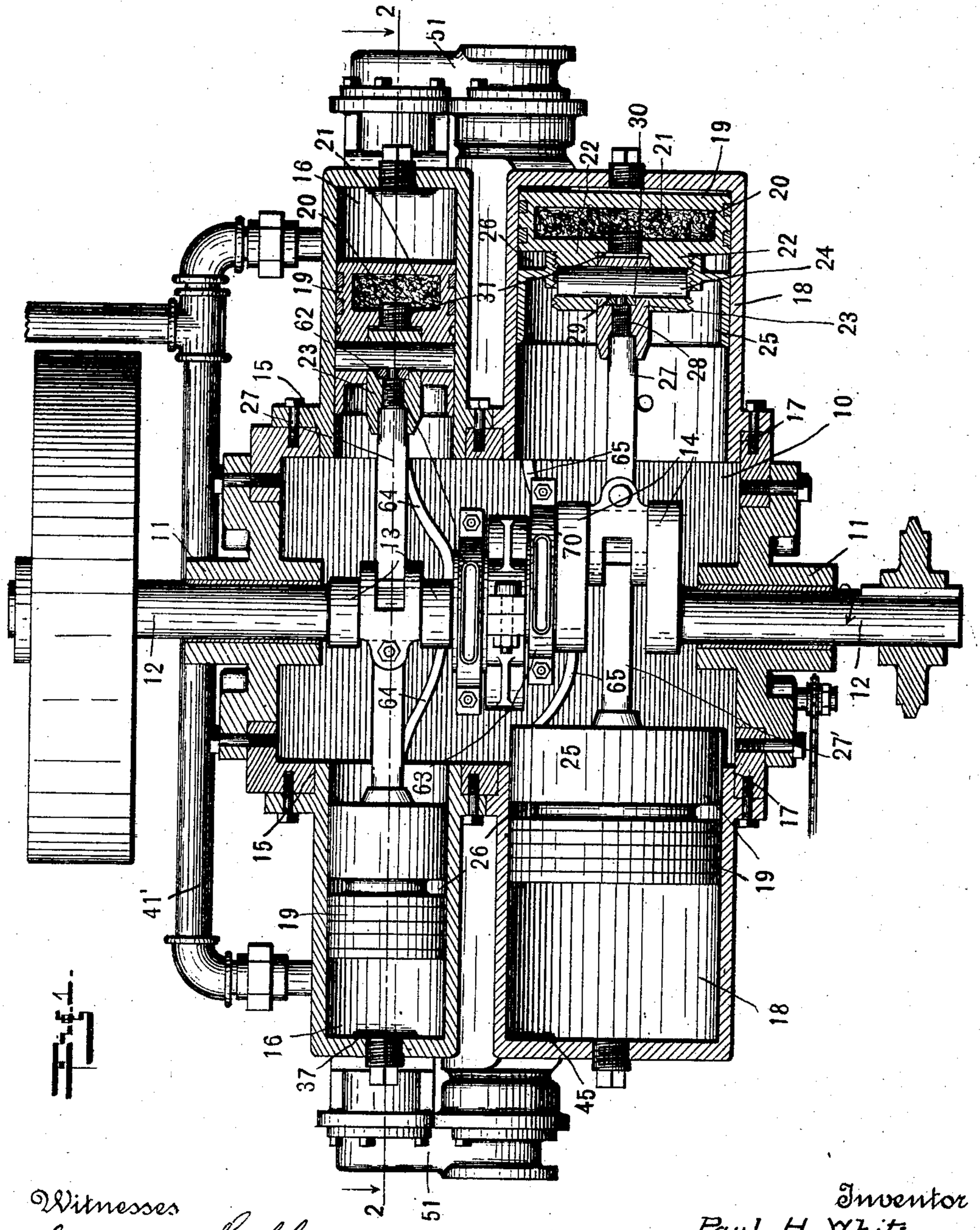
No. 711,606. Patented Oct. 21, 1902.

P. H. WHITE.

STEAM ENGINE.

(Application filed Oct. 3, 1901.)

(No Model.) 4 Sheets—Sheet 1.



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(No Model.) 4 Sheets—Sheet 2.

Fig. 4.

