No. 889,622. PATENTED JUNE 2, 1908.

E. H. KNAPP.

STEAM ENGINE.

APPLICATION FILED JUNE 10, 1907.

5 SHEETS—SHEET 1.

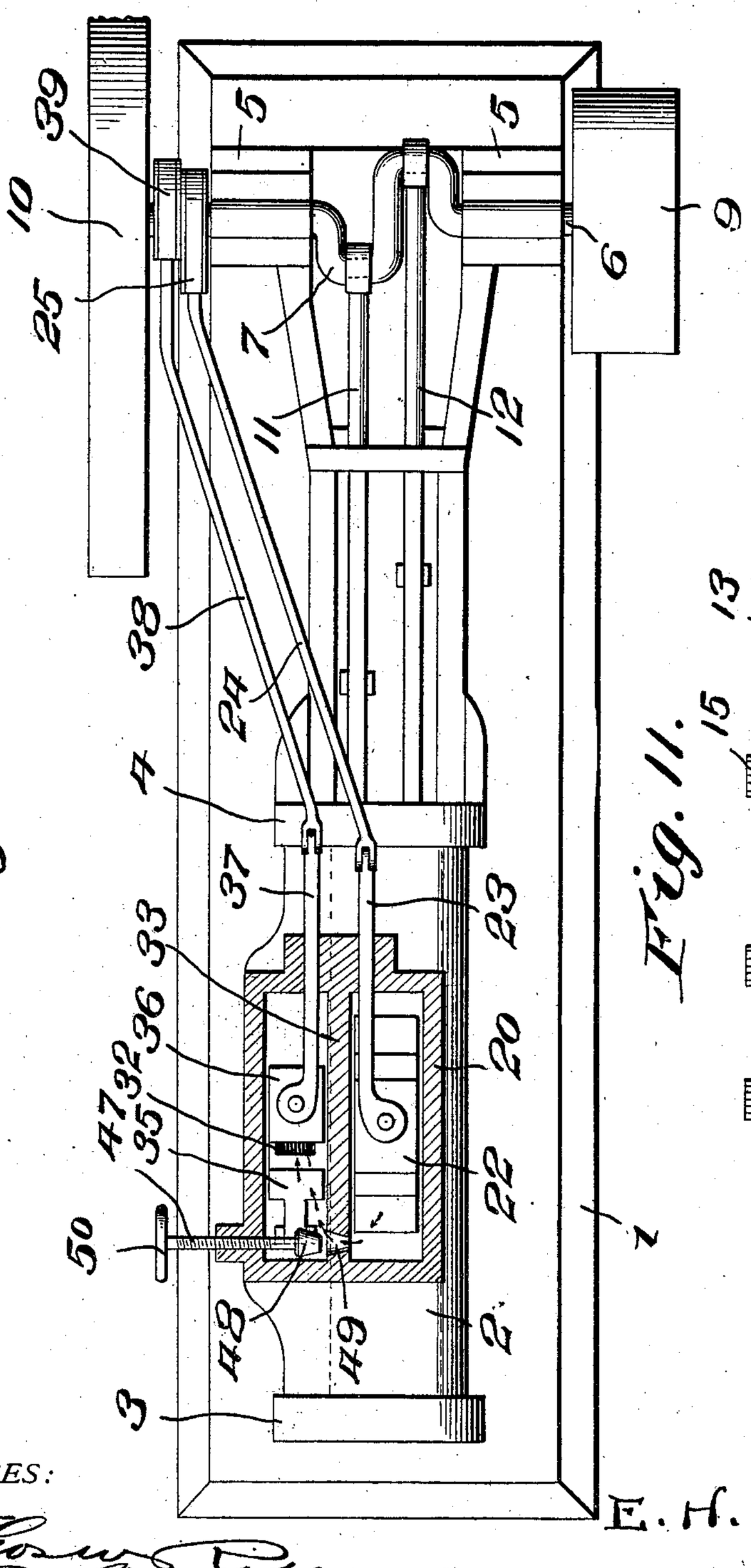

Fig. 1.

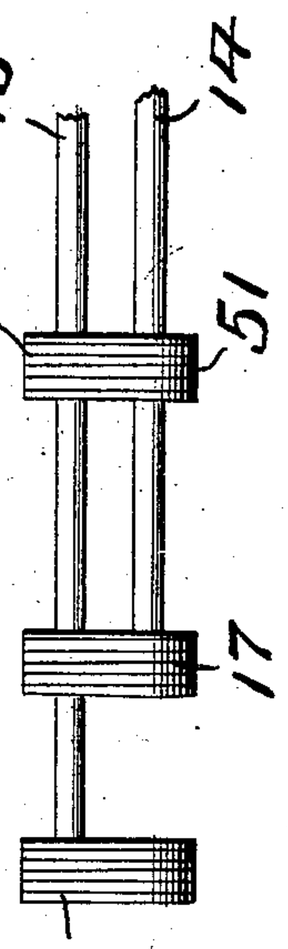

Fig. 11.

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6 SHEETS—SHEET 2.

Fig. 2.

