(No Model.)

4 Sheets—Sheet 1.

A. L. IDE.

STEAM ENGINE.

No. 441,364. Patented Nov. 25, 1890.

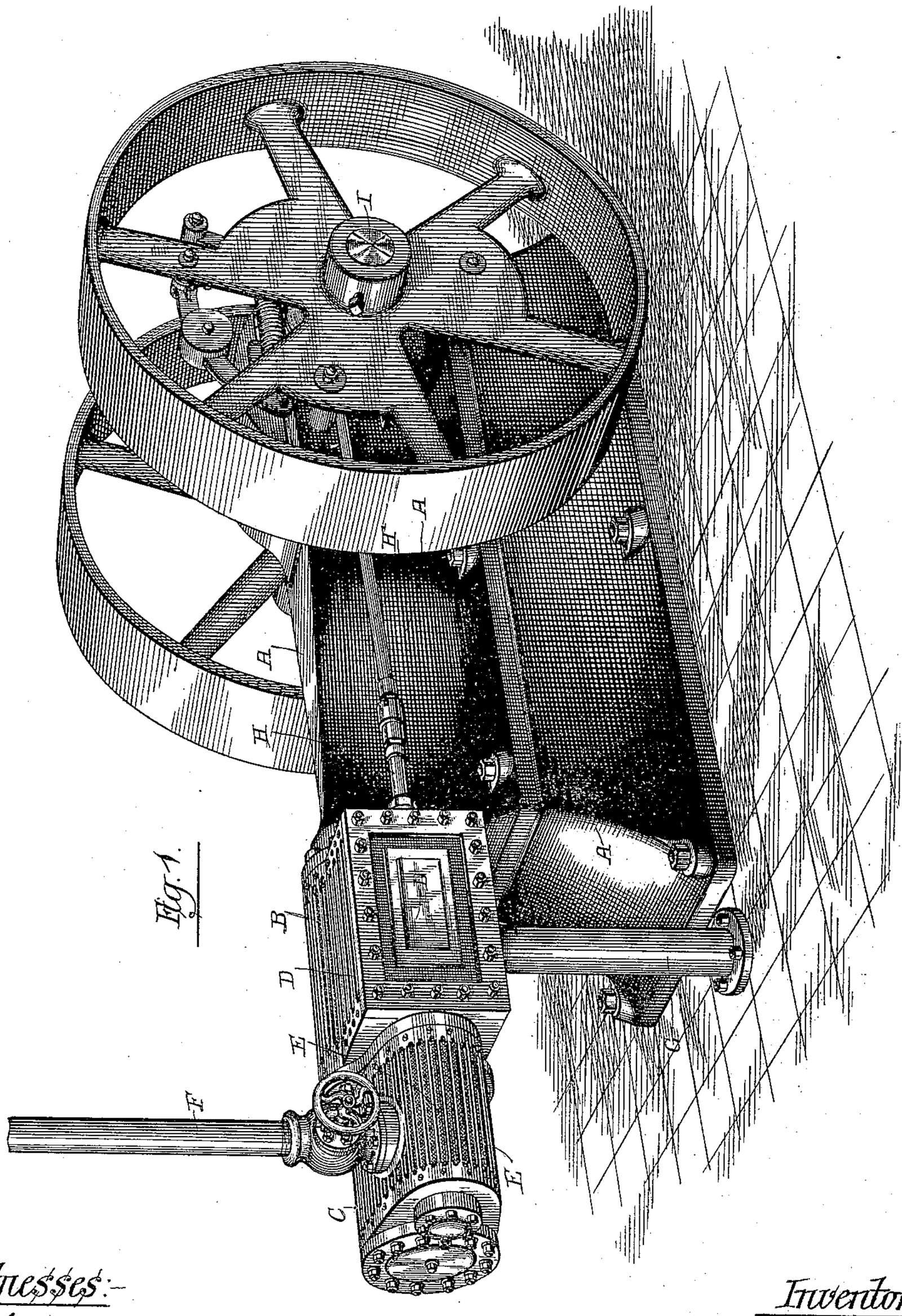

Fig. 1.

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Wm. F. Fleming

Inventor:—
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by:— Dayton, Poole & Brown
Attorneys.

(No Model.)

4 Sheets—Sheet 2.

A. L. IDE.

STEAM ENGINE.

No. 441,364. Patented Nov. 25, 1890.

Fig. 3.