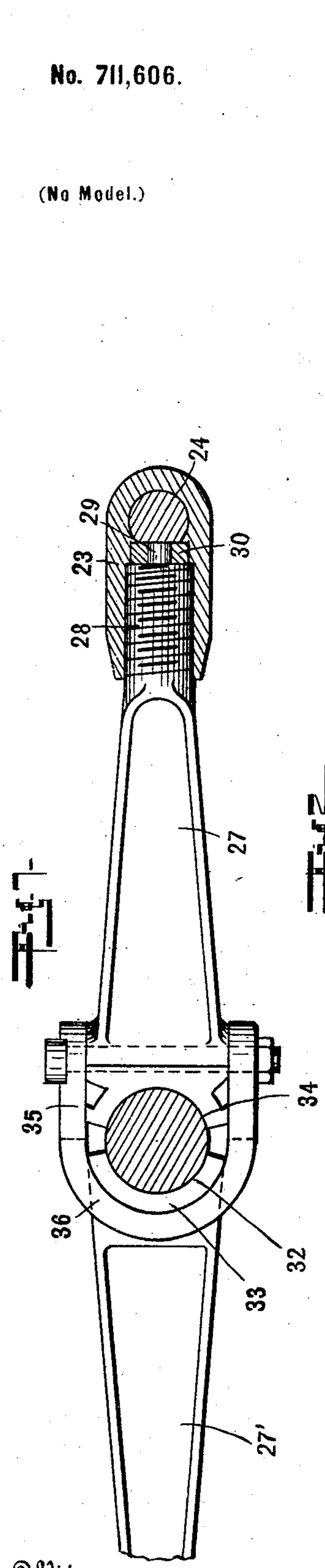
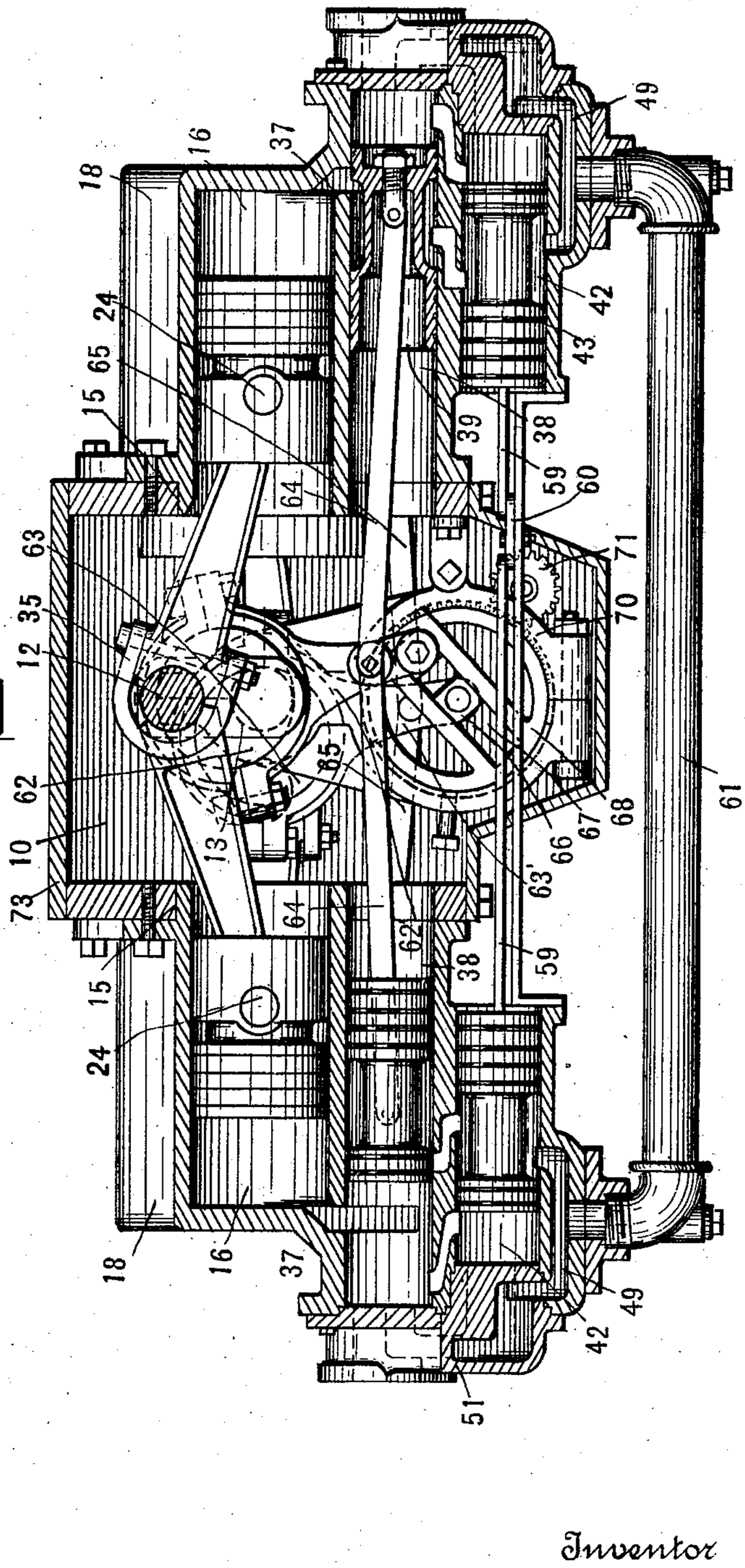