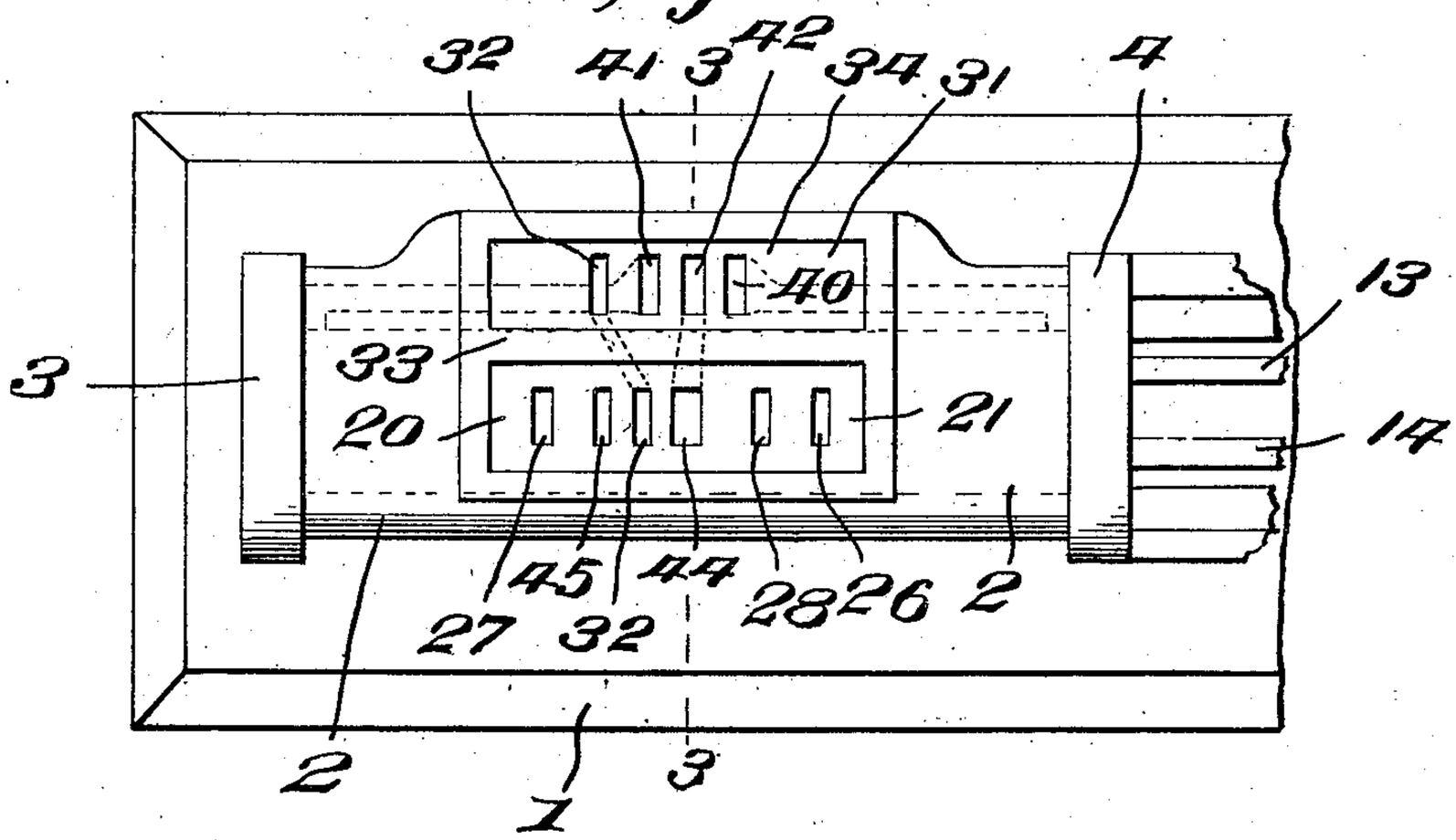


Fig. 4.

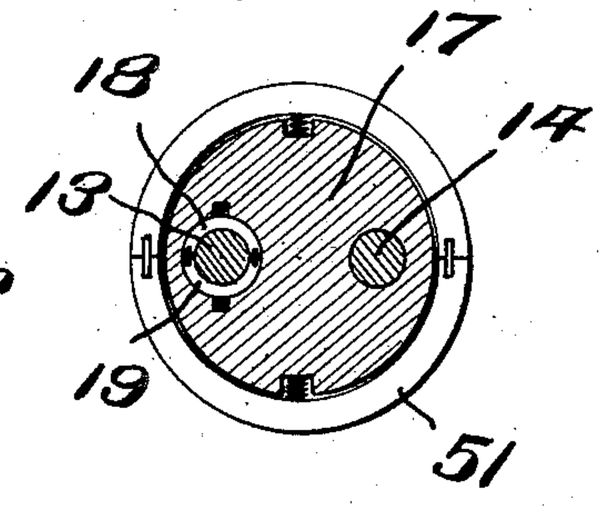
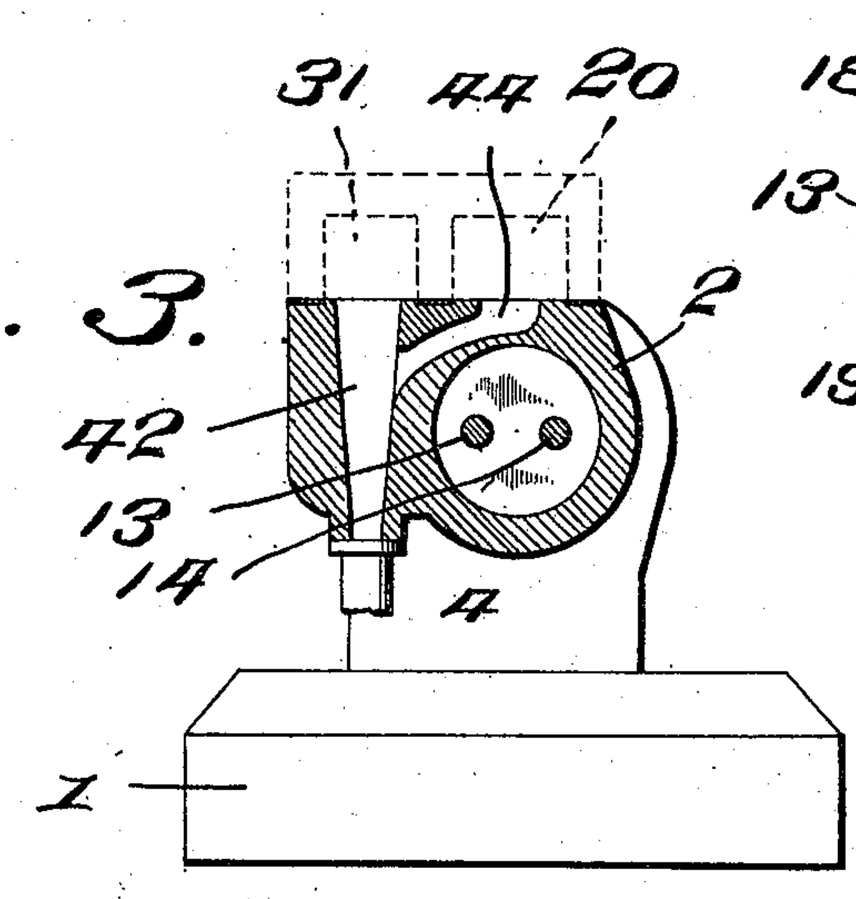