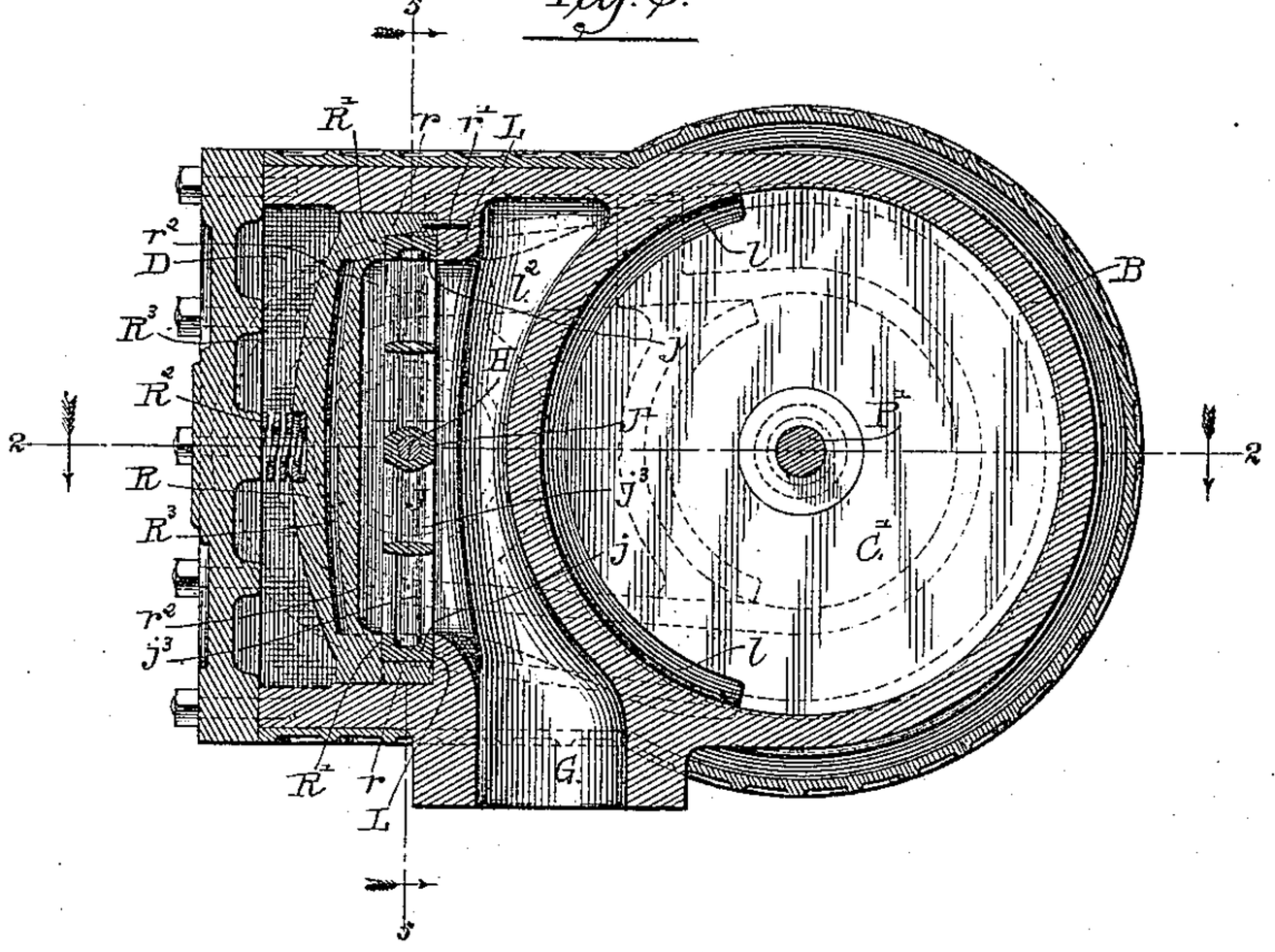
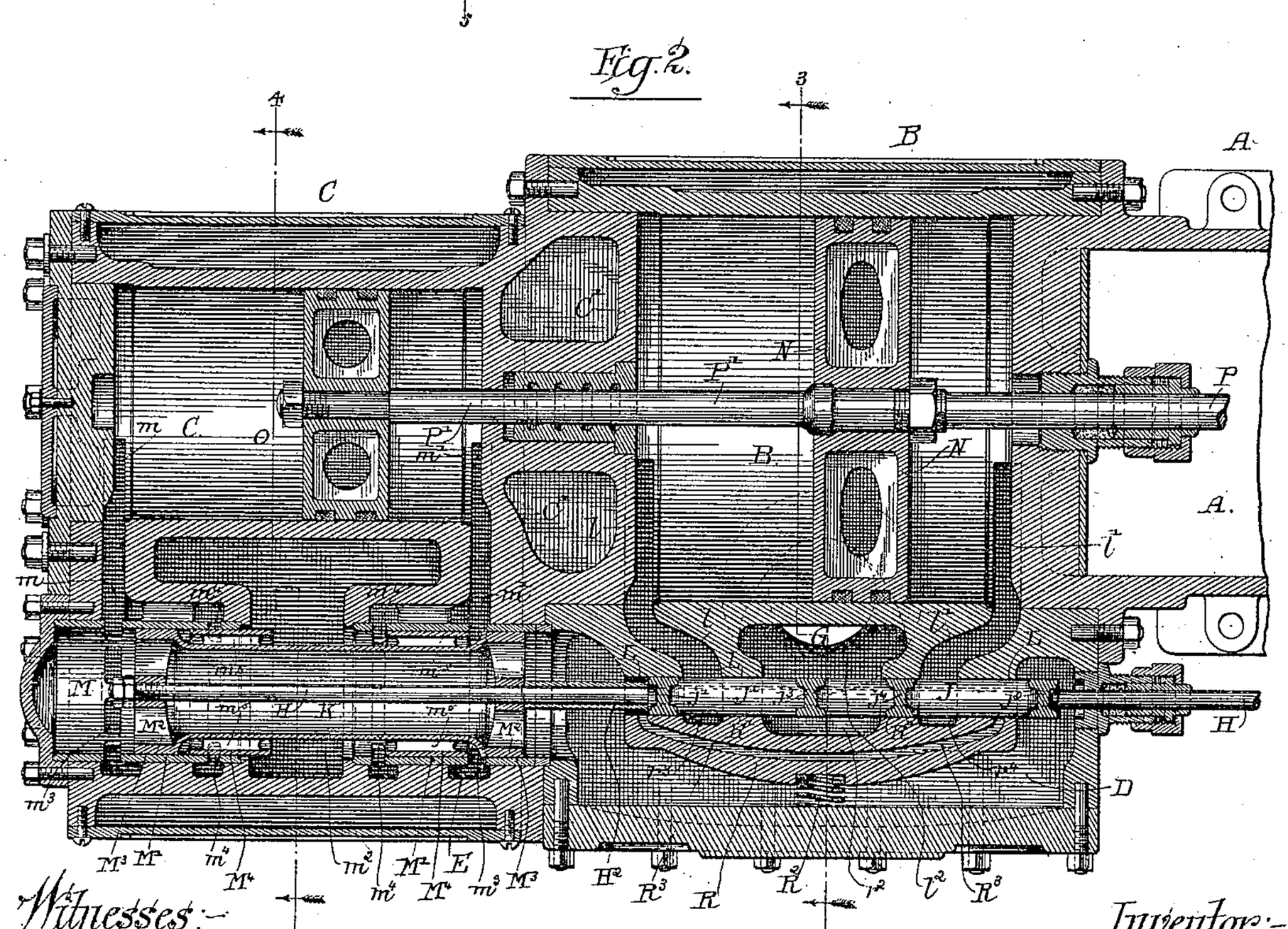


Fig. 2.



Witnesses:—

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Attorneys.—

(No Model.)

4 Sheets—Sheet 3.

A. L. IDE.

STEAM ENGINE.

No. 441,364. Patented Nov. 25, 1890.

Fig. 4.

