which there are seven for the two cylinders—are what are termed gridiron slides, and their peculiarity, as compared with the common gridiron slides, is that their motions are at right angles to the motion of the pistons, the valves being made long in the direction of their motion and narrow in the direction of the length of the cylinder, and each valve works over a number of short and narrow ports, so as to have a short travel, which ports open into a common passage that leads the steam into or out of the cylinder. And this part of my improvements also consists in the use of grooved cams for operating the several valves, having inclines upon opposite sides of the grooves to move the valves and gear in opposite directions by the direct action of the inclines, without the assistance of weights or springs, by which means unnecessary friction is avoided, and any desired movement of opening and closing each of the several valves can be obtained; and it also consists in making one of the inclines of the groove of the cams that works the induction-valves movable in a circumferential direction in relation to the other incline, so that the period of closing the valve may be varied without varying the point of opening, as may be desired; and it also consists in the combination, with the movable inclines of the induction-valve cams, of a governor, by means of suitable devices, by which the governor will control the period of cutting off of the steam, and thereby regulate the velocity of the engine; and it also consists in the combination, with the cam-shaft for carrying the several cams which work the valves, of a clutch for disconnecting said shaft from the main shaft of the engine, and a clutch or other disengaging device for connecting a hand-wheel with the said cam-shaft to operate the engine by hand, both of which are operated by the same shipper, so that the disengagement of one and the engagement of the other will be effected simultaneously.

The third improvement relates to the pump, which is of the type known as the "Thames Ditton" or "bucket-and-plunger pump," in which one half of the water in the pump-barrel is displaced by a plunger during the downward stroke, and the other half is lifted by the bucket during the upward stroke; thus the whole contents of the pump have to pass through the bucket on the downward stroke,

and as it cannot conveniently have an area of opening above half the area of the pump-barrel, it follows that the water must pass through the bucket with twice the velocity of its descent, thus consuming considerable power to overcome the friction of forcing the water through a contracted orifice. To avoid this evil is the purpose of this part of my invention, which consists in combining with the foot-valve chamber of the pump one or more supplementary discharge-pipes and valves, through which a portion of the water can pass without passing through the bucket, as will be described.

In the drawing, Figure 1 is a side elevation of the engine as viewed from the fly-wheel side. Fig. 2 is an elevation of the crank end of the engine; Fig. 3 is a side elevation of the cylinders and valve-gear drawn to a larger scale. Fig. 4 is a horizontal section on the line *x* of Fig. 3. Fig. 5 is a transverse elevation of the cylinders with parts in section on line *z* of Fig. 3; Fig. 6, a vertical section through the axes of the cylinders; Fig. 7, a vertical transverse section through the axis of the pump; Figs. 8, 9, and 10 are details of the cam which works the induction-valves of the small cylinder.