Fig. 3.



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5 SHEETS—SHEET 3.

Fig. 5.

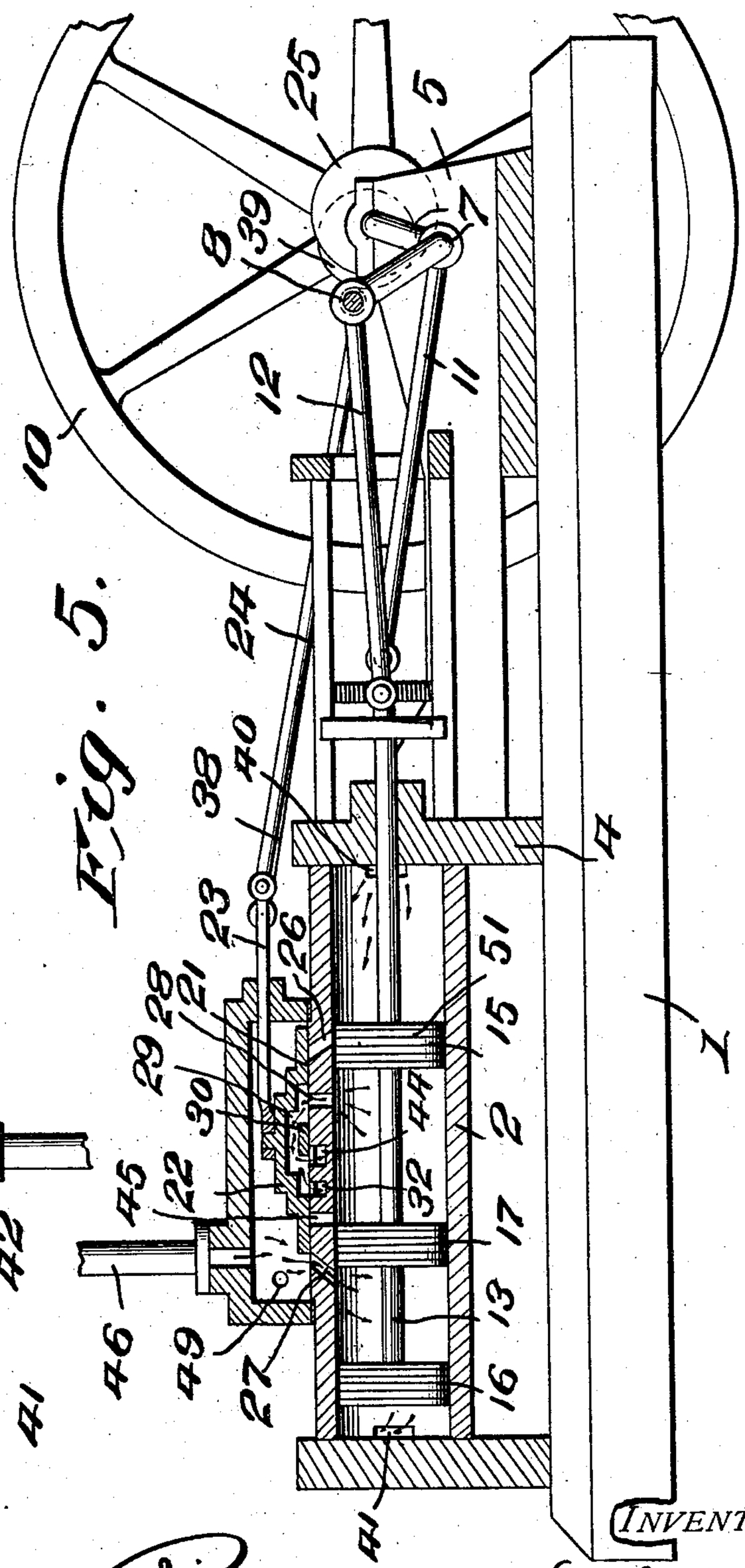
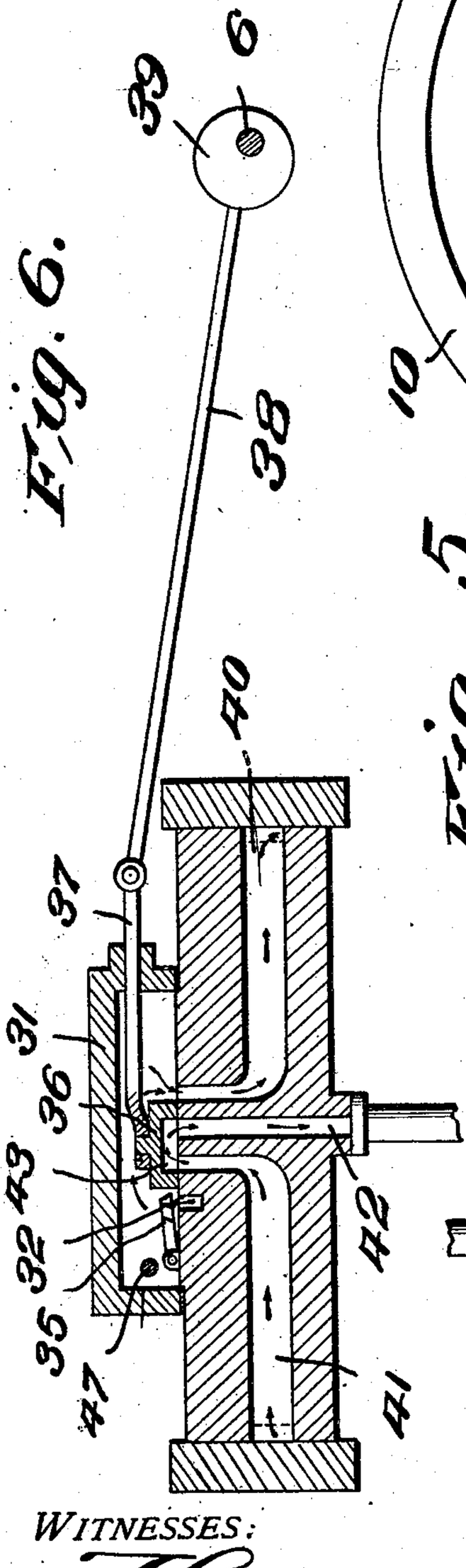