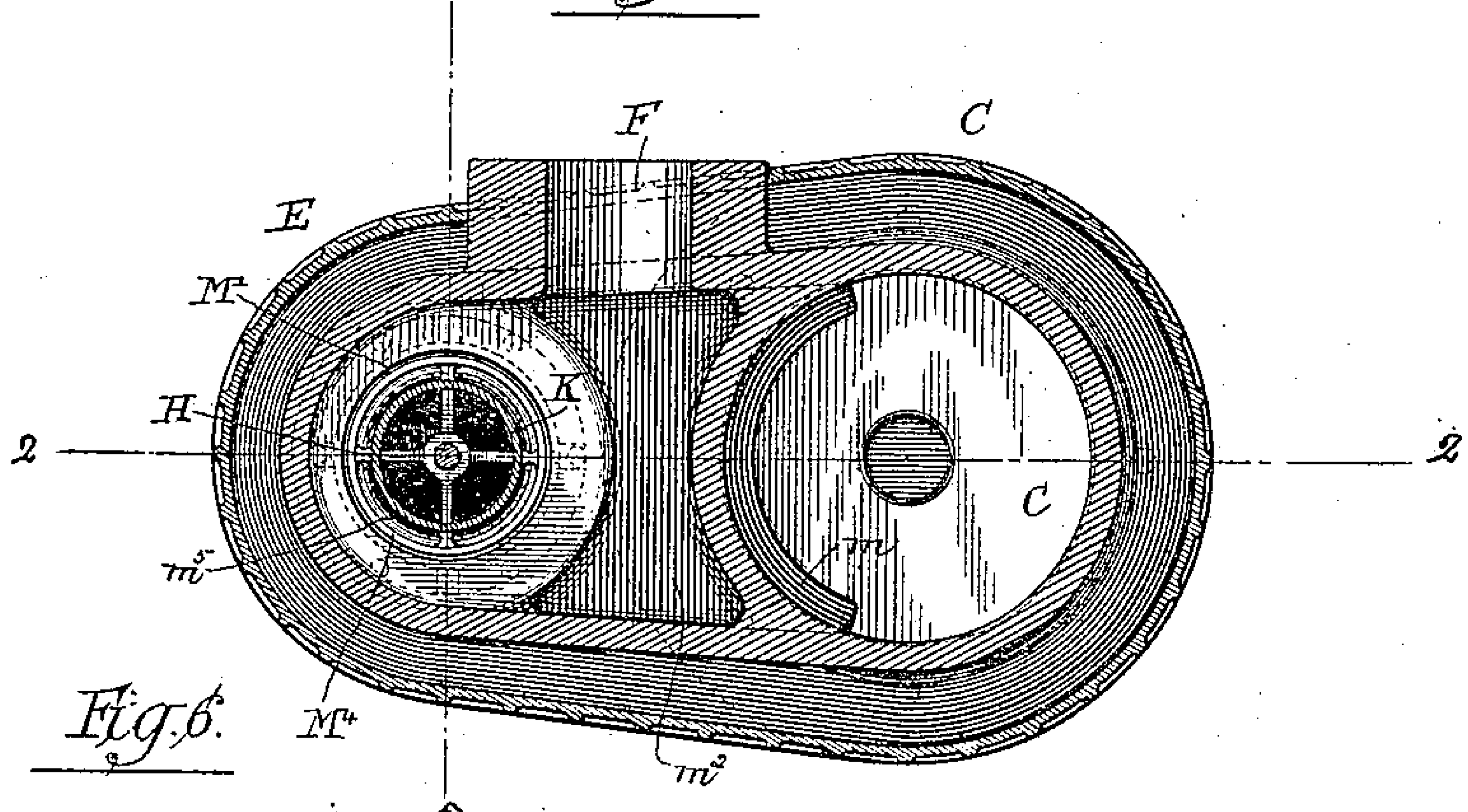


Fig. 6.