Fig. 2.



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(No Model.) 4 Sheets—Sheet 3.

Fig. 3.

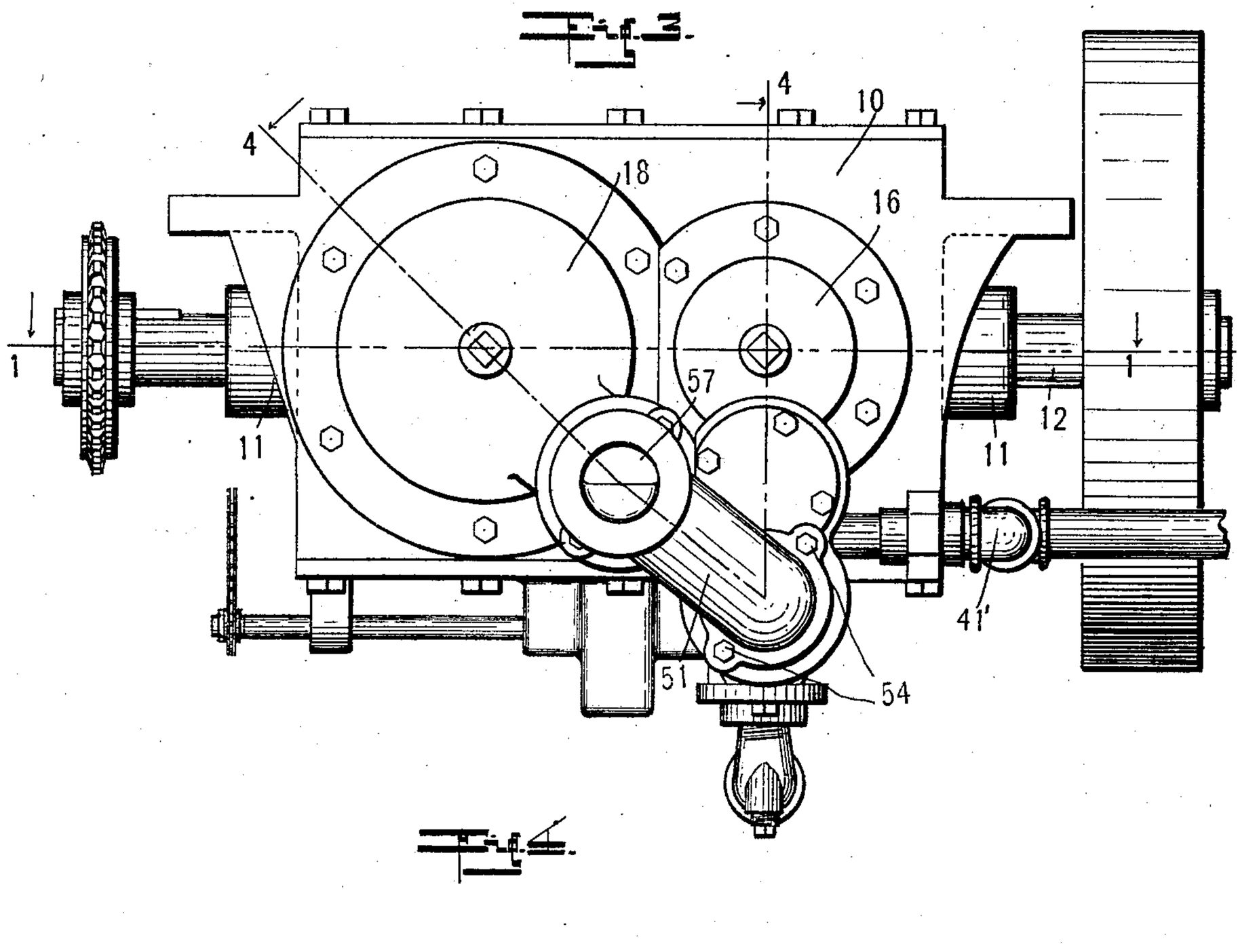
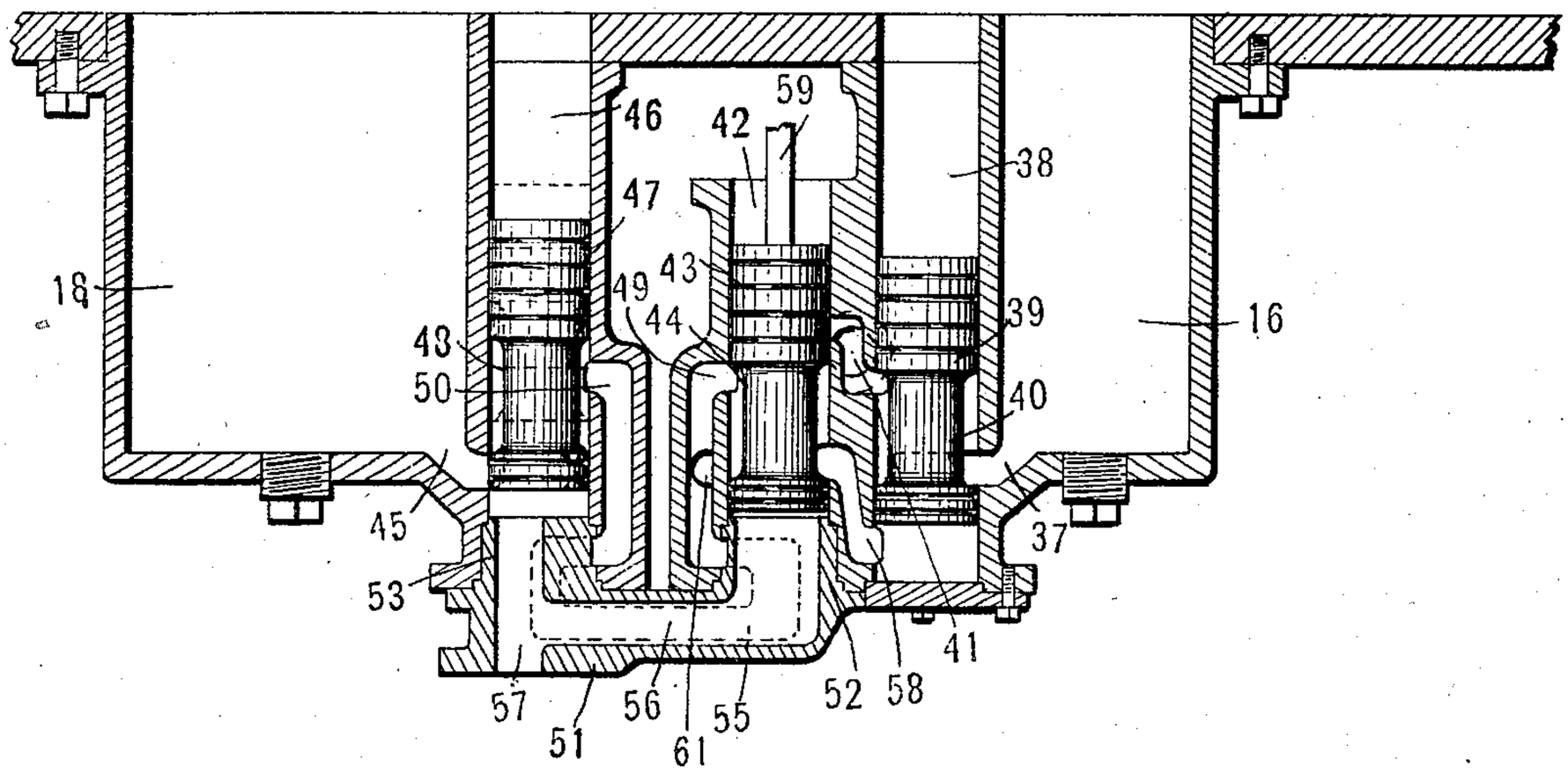


Fig. 4.