Fig. 6.



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5 SHEETS—SHEET 4.

Fig. 8.

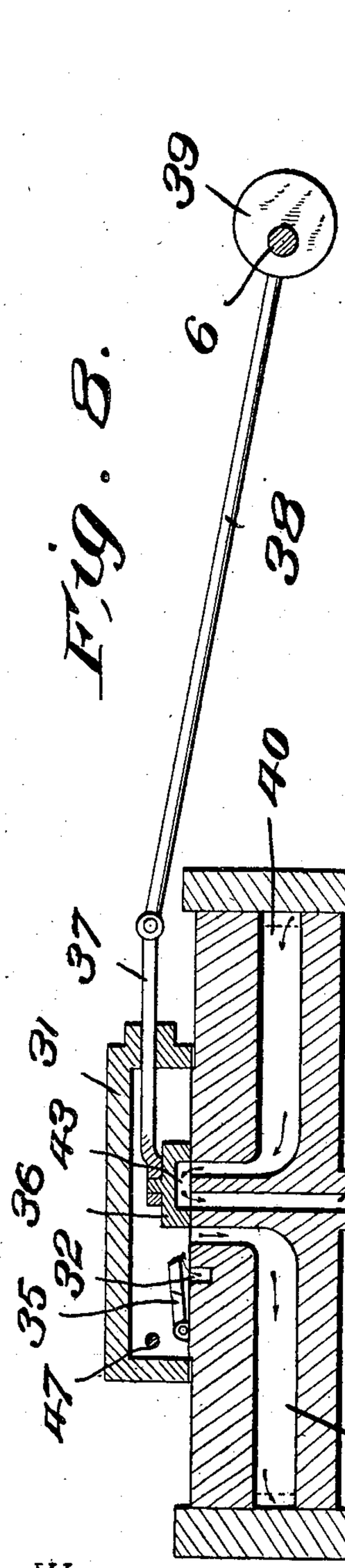
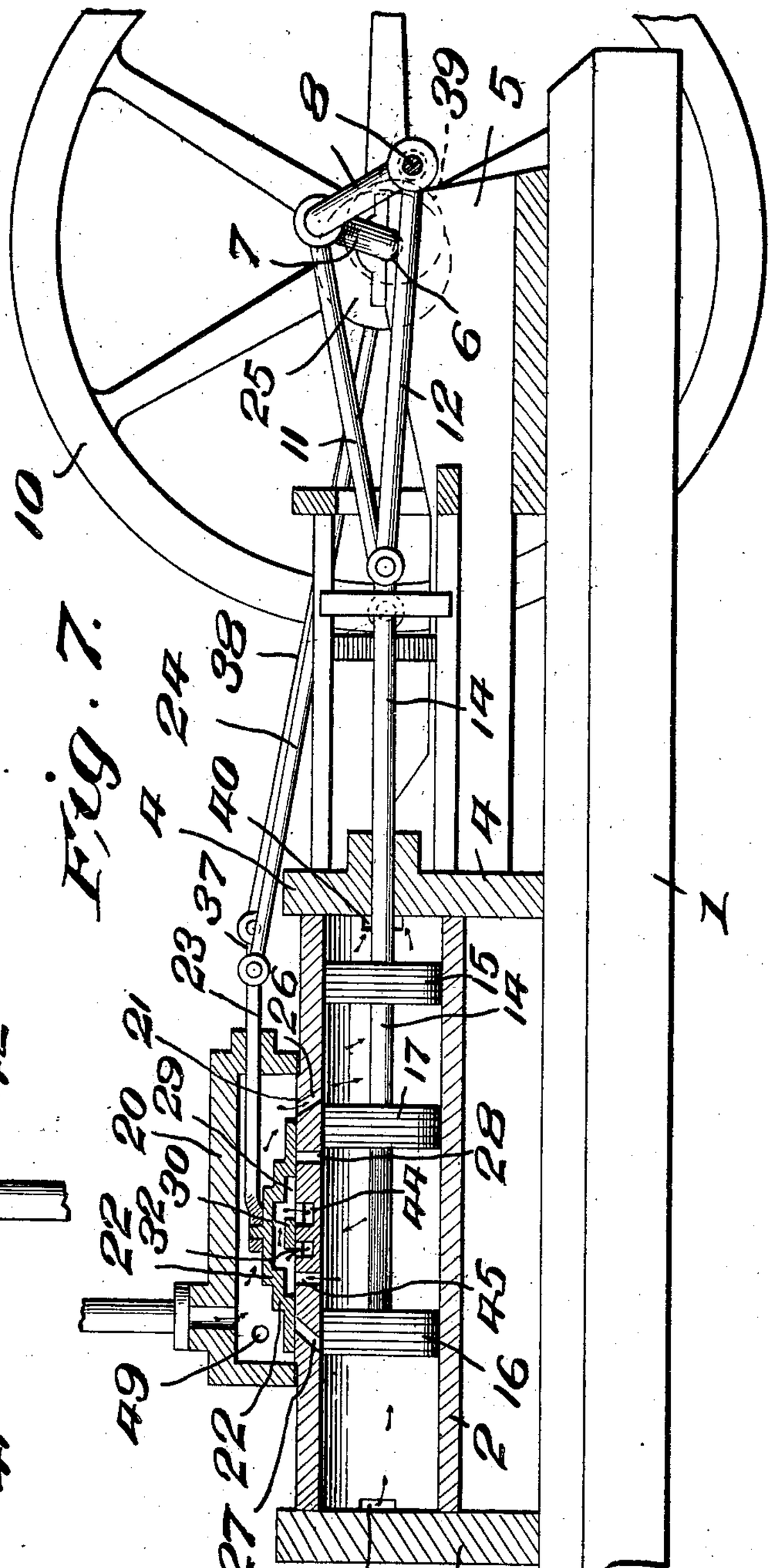