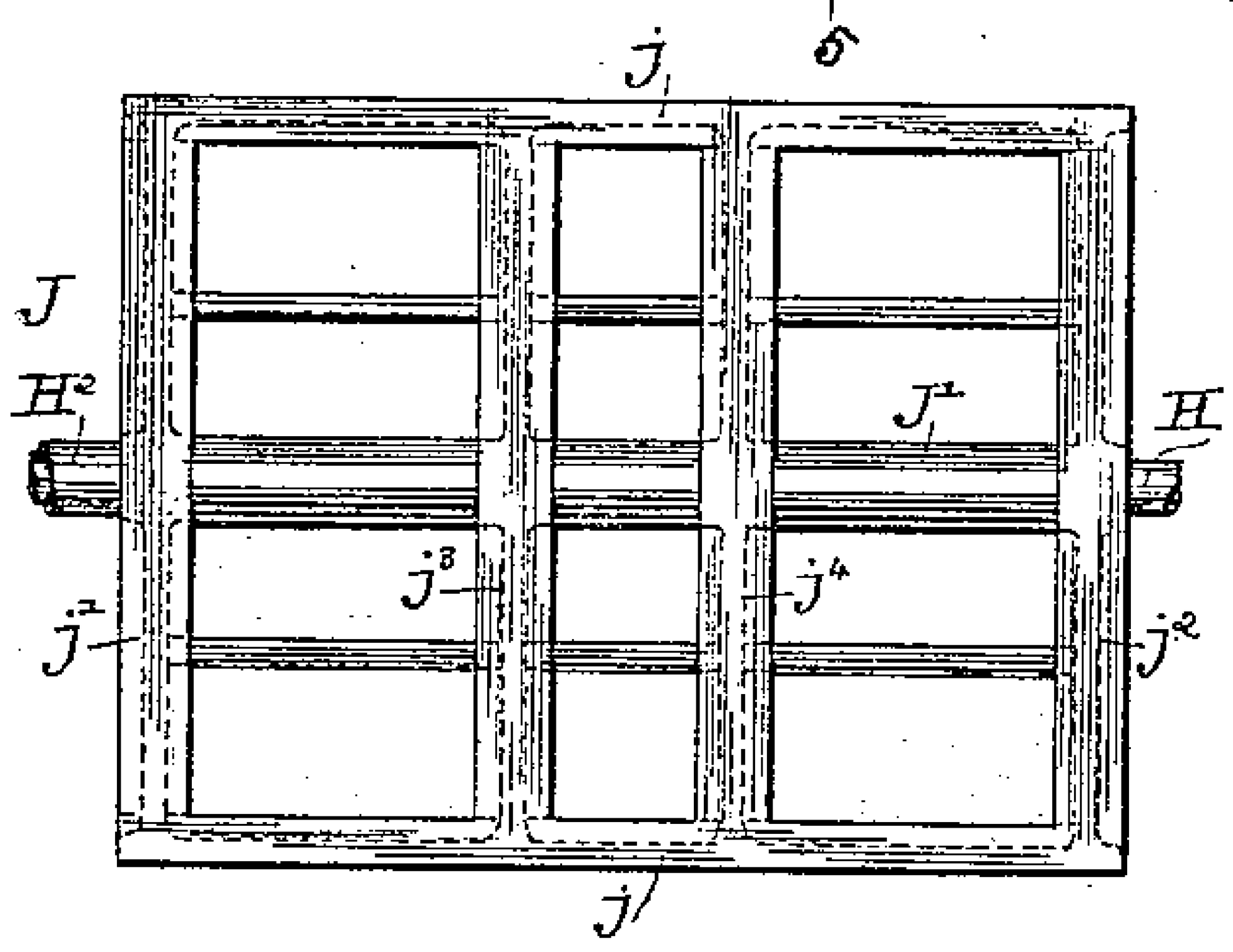
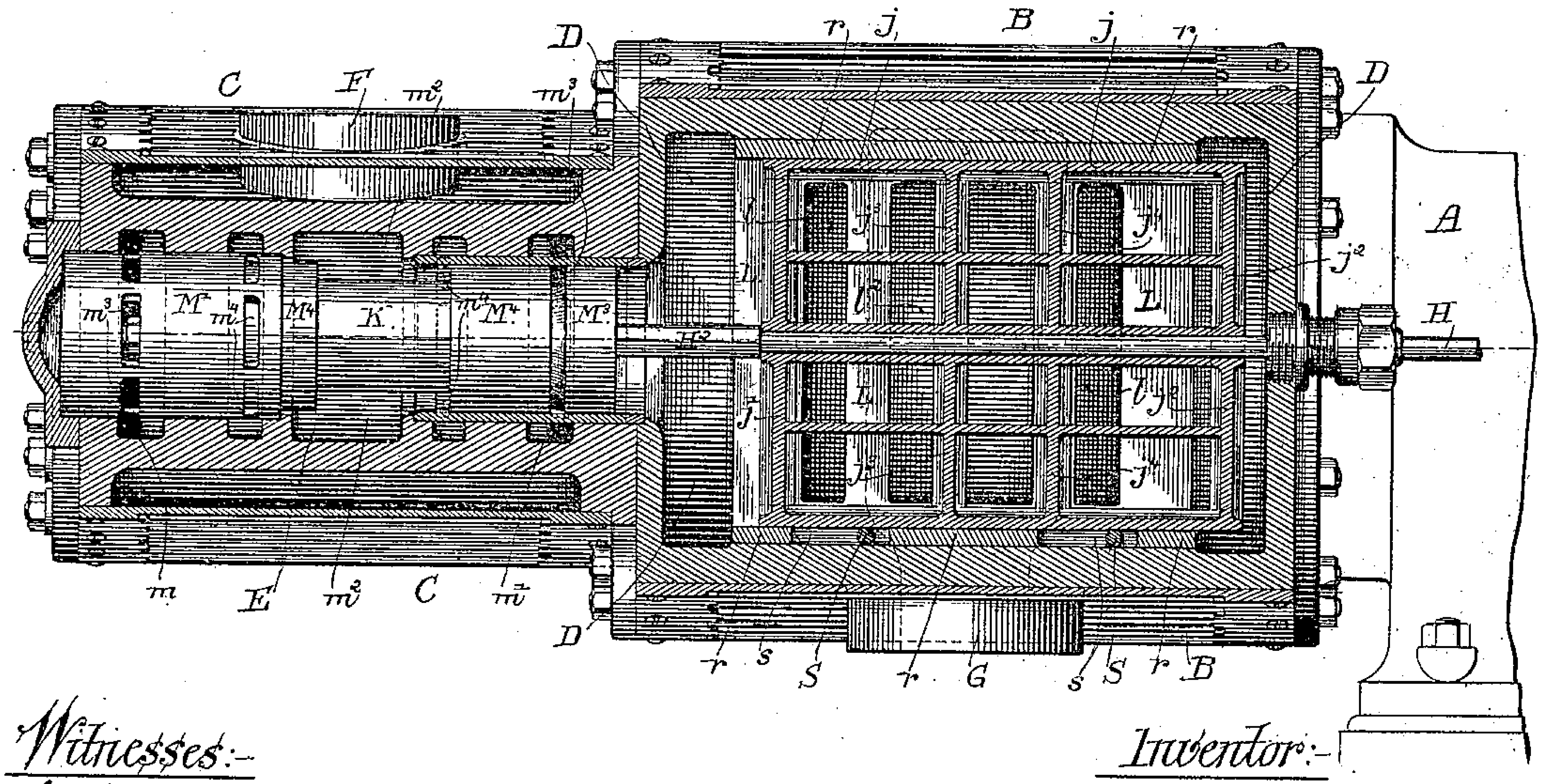


Fig. 5.



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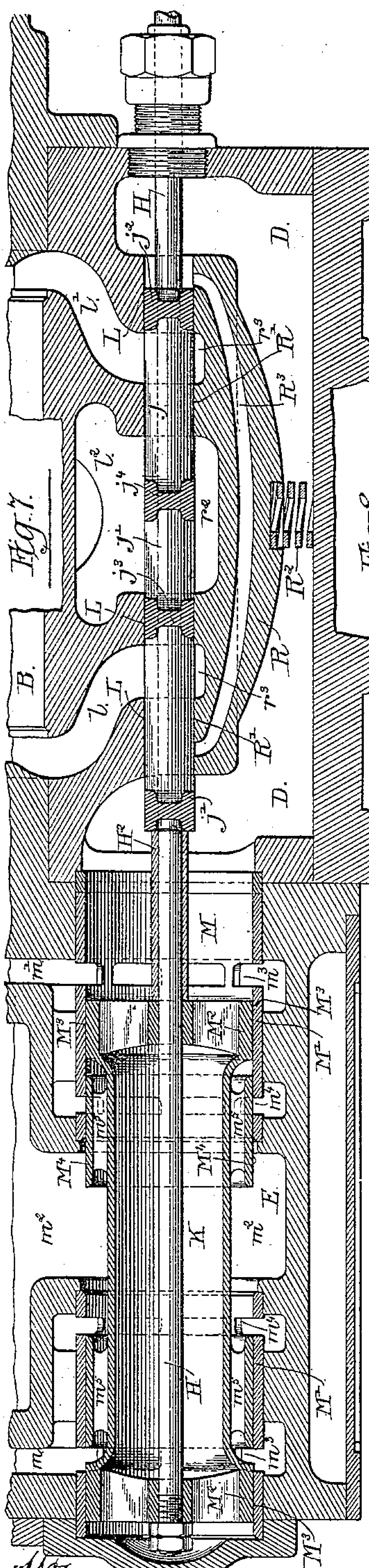
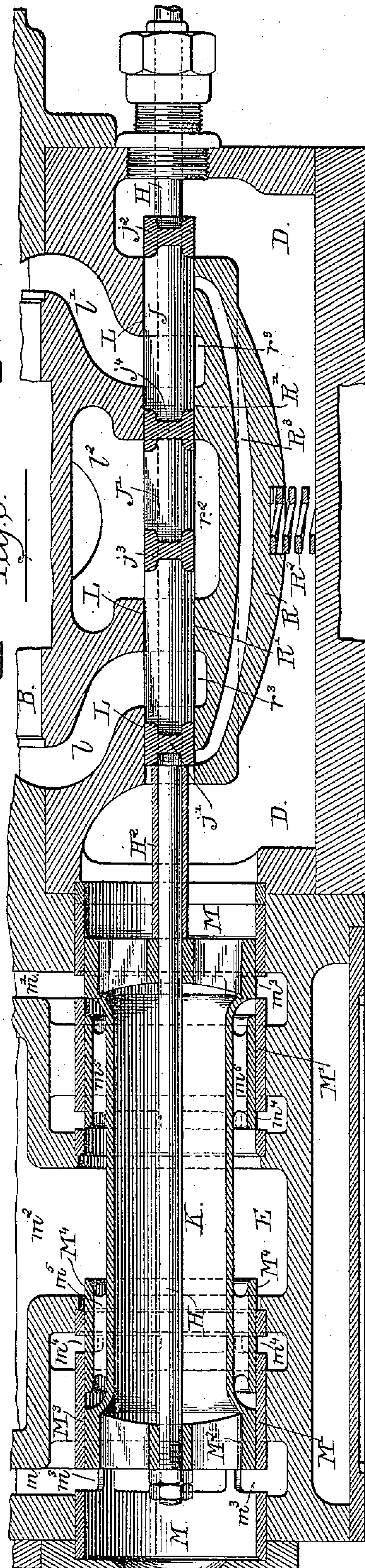
THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