A is the bed-plate of the engine to which all the other parts are attached. B is the crank-shaft; and C the main connecting-rod, which is connected with the end of the lever-beam D, in the usual way. The lever-beam shown is made in two parts, with the end bearings D^1 and D^2, which receive the main connecting-rod C and the pump connecting-rod E between them. Below the bearings D^1 and D^2, at each end of the beam, are two pairs of bosses, F, or jaws, which are formed thereon to receive the link-bearings F′, upon which the links G work which connect the two steam-cylinders H and H′ with the two ends of the beam, as is shown in the drawing. The radial distance of these bearings from the main center D^3 of the beam is the same as that of the end bearings D^1, and one pair of bosses or jaws which contain one of the bearings is formed upon each end of each half of the beam, so that it leaves a free space between the inner bosses in which the connecting-rods work without interfering with the links that connect with the cylinders, as is seen in Fig. 2. The beam-pillow blocks D^4 are set upon a center piece, I, which is supported upon four inclined columns, J J J J, which rest upon the bed-plate outside of the pump K at one end and of the crank-shaft B at the other. This arrangement of the columns counteracts the strains of the cylinders in a lateral direction and relieves the strains upon the bed, which is thus supported against them, outside of the two main points of resistance in an obvious manner. H is the high-pressure steam-cylinder, and H^1 is the low-pressure cylinder. They are placed beneath the main beam center, with their bases as near together as practicable, and inclined outward in opposite directions at such an angle as enables them to connect with the lever-beam D. They are set on the double-inclined bottom plate H^2. The general construction of the cylinders and their immediate connections is best seen in Figs. 3, 4, 5, and 6. They are each made with separate induction-valves L and eduction-valves L^1, and they are all gridiron slides, so called, one of them (the lower induction) being shown in elevation in Fig. 5, and all of them in section in Fig. 6. The seats of all of them are made separate, and their faces are so inclined that they will rest against their seats by gravity. They are all worked by stems and rods L^2 leading to several rocking shafts M M^1, N N^1, and O O^1. The upper rocking shafts M, N, and O are worked through the intervention of the rods M^2, N^2, and O^2, and rocking shafts M^3, N^3, and O^3, and they are all worked from the three cams P, Q, and R upon the cam-shaft C^1, which is connected, by the miter-gears C^2, with the main shaft B. The two induction-valves L of the high-pressure cylinder H are worked by means of the rods L^2 and rocker shafts M, M^1, and M^3 from the path-cam P, which is shown separately in Figs. 8, 9, and 10. The central portion P of this cam, which carries the incline which opens the valves, is fixed upon the shaft C^1, but the outer part *p′*, which carries the inclines which close the valves, is attached to a disk, *r*, which has a long hub or sleeve, *r′*, which turns loosely upon the shaft C^1, and is made with a long slot, *s*, extending nearly the entire length of the sleeve. Upon this sleeve the collar *t* slides, which carries a sliding block, *t′*, which fits in the slot *s* of the sleeve, and also extends beyond it and into a helical slot, *u*, which is formed in the shaft C^1, and is shown in dotted lines in Fig. 9 and in section in Fig. 10. By this arrangement the outer part of the cam *p′* can be turned forward or backward upon the shaft, so that its inclines will operate earlier or later to close the induction-valves by sliding the collar *t* lengthwise upon the sleeve. The collar *t* is made with a groove, *t′*, in which a forked lever works by which it is moved lengthwise of the sleeve by the governor S, through the system of levers and rods shown in the drawing, but which need not be more fully described. The rocking shafts M and M^3, which work in connection with the cam P, have cams that carry rollers which enter the groove of the cam, and upon which the inclines of the cam operate to move the induction-valves. These rocker-shafts are so set that their rollers will be exactly opposite to each other in the groove, or one hundred and eighty degrees apart. The outer inclines of the cam are made in two parts, as seen in Figs. 8 and 9, which can be adjusted to each other circumferentially, and the rollers are so placed in the groove as to each work on one of the parts, while the inner incline of the groove serves for both rollers. The object of this is to adjust the time of closing the induction-valves separately, so as to compensate for the obliquity of the connecting-rods and admit precisely the quantity of steam at each end of the cylinder that may be