Fig. 7.



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5 SHEETS—SHEET 5.

Fig. 10.

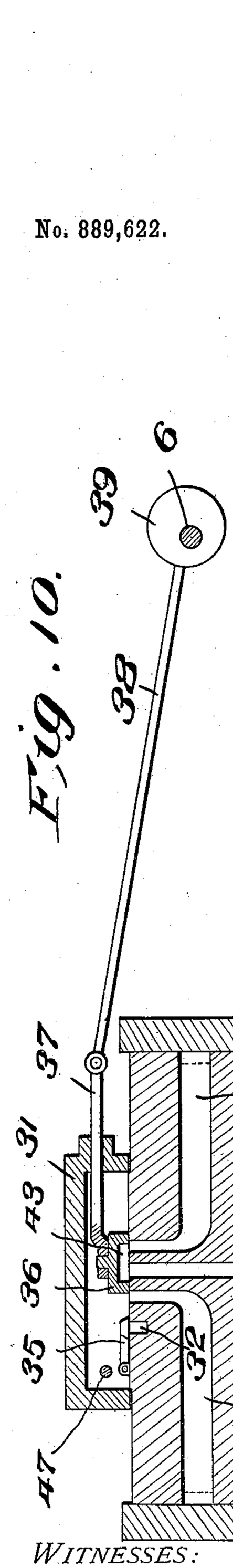
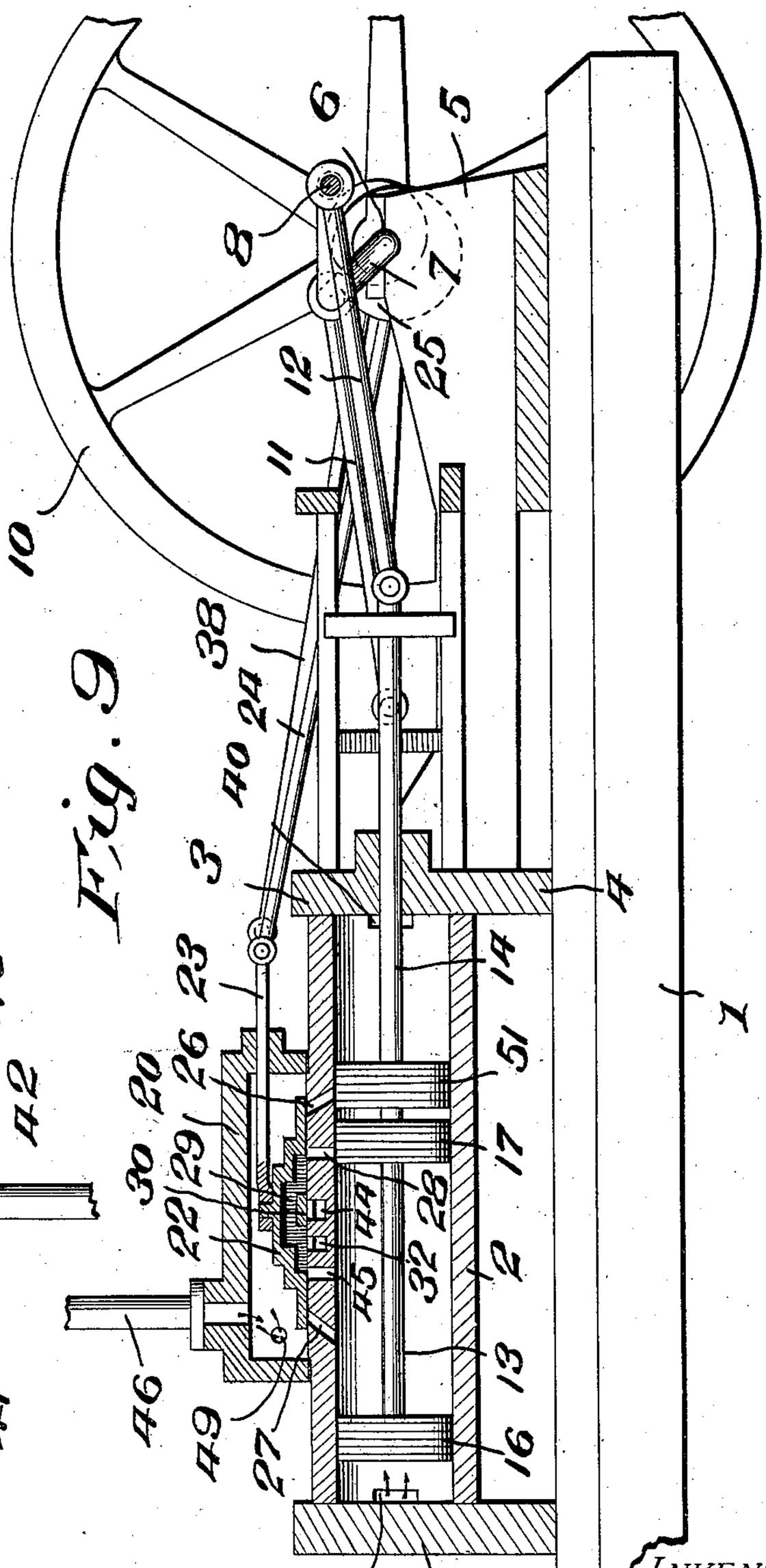