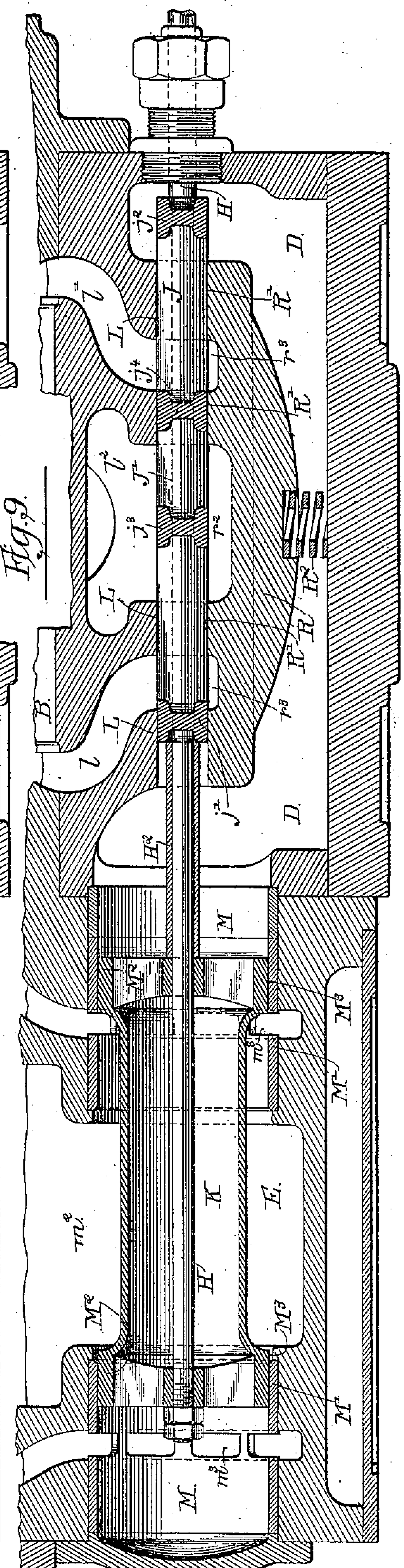
(No Model.) 4 Sheets—Sheet 4.

A. L. IDE.
STEAM ENGINE.

No. 441,364. Patented Nov. 25, 1890.







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UNITED STATES PATENT OFFICE.

ALBERT L. IDE, OF SPRINGFIELD, ILLINOIS.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 441,364, dated November 25, 1890.

Application filed June 10, 1890. Serial No. 354,927. (No model.)

To all whom it may concern:

Be it known that I, ALBERT L. IDE, of Springfield, in the county of Sangamon and State of Illinois, have invented certain new and useful Improvements in Steam-Engines; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to steam-engines, and more particularly to the class of steam-engines known as "compound engines."

The invention consists in the matters hereinafter described, and pointed out in the appended claims.

In the accompanying drawings, illustrating my invention, Figure 1 is a perspective view of a compound engine embodying the same. Fig. 2 is a central longitudinal section of the same, taken on a horizontal plane through the engine cylinders and valves on the lines 2 2 of Figs. 3 and 4. Fig. 3 is a transverse section through the low-pressure cylinder, taken upon line 3 3 of Fig. 2. Fig. 4 is a transverse section through the high-pressure cylinder, taken upon line 4 4 of Fig. 2. Fig. 5 is a longitudinal section through the valves illustrated in Fig. 2, taken upon the lines 5 5 of said Figs. 2, 3, and 4. Fig. 6 is a detail side elevation of the slide-valve belonging to the low-pressure cylinder. Fig. 7 is an enlarged detail section of the valves shown in Figs. 2 to 5, showing said valves in a changed position from that shown in Fig. 2. Fig. 8 is a similar section illustrating still another position of the valves. Fig. 9 illustrates valves embodying the invention, differing somewhat from that shown in the other figures.

As illustrated in said drawings, A indicates the engine-frame; B, the low-pressure cylinder, which is directly connected with the end of the frame; C, the high-pressure cylinder, which is secured to the end of the low-pressure cylinder remote from the engine-frame.

D is the steam-chest of the low-pressure cylinder B; E, the steam-chest of the high-pressure cylinder C; F, the steam-supply pipe which is connected with the steam-chest E of the high-pressure cylinder; G, the exhaust-pipe which communicates with the exhaust-space of the low-pressure cylinder B.

H indicates a valve-stem by which the slide-valves of the engine are actuated, said valve-stem being actuated by a connecting-rod H′, operated by an eccentric on the main shaft I of the engine in the usual manner.

J indicates, as a whole, the slide-valve of the low-pressure cylinder, and K the slide-valve belonging to the high-pressure cylinder. The steam-chest D of the low-pressure cylinder is provided with a valve-seat L, having at its opposite ends two ports $l\ l'$, leading to the opposite ends of the cylinder, and with a central port l^2, which communicates with the exhaust-pipe G. The steam-chest E of the high-pressure cylinder is provided with a valve-seat M, having at its opposite ends steam-ports $m\ m'$, communicating with the opposite ends of the said cylinder, and a central steam-port m^2 in communication with the steam-supply pipe F.

N is the piston of the low-pressure cylinder, and O is the piston of the high-pressure cylinder, said pistons being attached to a single piston-rod P in the usual manner. The portion P′ of said piston-rod between the pistons N and O passes through a suitable sleeve or bushing secured in the head C′ of the high-pressure cylinder, which head C′ constitutes also the adjacent or outer head of the low-pressure cylinder B.