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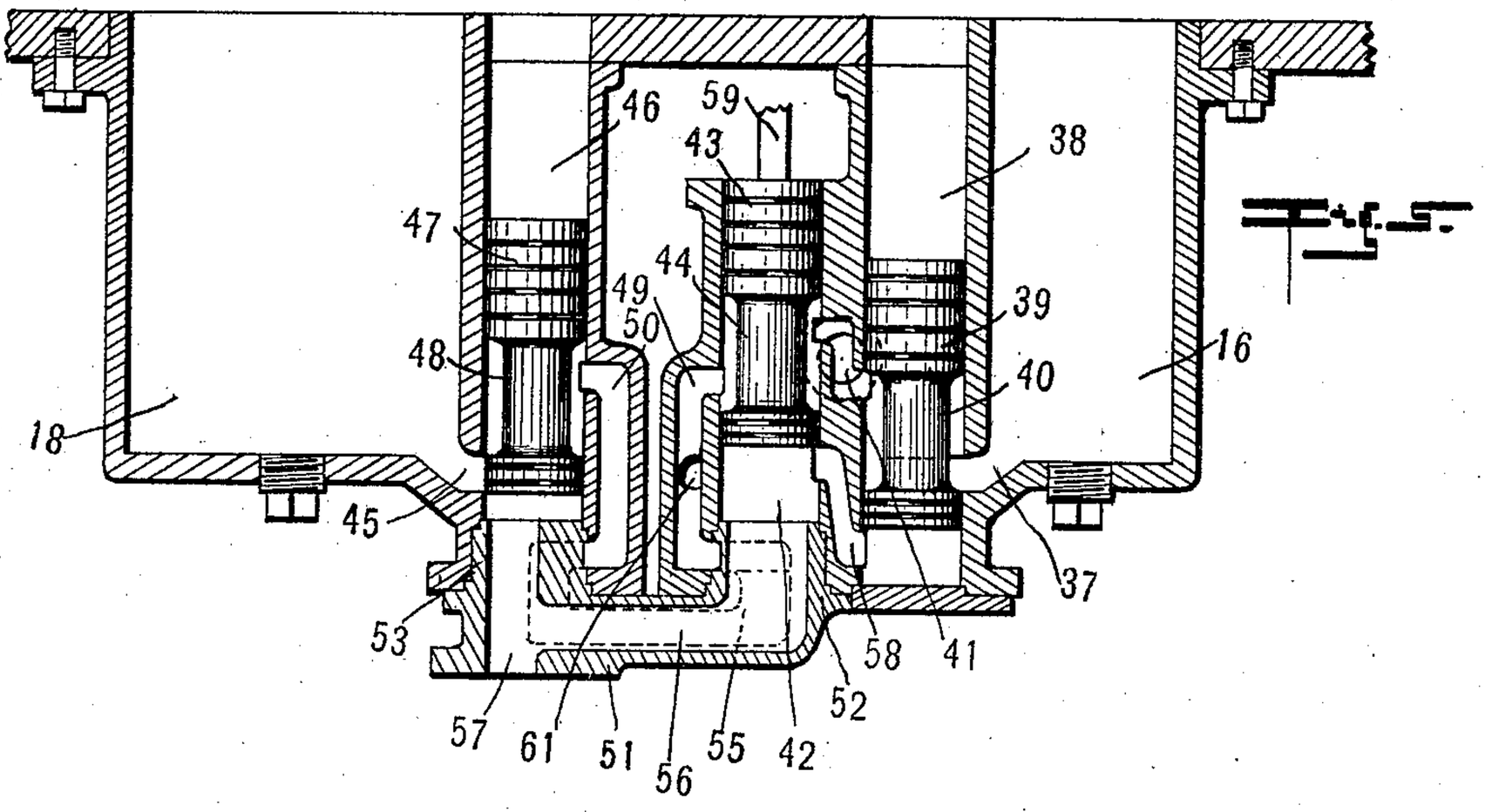


Fig. 5.