Fig. 9



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UNITED STATES PATENT OFFICE.

ERVIN HARM KNAPP, OF GODDARD, KENTUCKY.

STEAM-ENGINE.

No. 889,622. Specification of Letters Patent. Patented June 2, 1908.

Application filed June 10, 1907. Serial No. 378,677.

To all whom it may concern:

Be it known that I, ERVIN HARM KNAPP, a citizen of the United States, residing at Goddard, in the county of Fleming and State of Kentucky, have invented certain new and useful Improvements in Steam-Engines; and I do hereby 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.

My invention relates to new and useful improvements in engines, and more particularly to that class adapted to be operated by steam and my object is to provide means for increasing the driving capacity of the engines without materially increasing the size of the cylinder.

A further object is to provide means for employing the expanded steam as well as live steam for driving the pistons, and a still further object is to provide means for starting the engine when the crank, and parts carried thereby, are on a dead center.

Other objects and advantages will be hereinafter referred to and more particularly pointed out in the claims.

In the accompanying drawings which are made a part of this application, Figure 1 is a top plan view of my improved form of engine, showing the valve chest in section. Fig. 2 is a top plan view of the cylinder portion of the engine, showing the chest and valves therein removed. Fig. 3 is a sectional view as seen on line 3—3, Fig. 2. Fig. 4 is a sectional view through one of the pistons. Fig. 5 is a longitudinal, sectional view through the engine showing the same on its rearward stroke. Fig. 6 is a detail, sectional view through the auxiliary valve chest with the parts thereof in the position when the pistons are on their rearward stroke. Fig. 7 is a central, sectional view through the engine, showing the pistons on their forward stroke. Fig. 8 is a detail, sectional view through the auxiliary valve chest showing the position of the parts thereof when the pistons are on their forward stroke. Fig. 9 is a central, sectional view through the engine, showing the position of the parts thereof when the crank is at a dead center. Fig. 10 is a detail, sectional view through the auxiliary valve chest showing the position of the parts thereof when the crank of the engine is on a dead center, and, Fig. 11 is a detail, plan view of the pistons removed from the cylinder.

Referring to the drawings in which similar reference numerals designate corresponding parts throughout the several views, 1 indicates the base of my improved engine, which may be constructed in the usual, or any preferred form, upon which is mounted a cylinder 2, to each end of which is secured a head 3, said heads being extended below the cylinder 2 to form supports 4, said supports resting on the base 1 and being secured thereto in any preferred manner.

Rotatably mounted in bearings 5 at the forward end of the base 1 is a driving shaft 6, that portion of the shaft 6, between the bearings 5, being provided with cranks 7 and 8, while the ends of the shaft are extended beyond the bearings 5 to receive a pulley 9 at one end, and a power wheel 10 at the opposite end.

Secured at one end to the cranks 7 and 8 are arms 11 and 12, respectively, the opposite ends of said arms being pivotally connected to piston shafts 13 and 14, respectively, said piston shafts extending through openings in one end of the cylinder 2 and parallel with each other. The piston shaft 13 has fixed thereto a pair of pistons 15 and 16, the piston 16 being fixed to the extreme inner end of the shaft 13, while the piston 15 is at a distance therefrom and is provided with a bearing, through which the shaft 14 is adapted to reciprocate. The shaft 14 is of less length than the shaft 13 and is so arranged that the inner end thereof will always remain between the pistons 15 and 16, a piston 17 being fixed to the inner end of the piston 14 and provided with a bearing 18, through which the shaft 13 reciprocates, the bearings in the pistons 15 and 17 having the usual, or any preferred form of packing 19, to prevent leakage of steam through the pistons.

The cranks 7 and 8 rest at different angles, and are at an angle of substantially 45° from each other, so that when the pistons 15 and 16 are traveling in one direction, the piston 17 is traveling in the opposite direction, the pistons 15 and 16 being separated a sufficient distance to allow the piston 17 to make its full stroke, and by properly directing the steam into the cylinder, pressure may be applied simultaneously to the two pistons 15 and 16 to drive them in one direction and to

the piston 17 to drive the same in the opposite direction, thereby causing one of the arms to pull upon its respective crank, while the opposite arm is giving a thrust to the opposite crank, thereby increasing or doubling the driving capacity of the engine without increasing the cylinder space or employing more than one cylinder.

In directing live steam into the cylinder, a steam chest 20 is mounted above the cylinder, and that portion of the cylinder inclosed by the steam chest is flattened to form a seat 21 for a steam valve 22, said valve having a pitman 23 pivotally secured to the upper surface thereof and extended through the usual form of stuffing box at one end of the steam chest.