The slide-valve J belonging to the low-pressure cylinder is constructed as follows: Said valve is generally of flat or gridiron form, Figs. 5 and 6, and consists of two parallel side pieces $j\ j$, two end cross-bars $j'\ j^2$, and two intermediate cross-bars $j^3\ j^4$. As a detail of construction in the particular valve shown, the latter is provided with a central tubular part J′, through which passes the valve-stem H, said tubular part affording a brace to connect the cross-bars of the valve, and thereby give strength and rigidity to the same.

The valve J, made as above described, is located in contact with the valve-seat L and operates in connection therewith, and also with a stationary valve-plate R, which is sustained within the steam-chest opposite the valve-seat L, and is provided with a flat bear-

ing-surface R′, which is in contact with the outer side of the valve J. Said valve-plate R is conveniently held in position by means of inwardly-projecting flanges *r r*, which rest at their edges in contact with the valve-seat L at opposite sides or edges of the valve J, Fig. 3, the said valve-plate R being arranged to bear at its side edges against the side walls of the steam-chest, whereby the said valve-plate is held from shifting sidewise, as clearly shown in the drawings. A pin or stud *r′*, Fig. 3, is inserted in the valve-seat L, and enters a recess in the flange *r* of the valve-plate to hold the latter from shifting endwise or longitudinally.

R^2 is a spring interposed between the outer wall or cover of the steam-chest and the said valve-plate R to hold the latter in operative position. Said spring R^2 does not act against steam-pressure in holding the valve-plate against the seat L, inasmuch as the steam-pressure comes outside of the said valve-plate and tends to press the same against the valve-seat, and said spring enables the valve-plate to yield outwardly to relieve the parts from strain in case of an accumulation of water in the cylinder, thereby avoiding danger of breakage of the parts by the compression of the water in either end of the cylinder at such time. The valve-plate R is made shorter than the length of the steam-chest, and the end or outer cross-bars $j' j^2$ of the valve J are arranged at such distance apart and the valve is moved through such distance that said cross-bars are carried alternately past the ends of the valve-plate or outwardly from beneath the same, so as to admit steam from the steam-chest between the ends of the valve-plate and the valve-seat to the steam-ports *l l′*. The inner cross-bars $j^3 j^4$ of the valve are arranged at such distance apart that they are moved alternately away from the surface of the valve-seat to a point opposite the exhaust-port l^2, thereby leaving open the space between the valve-seat and valve-plate for the passage of steam from one of the steam-ports *l l′* to the said exhaust-port. In order that the steam may enter at both sides or edges of the end cross-bars of the valve when the latter are moved outwardly past the end of the valve-plate, as above described, the valve-seat L is made of the same length as the valve-plate, so that spaces are left between the ends of the said valve-seat and the ends of the steam-chest, and the parts of the wall of the steam-chest adjacent to the ends of the valve-seat are recessed; or, in other words, the valve-seat is elevated above the adjacent parts of the inner wall of the steam-chest. This construction enables the steam to pass around the said end cross-bars of the valves, so as to enter the space between the valve-seat and valve-plate at both sides of the said cross-bars, thereby affording a steam-passage of twice the area, with the same movement of the valve, as is afforded in case the steam enters at one side only of said cross-bar. For a similar purpose the valve-plate R is provided with a central recess r^2 of the same length and width as the exhaust-port l^2 and arranged opposite the latter. Said recess allows the exhaust-steam to pass around both sides of the inner cross-bars $j^3 j^4$ in its passage from the ports *l l′* to the exhaust-port l^2, thereby affording a large area for the exit of steam with a small movement of the valve. Said valve-plate R is herein shown as provided on its inner or bearing surface near its ends with two transversely-arranged recesses $r^3 r^4$, made of the same length and width as the steam-ports *l l′* and located opposite the latter. By the presence of said recesses in the bearing-surface of the valve-plate the latter is made to correspond exactly with the bearing-surface of the valve-seat, thus insuring an equal steam-pressure on opposite sides of the valve and the perfect balancing of the latter. As a separate and further improvement, the said valve-plate R is provided with a steam space or passage R^3, extending longitudinally through the body of the plate and opening at its ends through the inner or bearing surface of the plate near the ends of the latter. The said passage R^3 is designed to afford an additional area of passage for the inflow of steam to the cylinder-ports, and for this purpose its ends are so located with reference to the ends of the valve-plate that when the cross-bar at one end of the valve begins to leave the edge of said plate the cross-bar at the opposite end of the valve will begin to pass from over the end of said passage, thereby admitting steam through said passage to the steam-port *l* or *l′* at the same time that steam is admitted to the steam-port at the edges of the outwardly-moving cross-bar of the valve.

The operation of the valve will be pointed out more in detail hereinafter in explaining the operation of both of the valves J and K in operating together.

To next describe the construction of the valve K and the valve-seat M, in which the same is located, said parts are made as follows: Said valve K is a tubular or hollow piston-valve, and the valve-seat M is of cylindric form and provided with annular ports, said valve and seat being constructed in the same manner as the corresponding parts shown in a prior patent, No. 360,594, granted to me April 5, 1887. The valve-seat M is, as shown in the drawings, provided with two annular steam-ports $m^3 m^4$, connected with each other and with the main steam-ports *m m′* by means of longitudinal passages formed in the walls of the steam-chest. As herein shown, cylindric bushings M′ M′ form the bearing-surfaces of the valve-seats and are provided with a series of annularly-arranged slots or openings, forming the annular ports $m^3 m^4$ above referred to. The valve K is provided at its ends with enlarged parts or portions M^2 M^2, which enlarged parts are fitted to slide in the opposite ends of the cylindric valve-seat M. The said enlarged portions M^2 M^2 are

that shown in Fig. 2. This figure shows the exhaust-ports as already partially opened to allow the passage of exhaust-steam from the outer ends of the high and low pressure cylinders. At this time the opening of the exhaust-port m^3 of the high-pressure cylinder is accomplished by the passage of the end of the valve K from over said port, while the opening of the exhaust of the low-pressure cylinder is produced by the movement of the intermediate bar j^3 of the valve J from contact with the valve-seat L and the bearing-surface R′ in that part of the same between the steam-port l and the exhaust-port l^2, thereby allowing the exhaust-steam to pass around both sides of the cross-bar j^3 to the exhaust-port. Admission of steam to both the high and low pressure cylinders will begin as soon as the cross-bar j^2 passes from between the valve-seat and valve-plate, and as soon as the annular ports m^3 m^4 at the inner end of the high-pressure cylinder are uncovered by the annular surfaces M^3 M^4 of the valve K, the parts being so arranged that all of the several ports are opened and closed simultaneously, as will be clearly understood from the drawings.