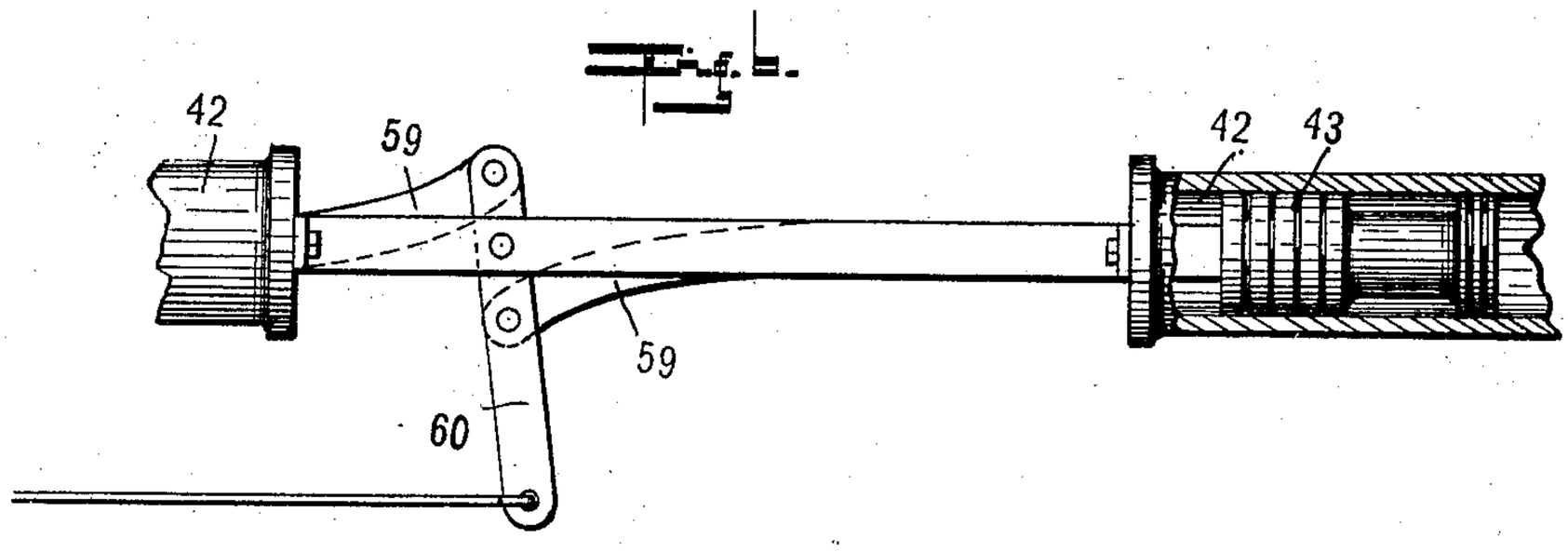


Fig. 6.

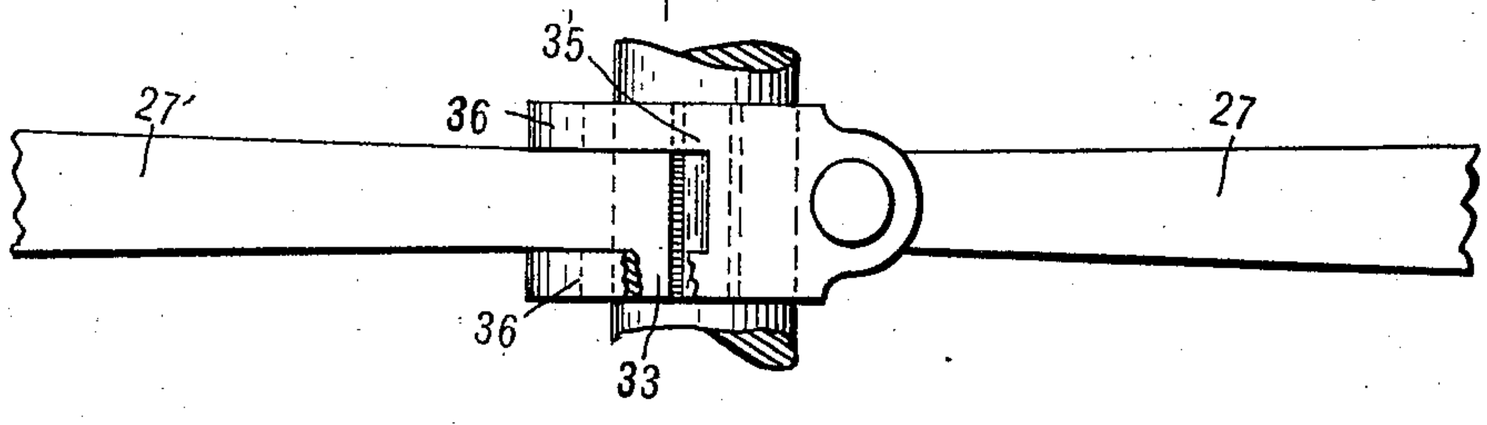
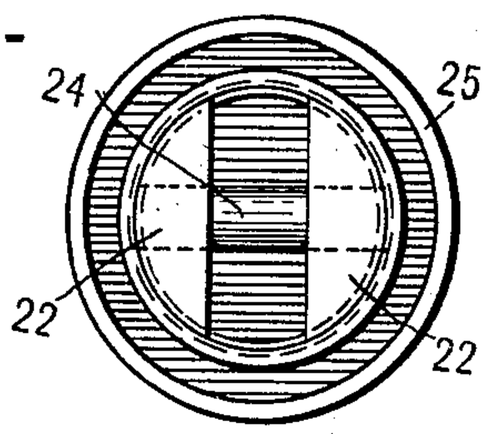


Fig. 7.