The outer end of the pitman 23 has secured thereto an eccentric shaft 24, which extends forwardly from the pitman 23 and is secured to an eccentric 25 carried by the driving shaft 6, and it will be seen that as the shaft 6 is rotated, the valve 22 will be moved longitudinally over the seat 21, and in order to properly conduct the steam into the cylinder, so that the pistons will be reciprocated, I provide ports 26 and 27, said ports being located at opposite ends of the steam chest and are so arranged that when one of the ports is open, the opposite port is closed by the valve 22 and the pistons 15 and 16 are arranged to travel between their respective ports and the ends of the cylinder, while the piston 17 is adapted to travel between the two ports, and as shown in Figs. 5 and 7, when the live steam is entered into the cylinder, it passes between one of the end pistons of the intermediate piston, thereby driving said pistons in opposite directions.

In Fig. 5 of the drawings, the live steam is entering through the port 27 and between the pistons 16 and 17, thereby driving the pistons 15 and 16 towards the rear end of cylinder, while the piston 17 is driven in the opposite direction, thereby causing the arm 11 to pull upon its respective crank 7, while the arm 12 is given a forward thrust, and thus driving the crank 8. At the same time that the live steam is entering between the pistons 16 and 17, the expanded steam between the pistons 15 and 17 will pass through a port 28, through the seat 21, and into a cavity 29 formed in the lower face of the valve 22, a bar 30 being extended from side to side of the valve so that the expanded steam, in its course through the cavity will pass over the bar 30 to gain the opposite end of the cavity, and in order to utilize the expanded steam in operating the pistons, an auxiliary steam chest 31 is provided, which is located at one side of the steam chest 20 and is placed in communication therewith through the medium of a duct 32, said duct extending below the partition wall 33 of the two chests and communicating with the chests through the seats 21 and 34 of the chests 20 and 31, respectively, that end of the duct entering the auxiliary steam chest 31, being covered by a flap valve 35, pivotally mounted upon the seat 34 and the weight of the outer end of the valve being sufficient to normally hold the same over the end of the duct, so that as soon as the pressure of the expanded steam is removed, the valve will seat itself over the duct and prevent the return of the steam to the cylinder through the duct. The expanded steam, therefore, when passing through the port 28 and through the cavity 29 will enter the duct 32 and be conveyed to the auxiliary chest 31, the pistons 15 and 17 moving towards each other, serving to force the expanded steam through the port and duct.

The auxiliary chest 31 has slidably mounted therein a cut-off valve 36, which moves over the seat 34 and has pivotally secured to its central portion, an auxiliary pitman 37, said pitman extending through a suitable bearing in the forward end of the auxiliary chest 31 and has pivotally secured to its extended end, an auxiliary, eccentric shaft 38, the forward free end of which is mounted upon an auxiliary eccentric 39, said auxiliary eccentric being in turn fixed to the shaft 6.

A pair of passages 40 and 41 are provided for the auxiliary steam chest 31, said passages extending downwardly and outwardly from the seat 31 to opposite ends of the cylinder 2, and by properly arranging the cut-off valve 36, one of the passages will be open, when the other passage is closed, so that the expanded steam entering the auxiliary steam chest may again return to the cylinder 2 through one end thereof, and in the rear of the pistons 15 or 16, and, in this instance, the passage 40 is open, thereby conducting the expanded steam from the auxiliary steam chest to the forward end of the cylinder and between the cylinder head and the piston 15, the force of the steam thus assisting in propelling the pistons 15 and 16 through the cylinder. As this operation is taking place, the piston 16 is traveling towards the rear end of the cylinder, which will result in forcing the exhaust steam in that end of the cylinder through the passage 41, from whence it enters an exhaust port 42 communicating with the seat 34 of the auxiliary steam chest, the cut-off valve 36 being provided, in its lower surface, with a cavity 43, through which the exhaust steam is conveyed from the passage 41 into the exhaust port 42.

The exhaust port 42 is provided with a branch port 44, which extends below the wall 33 and enters the steam chest 20 and the bar 30, extending through the cavity, is so arranged that it will cover substantially one-half of the branch port 44 when

the valve 22 is in the position shown in Fig. 5, thereby allowing a portion of the steam to exhaust on its passage through the cavity 29 and duct 32, as the volume of the expanded steam is greater than is required to operate on the pistons, in the manner described.

In Fig. 7 of the drawings, the position of the parts of the engine are shown when the opposite stroke from that shown in Fig. 5 is being made, and, in this instance, the valve 22 has been moved to the opposite end of the steam chest 20, thereby closing the port 27 and opening the port 26, the live steam being thereby directed between the pistons 15 and 17, this operation also closing the port 28 and opening a similar port 45 at the opposite side of and adjacent to the duct 32 and as the pistons 16 and 17 are traveling towards each other, the expanded steam between said pistons will be directed through the port 45 and into the auxiliary steam chest through the duct. As the port 45 is in juxtaposition to the duct 32, the expanded steam will enter directly into the duct, thereby necessitating that the duct be partially closed to equalize the amount of the expanded steam entering the auxiliary chest with the different strokes of the valve 22 and by referring more particularly to Fig. 7, it will be seen that the bar 30 will be partially disposed over the end of the duct 32 and partially over the branch port 44, thereby reducing the mouth of the duct when the expanded steam is entering through the port 45 and equalizing the flow of the expanded steam through the duct and the exhaust port, when the valve 22 is on its rearward stroke, with the flow from the port 28 through the cavity 29 and into the duct 32.