The passage R^3 in the valve-plate R affords an additional or increased area for the passage of live steam to the low-pressure cylinder during the opening of the steam-ports, the ports or openings at the ends of said passage being so arranged that one of the end cross-bars, as j', will begin to uncover the said passage at one end of the valve at the same time the cross-bar j^2 at the opposite end of the valve begins to leave the edges of the valve-seat and the valve-plate. This will be clearly seen from Fig. 8, from which it will be obvious that a slight further movement of the valve J toward the right hand will bring the cross-bar j' past the edge of the opening of the passage R^3 at the same time that the inner margins of the cross-bar j^2 pass beyond the edges of the valve-plate and valve-seat. It will of course be seen that one end of the passage R^3 is always in communication with the steam-port into which live steam is about to be admitted when the other end of said passage is being opened for the admission of steam from the steam-chest.

It will of course be understood that a larger steam-inlet opening is required for the low-pressure than for the high-pressure cylinder, and in a valve provided with the passage R^3 a sufficient area for the admission of steam will be provided by said passage in connection with the valve proper—as, for instance, assuming that the area required for the admission of steam to the low-pressure cylinder is twice as great as that required for the high-pressure cylinder, then the area for the inlet of steam afforded by the openings at either side of the cross-bar j' or j^2, combined with the area of steam-inlet opening afforded by the said passage R^3, will be twice as great as the area of the two annular ports m^3 m^4. Said passage R^3 being of considerably less width than the opening afforded by the cross-bar j' or j^2 when the valve is at either limit of its throw, it will commonly be of use only when the engine is working at short stroke, it being obvious that when the valve is moved throughout the full length of its throw, or nearly so, the steam-inlet space afforded between each cross-bar j' and j^2 and the adjacent ends of the valve-plate and valve-seat will be as large or larger than required to admit all of the steam that can pass through the steam-ports.

It will of course be understood that desired area for the admission of steam to the low-pressure cylinder may be provided without employing the passage R^3 by making the valve J of sufficient width for the purpose; but for compactness of construction and to avoid the objectionable features which would be connected with a very broad valve said passage R^3 is employed.

The valve J (shown in the accompanying drawings) is arranged vertically, the steam-chest being placed at one side of the cylinder, so that the weight of the said valve J comes entirely upon the lower edge thereof. As a further and separate improvement applicable to valves of this general character, I place between the lower edge of the same and the supporting-surface of the steam-chest adjacent to it one or more anti-friction rollers, which sustain the weight of the valve, and thereby avoid the frictional resistance which would result from the sliding contact of the lower edge of the valve with the surface by which the same is sustained. As illustrated in the accompanying drawings, two anti-friction rollers S S are employed, said rollers being located in notches or recesses s s, formed in the lower flange r of the valve-plate R, so that the rollers rest upon the bottom wall of the steam-chest. In this construction, of course, the rollers are of the same diameter as the thickness of the said flange r. The rollers S S illustrated are of cylindric form and are made of such length that their flat end faces come flush with the side faces of the valve J. This particular construction is not, however, essential, and the rollers employed may be of spherical instead of cylindric shape, and the bearing-surfaces, therefore, may be arranged otherwise than in the manner shown.

One main feature of the valve shown may be used with advantage when other features illustrated in the drawings are absent, it being obvious that under some circumstances the reduction in first cost of the engine or cheapness of fuel will warrant the omission of some of the novel features herein shown, even at a loss of the advantages gained by the presence of such features—as, for instance, a different construction in both of the valves is illustrated in Fig. 9, in which the valve-plate R is without any passage R^3, and the piston-valve K is provided at each end with only one annular bearing-surface M^3, which operates in connection

each provided with two separate annular working or bearing surfaces M^3 M^4, the bearing-surface M^3, adjacent to the outer end of the valve, being constructed to operate in connection with the outermost port m^3, and the surface M^4 acting in connection with the port m^4, adjacent to the middle part of the valve. Live steam is admitted to the valve through the central port m^2 and gains access to the ports m^4 m^4, which are nearest the middle of the valve, through the space between the reduced or smaller middle part of the valve K and the inner portions of the seat M. Passage is afforded for the steam to the outer ports m^3 m^3 by means of passages m^5 m^5, formed in the wall of the valve K and leading from the step or shoulder at the inner ends of the surfaces M^4 M^4 to annular openings or ports formed between the surfaces M^3 and M^4, the said surfaces M^4 M^4 in this construction being formed by or upon rings sustained from the body of the valve by radial ribs or flanges, as clearly seen in the drawings, Fig. 4, and as fully set forth in said prior patent. The width of the inner bearing-surfaces M^4 M^4 is so proportioned relatively to the distance between and width of the ports m^3 m^4 that when the annular opening between said surfaces M^3 M^4 coincides with the outer port m^3 of the valve-seat the inner port m^4 of said seat will be uncovered, as clearly shown at the right-hand side of Fig. 2, it being entirely obvious that when the valve is in the position illustrated in said figure steam will have free access from the steam-port m^2 to the ports m^3 m^4, which communicate with the main port m' at the right-hand side of the steam-chest. The exhaust-steam in this construction passes through the outer ports m^3 m^3 only, the inner ports m^4 at one end of the valve, obviously, being closed when steam is being admitted to the ports at the opposite end of the valve, as clearly seen in said Fig. 2. To allow sufficient area for the passage of the exhaust-steam, the said ports m^3 m^3 are desirably made wider than the ports m^4 m^4.

The interior space of the steam-chest D is in direct communication with or opens into the interior of the steam-chest E, so that the exhaust-steam from the end of the valve K nearest the steam-chest D escapes directly into the latter, while the exhaust-steam from the opposite or outer end of said valve K passes through the hollow interior of the valve and is discharged into the said steam-chest. The particular arrangement described whereby the live steam in the port m^2 surrounds the central part of the tubular piston-valve K is of advantage for the reason that such live steam retains the tubular valve at a high temperature, and thus prevents or lessens condensation of the exhaust-steam in the passage of the latter from the outer end of the high-pressure cylinder to the valve of the low-pressure cylinder. The piston-valve K, constructed as above described, affords a double admission of steam to the high-pressure cylinder, thereby enabling a large area of passage for the influx of live steam to the cylinder to be secured by a short movement of the valve, whereby a high pressure may be quickly established within the cylinder when the ports are opened.