desired. The cam Q is fixed upon the shaft C, and is made with a groove upon each side and works the intermediate valves between the cylinders, opening and closing them at the commencement and end of the stroke. The rocking shaft N^1 has an arm and roller that works in the groove upon one side of the cam Q and operates the lower intermediate valve; and the rocking shaft N^3, by means of the rod N^2 and rocking shaft N, works the two upper intermediate valves, as is shown. The cam R is also fixed upon the shaft C and also has two grooves upon opposite sides which respectively operate the rocking shafts O^1 and O^3, which operate the upper and lower eduction-valves of the low-pressure cylinder, as is shown. The cams Q and R may be made each with a single groove, if desired, and all its valves worked from one rocker-shaft; but the arrangement shown was adopted for convenience. The upper eduction-valve of the high-pressure cylinder opens into the passage T which leads to the upper end of the cylinder H^1, and is jacketed with high-pressure steam. At the opposite end of this passage is situated the upper induction-valve of cylinder H, which opens slightly later than the eduction-valve of the high-pressure cylinder, so as to give time to fill the passage before the induction-valve of cylinder H^1 opens, and this is accomplished by making narrower ports and wider lap on this valve than is given to the eduction-valve of the small cylinder, both valves being worked from arms on the same rocking shaft N. The advantage of having two valves in connection with this passage is, that the eduction-valve prevents it from being filled with high-pressure steam at the commencement of the stroke, and the induction-valve prevents the steam which remains in the passage at the end of the stroke of the low-pressure cylinder from escaping into the condenser. At the lower ends of the cylinder the passage between them is so short that one valve suffices for both of them. Both of the cylinders are provided with steam-jackets and are covered with an external casing in the usual way. U U are the guides for the cross-heads of the cylinders. They are attached to the cylinders at their lower ends, and at their upper ends to the framing of the upper gallery by swiveling-joints at *u'*. The gallery-frames V V are also connected to the center-piece of the main frame by swiveling-joints at *v*. By this arrangement the gallery-frames become the supports for the upper ends of the guides, and these, in turn, support the gallery and the swiveling-joints permit the expansion and contraction of the cylinders and guides by the heat without breaking, and as the line connecting the joints *u* and *v* is at a right angle to the axis of the cylinder, the expansion or contraction does not throw the guides out of line. The minor details of the engine may be made in any of the usual ways. K is the pump, which is suspended from the bed-plate A, which forms its entire support. The mode of constructing the pump and its subordinate parts is best seen in Fig. 7, which is a transverse section through the axis, in which K is the plunger, K^1 is the bucket, K^2 is the pump-rod, and K^3 are the foot-valves, all constructed substantially as has heretofore been done. The pump is worked from the end of the beam D by the connecting-rod E, as is shown. W W are side pipes leading from the foot-valve chamber to the delivering-pipe, which conveys the water into the air-chamber X, which, also, is attached to the bed A of the engine. The side pipes are provided with valves W' W', as is shown, which permit a portion of the water to pass out that way when the plunger and bucket descend, if the resistance of the water to passing through the bucket is sufficient to open them. By this arrangement of the engine it will be seen that the pump is worked vertically from the end of the beam, with free space above it to raise the pump-cover and other parts without obstruction by the cylinder. Y is the condenser, and Z the air-pump, made double-acting in any usual way, and also suspended from the bed-plate A by the pieces Z^1, which also serve as guides to its cross-head. It is worked by the rod Z^2 from the beam D, as is shown. A^2 is the frame of the lower gallery. It is made of cast-iron, and is attached to lugs upon the columns J J J J, and upon the cylinders H H', and serves to stay those parts together and to the air-chamber X, as is shown, as well as to serve as a gallery for getting access to the parts of the engine. B^1 is the hand-wheel by which the cam-shaft C^1 is worked when the engine is operated by hand. The wheel B^1 is engaged with the shaft C^1 by drawing the bevel-gear C^2, which slides upon the shaft C^1, into gear with the bevel-gear C^3 upon the shaft of the hand-wheel, by means of the shipper-lever B^2, the fork of one arm of which works in a groove upon the hub of the gear C^2, as shown, and the lower arm of which, through the rod B^3 and the lever B^4, works the clutch C^4, which connects the cam-shaft C^1 with the main shaft B, so that the hand-wheel B^1 is thrown into gear with the shaft C^1 by the same movement of the lever B^2 that throws the clutch C^4 out of engagement.

The operation of the machine is believed to be sufficiently obvious without further detailed description.

What I claim as my invention is—

1. The combination, in a beam-engine, of a high and low pressure cylinder, arranged with their bases near together, and inclined outward so as to connect with opposite ends of the lever-beam, substantially as described.

2. The combination of the cylinders inclined in opposite directions and connected with opposite ends of the beam, as described, with a crank-shaft and fly-wheel at one end, and a pump at the other end of the beam, substantially as described.

3. The combination of the end bearing of one or both ends of the beam, with two bearings, also upon the beam, that receive the cylinder-

links, and have an open space between them in which the connecting-rod or rods which work on the end bearings can vibrate, substantially as described.

4. The combination of the steam-cylinder and its guides with the framing of the gallery and main frame, by means of the swiveling-joints *u* and *v*, arranged substantially as described.

5. The combination, with an inclined-slide cylinder, of gridiron-slide induction or eduction valves, arranged to slide transversely to the axis of the cylinder, with their seats so inclined that the valves will be held to them by gravity, substantially as described.

6. The duplex cam for working an induction valve or valves, having the incline which opens the valve fixed upon its shaft, and the incline that closes the valve movable in the direction of the circumference, to vary the point of cutting off the steam, substantially as described.

7. The combination of the movable incline of said cam with a governor, by means of the devices shown, so that the point of cutting off the steam shall be automatically controlled, and the velocity of the engine thereby regulated, substantially as described.

8. The combination of the induction-cam with the two valve-gears that operate the two induction-valves of the high-pressure cylinder, so arranged that the points of action of the cam upon the valve-gears will be one hundred and eighty degrees apart, so that both valves can be operated by the same cam, substantially as described.

9. The closing-incline of the induction-cam, formed with two acting surfaces for the two valve-gears, made adjustable to each other, to determine the relative amount of steam to be admitted at each end of the cylinder, substantially as described.

10. The combination of the cam-shaft C^1 and its connections with the main shaft B and the hand-wheel B^1, by means of the devices described, so arranged that the engagements and disengagements of the cam-shaft, as described, will be thereby effected simultaneously.

11. The supplementary delivery-passage W and valve or valves W′, in combination with the pump, substantially as described.

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