By referring more particularly to Fig. 8 of the drawings, it will also be seen that when the valve 22 is on its rearward stroke, the cut-off valve 36 will move forwardly on its seat and connect the passage 40 with the exhaust 42 and open the passage 41, thereby directing the expanded steam from the auxiliary chest to the rear end of the cylinder 2 and in the rear of the piston 16, thereby assisting in giving the pistons 15 and 16 and arm 11 a forward stroke, while the piston 17 and arm 12 are being given a rearward stroke. If, when the engine stops, the parts should be in the positions shown in Figs. 9 and 10 of the drawings, it will be seen that the valve 22 is in such position as to close both of the ports 26 and 27, so that when steam is directed into the chest 20, through the steam pipe 46, the steam cannot enter the cylinder, and in order to cause the engine to start without employing manual labor to rotate the driving shaft to uncover one of the inlet ports 26 or 27, a valve stem 47 is directed through a threaded opening extending through the side wall of the auxiliary steam chest 31 and has on its inner end a tapered valve 48, which is adapted to enter a tapered bore, or seat 49 in the wall 33, said bore extending entirely through said wall, so that by turning the valve stem 47 until the tapered valve 48 is removed from the bore, the steam will pass from the steam chest 20 into the auxiliary chest 31 and thence through the opening 41 into the rear end of the cylinder, which will result in moving the pistons 15 and 16 a sufficient distance to throw the cranks 7 and 8 off of the dead center, and at the same time opening the port 26, when the engine will operate in the usual manner, and as soon as the engine has started, the tapered valve 48 is returned to the bore 49 and the flow of steam through the bore stopped, the stem being exteriorly threaded and readily operated through the medium of a hand-wheel 50.

The valves 22 and 36 are so timed as to have a phase difference in their strokes, whereby when the parts of the engine are in the positions shown in Fig. 9, or on a dead center, the valve 36 will have completed its rearward stroke and started on its forward stroke, so that the opening 41 will be partially uncovered when the valve 22 is in the position shown, the phase difference of the strokes of the two pistons being thus arranged to allow the steam passing through the bore 49 to readily enter the opening 41 and accomplish the result above described.

The pistons 15, 16 and 17 are provided on their peripheries with a plurality of packing rings 51, so that leakage of steam between said pistons and the wall of the cylinder will be prevented, thereby dividing the cylinder into four distinct steam chambers. It will thus be seen that I have provided economical means for employing a multiplicity of pistons with a single cylinder, and by arranging the pistons as shown and providing the auxiliary steam chest, I am enabled to employ the expanded steam for additional driving purposes without increasing the number of cylinders or providing a separate expansion cylinder, and it will further be seen that by providing a phase difference in the stroke of the valves in the main and auxiliary steam chests, the engine may be started from a dead center without employing manual labor in rotating the driving shaft. It will further be seen that by employing the same cylinder for utilizing the expanded steam, I am able to produce a very compact form of engine and at the same time greatly enhance the driving properties of the same.

What I claim is:

1. In an engine of the class described, the combination with a cylinder, and a driving shaft; of a plurality of pistons in said cylinder two of which are fixed together and the other movable independently between the fixed pistons, and means to direct steam into said cylinder, whereby the live and expanded steam may be employed to drive said pistons and rotate the driving shaft.

2. In an engine of the class described, the combination with a cylinder, a driving shaft and cranks on said driving shaft; of a plurality of pistons in said cylinder two of which are fixed to move together and the other to move independently between the fixed pistons, means to connect said pistons to the cranks, means to direct steam between said pistons and additional means to direct expanded steam into each end of said cylinder and against the end piston.

3. In an engine of the class described, the combination with a cylinder and a driving shaft; of a trio of pistons in said cylinder, one of which is movable independently of the remaining pistons, means to operatively connect said pistons to the driving shaft, a steam chest above said cylinder, a plurality of ports between said steam chest and cylinder, means to intermittently direct steam through said ports and between the two end pistons and the intermediate piston, an auxiliary chest, a duct between said first-mentioned chest and auxiliary chest to convey the expanded steam into the auxiliary chest and means to alternately convey said expanded steam to opposite ends of the cylinder and into engagement with the end pistons.

4. In an engine of the class described, the combination with a cylinder; of a pair of pistons adapted to reciprocate in opposite ends of said cylinder, an independently movable piston between said end pistons, a steam chest for said cylinder, means to alternately direct live steam to opposite sides of the central piston, an auxiliary chest, means to convey the expanded steam from opposite sides of the central piston to the auxiliary chest and additional means to alternately direct the expanded steam from the auxiliary chest to opposite ends of the cylinder.

5. The combination with a cylinder; of a pair of pistons fixed together and adapted to reciprocate in opposite ends of said cylinder, an independently movable piston between said end pistons, a steam chest for said cylinder, a port adjacent each end of said steam chest adapted to direct steam between the two end pistons and at opposite sides of the independently movable piston and a valve in said steam chest adapted to alternately open and close said ports and means to convey the expanded steam from between said pistons to opposite ends of the cylinder.

6. In an engine of the class described, the combination with a cylinder, a pair of pistons adapted to reciprocate in opposite ends of the cylinder and fixed with relation to each other, an independently movable piston between the end pistons and means to alternately direct steam to opposite sides of the independently movable piston; of an auxiliary steam chest, means to convey the expanded steam from between the pistons to the auxiliary steam chest and additional means to alternately direct the expanded steam from the auxiliary steam chest to opposite ends of the cylinder.

7. In an engine of the class described, the combination with a cylinder; of a plurality of pistons in said cylinder, a steam chest for said cylinder, ports connecting said cylinder and steam chest, a valve adapted to alternately open and close said ports, an auxiliary steam chest at one side of the first mentioned steam chest, openings extending from said auxiliary steam chest to opposite ends of the cylinder and means to direct live steam from the first mentioned steam chest to the auxiliary steam chest and into the cylinder, whereby the engine will be started from a dead center.

8. In an engine of the class described, the combination with a cylinder having a plurality of pistons therein; of a steam chest, a valve slidably mounted in said steam chest, ports connecting said cylinder and steam chest, an auxiliary steam chest, a duct connecting said first mentioned steam chest with the auxiliary steam chest, means to convey the expanded steam from the cylinder to said duct, and a valve in the auxiliary chest adapted to automatically close said duct and prevent the return of the expanded steam to the first-mentioned steam chest.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ERVIN HARM KNAPP.

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