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UNITED STATES PATENT OFFICE.

PAUL H. WHITE, OF INDIANAPOLIS, INDIANA, ASSIGNOR TO WHITE STEAM WAGON COMPANY, OF INDIANAPOLIS, INDIANA, A CORPORATION OF INDIANA.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 711,606, dated October 21, 1902.

Application filed October 3, 1901. Serial No. 77,376. (No model.)

To all whom it may concern:

Be it known that I, PAUL H. WHITE, a citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented a new and useful Steam-Engine, of which the following is a specification.

My invention relates to an improvement in steam-engines, especially in single-acting multiple-cylinder engines particularly designed for steam wagons or carriages.

The objects of my invention are to produce a compact yet comparatively powerful engine which may be cheaply constructed, to provide means by which the cylinder may be connected to run either simple or compound, to provide a peculiar connecting-rod construction for oppositely-arranged pistons, and to provide such improvements in details of construction as shall be hereinafter pointed out.

The accompanying drawings illustrate my invention.

Figure 1 is an axial section on line 1 1 of Fig. 3. Fig. 2 is a transverse section through the high-pressure cylinders on line 2 2 of Fig. 1. Fig. 3 is an end elevation. Fig. 4 is a developed section on line 4 4 of Fig. 3, with the compounding-valve set to compound the cylinders. Fig. 5 is a view similar to Fig. 4, with the compounding-valve set to connect both the high-pressure and low-pressure cylinders directly to the steam-supply. Fig. 6 is a detail of the means for shifting the compounding-valve. Fig. 7 is a side detail of the adjacent ends of opposite connecting-rods. Fig. 8 is a detail at right angles to Fig. 7. Fig. 9 is a detail of the low-pressure piston.

In the drawings, 10 indicates a four-sided box-like body, to each end of which is secured a bearing 11, within which is mounted a crank-shaft 12. Shaft 12 extends through the body 10 and is provided in that portion which lies inside of the body with a pair of cranks 13 and 14, which are preferably set at an angle to each other, the said cranks being in the drawings shown at right angles to each other. Opposite crank 13 openings 15 are formed in the two sides of body 10, and in each is fitted the inner open end of a high-pressure cylinder 16, each of said cylinders being preferably bolted to the body. Opposite crank 14 openings 17 are formed in the sides of body 10, and in each is fitted the inner open end of a low-pressure cylinder 18, also bolted to the body. Each cylinder is provided with a suitable piston, steam being admitted to one side of the piston only. I prefer a piston construction consisting of a chambered body 19, the chamber 20 of which may be filled with an insulator 21, such as mineral wool. The body 19 is provided at its rear end with a pair of bosses 22, between which is placed a head 23, adapted to receive a pin 24, which is passed therethrough and through the bosses 22. The peripheries of the bosses 22 are threaded, and upon said threads is screwed a flange or supplemental piston 25, the said part being so formed as to leave an annular groove or space 26 between the rear of the body 19 and the supplemental piston, the said supplemental piston at the same time retaining the pin 24 in position. Each connecting-rod 27 or 27′ is provided at its piston end with a threaded portion 28 and a reduced portion 29, which reduced portion is adapted to receive a washer 30. The portion 28 is screwed into head 23 at right angles to pin 24 until the reduced end 29 engages said pin, a washer 30 of desired thickness being introduced, so as to allow the rod 27 to be properly adjusted and seated in position. Access is had to the interior of body 19 through an opening closed by a suitable plug 31. The construction described may be slightly varied, as shown in the high-pressure cylinder in Fig. 1, if such variation is necessary on account of the size of the piston and still retain the insulating-chamber 20. In view of the fact that the cylinders are single-acting the force exerted by each piston through its rod to the crank-shaft is always a thrust, and the force of the crank-shaft upon the rod in returning the piston is also a thrust. For this reason I have devised the peculiar construction now to be described, the construction being cheap and at the same time of such character that no adjustment need be made for wear. Neither can there be any pounding due to looseness of parts, so that there is no temptation for a comparatively unskilled operator to attempt to adjust the bearings.