The valves J and K are connected by means of the valve-stem, which passes through central part J′ of the valve J, as hereinbefore described, and through centrally-arranged hubs of the valve K. As a convenient means of holding the valves at the desired distance apart, a tube or sleeve H^2 is placed around the valve-stem between the valves in the manner illustrated. The operation of these said valves will be more easily understood by reference to Figs. 2, 7, and 8. As illustrated in Fig. 2, the valve K is in position for the passage of live steam through the double ports m^3 m^4 to the main port m', leading to the inner end of the high-pressure cylinder, and for the exit of steam through the main port m at the outer end of the high-pressure cylinder through the valve K to the steam-chest D. At this time the valve K is at the extreme end of its throw to the right, and the valve J is also at the extreme limit of its throw in the same direction and in position for the greatest admission of steam to the inner end of the low-pressure cylinder through the port l'. At this time the cross-bar j^2 of the valve J stands outside of and free from the valve-seat L and the plate R, so that steam is free to pass from the steam-chest around both sides of the said bar j^2 to the space between the said valve-plate R and the valve-seat L and into the said port l', as hereinbefore described. At this time the intermediate cross-bar j^4 nearest the cross-bar j^2 stands between the steam-port l' and the exhaust-port l^2, thus closing the space between said ports, while the external cross-bar j' at the opposite end of the valve stands between the port l and the end of the valve-seat, thus closing the space between the said valve-seat and the valve-plate R at this point. Exhaust-steam is at this time free to pass from the said port l to the exhaust-port l^2 through the space between the valve-seat and valve-plate, the cross-bar j^3 at this time being located opposite the exhaust-port and in position to allow the free passage of steam around both sides of the bar into said port. Fig. 7 shows both of the valves at the limit of their movement opposite to that shown in Fig. 2, live steam at this time passing to the outer end of the high-pressure cylinder through the port m, and the exhaust-steam passing from the inner end of said cylinder through the port m' to the valve-chest D, from which it is passing through the port l to the low-pressure cylinder, the exhaust from the low-pressure cylinder passing through the port l' to the port l^2 in the manner illustrated. Fig. 8 illustrates an intermediate position of the parts when the valve is being shifted from the position shown in Fig. 7 to

with a single annular steam-port m^3 at each end of the steam-chest E. The construction shown in said Fig. 9 is a simple one, adapted for use in cases where the cheapness of fuel or other circumstances will enable good results to be obtained without the advantage in steam economy gained by the use of all of the features shown in the other figures of the drawings. In the flat valve J (shown in said Fig. 9) the advantages of a double admission of steam is obtained—that is to say, a relatively-large opening for the passage of steam is afforded by a short movement of the valve; but these favorable results are obtained to a greater degree when the passage R^3 in the valve-plate is employed, such passage obviously affording a triple instead of a double opening for the admission steam without increasing the stroke of the valve.

The flat, gridiron, or barred valve, combined with a valve-seat and imperforate valve-plate, as herein described, may obviously be used in single-acting engines as well as when combined with a piston-valve in a compound engine, in the manner herein illustrated.

In compound engines of the character herein shown as heretofore commonly constructed the cylinders have been separated from each other by an open space, the cylinders being provided with heads on their adjacent ends, containing two separate stuffing-boxes, through which the piston-rod passes. The construction herein illustrated, in which the two cylinders arranged end to end are separated by a single diaphragm or wall only, has the important advantage of enabling the stuffing-boxes to be dispensed with, it only being necessary to fit the piston-rod with reasonable closeness in the hole through which it passes, inasmuch as any steam which leaks past the piston-rod will merely escape from one cylinder to the other. The construction illustrated, furthermore, has the advantage of bringing the two valve-chests close to each other, so that they are directly connected and form in effect one steam-chest, while at the same time dispensing with the stuffing-boxes heretofore used on the adjacent ends of the steam-chests for the purpose of making steam-tight joints with the valve-stem. The connection of the steam-chests directly with each other in the manner described has the advantage of affording a direct passage of steam from one valve to the other, so that no steam is wasted by condensation or otherwise, as occurs when the two steam-chests are separated and are connected by pipes or passages, as heretofore common.

It will be understood that this invention relates to improvements in compound engines only, the valve construction shown and described as applied to the low-pressure cylinder forming the subject of a separate application for patent, Serial No. 364,046, filed September 5, 1890.

I claim as my invention—

1. The combination, with the high and low pressure cylinders of a compound engine, of a steam-chest for the high-pressure cylinder having a cylindric valve-seat provided with annular steam-ports communicating with opposite ends of the high-pressure cylinder and with a central steam-supply port, a steam-supply pipe communicating with said steam-supply port, a steam-chest for the low-pressure cylinder, opening into the steam-chest of the high-pressure cylinder and having a flat-valve seat provided with steam-ports leading to the opposite ends of the low-pressure cylinder and with a central exhaust-port, a valve-plate located in said steam-chest opposite the said valve-seat, a hollow piston-valve located in the steam-chest of the high-pressure cylinder and a flat valve provided with transverse parallel bars working in connection with the valve-seat and valve-plate belonging to the steam-chest of the low-pressure cylinder, and a rigid connection uniting said hollow piston-valve with the flat valve, substantially as described.

2. The combination, with the high and low pressure cylinders of a compound engine, of a steam-chest having a cylindric valve-seat provided at each end with two annular steam-ports communicating with opposite ends of the high-pressure cylinder and with a central annular steam-supply port, a steam-supply pipe communicating with said steam-supply port, a hollow piston-valve located in said valve-seat and provided at each end with two annular bearing-surfaces having between them an annular steam passage or port communicating with the central steam-supply port, a second steam-chest having a flat-valve seat provided with steam-ports leading to opposite ends of the low-pressure cylinder and with a central exhaust-port, a valve-plate arranged opposite and parallel with said valve-seat, and a flat valve located between said valve-seat and valve-plate, and provided with four transverse parallel bars, said valves being rigidly connected with each other, substantially as described.

3. The combination, with the high and low pressure cylinders of a compound engine, of a steam-chest having a cylindric valve-seat provided at each end with two annular steam-ports communicating with opposite ends of the high-pressure cylinder and with a central annular steam-supply port, a steam-supply pipe communicating with said steam-supply port, a hollow piston-valve located in said valve-seat and provided at each end with two annular bearing-surfaces having between them an annular steam passage or port communicating with the central steam-supply port, a second steam-chest having a flat-valve seat provided with steam-ports leading to opposite ends of the low-pressure cylinder and with a central exhaust-port, a valve-plate arranged opposite and parallel with said valve-seat, and a flat valve located between said valve-seat and valve-plate and provided with

four transverse parallel bars, said valves being rigidly connected with each other, and said valve-plate being provided with a passage leading from end to end thereof and opening at the inner face of the valve-plate near the ends thereof, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

ALBERT L. IDE.

Witnesses:
C. CLARENCE POOLE,
GEORGE W. HIGGINS, Jr.