The connecting-rods 27 and 27′ are identi-

cal, with the exception of their crank ends. Rod 27′ is provided at its crank end with a socket 32, slightly less than a semicircle in length and of a radius to fit the wrist-pin of the crank. Adjacent said socket and concentric therewith the rod 27′ is provided with a pair of segmental flanges 33, which project from the sides. The rod 27 at its crank end is of a thickness equal to the thickness of the piston-rod 27′, including the flanges 33, and is provided with a socket 34, similar in size and extent to the socket 32. In order to prevent displacement of the two connecting-rods and to form a running connection when the parts are operated without pressure upon the pistons, I provide a yoke 35, which yoke is slotted in its middle, so as to form a pair of straps 36, between which may be passed the rod 27′. The ends of yoke 35 are bolted to the crank end of the rod 27, and the straps 36 thereof pass around and outside of flanges 33 of the rod 27′. A limited movement of each crank with relation to the other upon the wrist-pin is allowed, owing to the shortness of the sockets 32 and 33. By this construction each connecting-rod has a bearing upon the full length of the wrist-pin.

Each high-pressure cylinder is provided with a single port 37, which is both an admission and exhaust port, and this port communicates with a cylindrical valve-chamber 38, within which is mounted a valve 39, having a reduced middle portion 40. Leading into chamber 38 is a steam-inlet 41, the said inlet leading also into a cylindrical valve-chamber 42. In chamber 42 is mounted a compounding-valve 43, said valve having a reduced middle portion 44 and being preferably exactly like valve 39. Each low-pressure cylinder has a single port 45, which serves both as an exhaust and admission port, and said port leads into a cylindrical valve-chamber 46, in which is mounted a valve 47, having a reduced middle portion 48. Leading from about the middle of chamber 42 is a by-pass 49, which returns into the chamber 42 near its outer end, and leading from chamber 46 is a by-pass 50, which is similar to by-pass 49 and returns into chamber 46 near its outer end. The two chambers 42 and 46 are connected by a connector 51, which is preferably a single casting provided with a pair of bosses 52 and 53, boss 52 fitting into the outer end of valve-chamber 42 and boss 53 fitting into the outer end of valve-chamber 46. The connector is bolted into place, so as to form steam-tight joints, by means of suitable bolts 54. Running through connector 51 is a passage 55, (shown in dotted lines in Figs. 4 and 5,) which passage forms a connection between the outer ends of the by-passes 49 and 50. The connector 51 is also provided with a passage 56, which passage is entirely independent of the passage 55 and forms a direct connection between the outer ends of chambers 42 and 46. Leading from passage 56 or forming part thereof is an exhaust-passage 57. A passage 58 forms a connection between the outer end of chamber 38 and the outer end of chamber 42.

Each pair of the high and low pressure cylinders is fitted with a compounding-valve 43 in the manner described, and each of said valves is provided with a link 59. Both of said links 59 are connected to a shifting-lever 60, upon opposite sides of the pivot thereof, so that by swinging said lever the two compounding-valves may be similarly and simultaneously shifted in their chambers.

The several parts described are shown diagrammatically in Figs. 4 and 5, the ports being slightly distorted due to the development of the peculiar section taken. In Fig. 5 the parts are in position for both cylinders to receive high-pressure steam, valve 43 being so placed in its chamber 42 as to bring the reduced portion 44 opposite the inlet-port 41 and the by-pass 49 and at the same time cut off passage 59 from that portion of chamber 42 occupied by the reduced portion 44. In this position the high-pressure steam passes from port 41 into that portion of chamber 38 surrounding the reduced portion 40 of the valve 39, and when said valve is properly moved by the valve-gear steam will be admitted through port 37 into the high-pressure cylinder. At the same time the steam passes into that portion of chamber 42 occupied by the reduced portion 44 of valve 43, and from thence passes through passages 49, 55, and 50 into that portion of chamber 46 occupied by the reduced portion 48 of valve 47, and from thence is admitted by the valve 47 into the low-pressure cylinder through port 45. The exhaust from the high-pressure cylinder passes upon proper movement of valve 39 into the outer end of valve-chamber 38, from thence through passage 59 into the outer end of chamber 42, and from thence through passage 56 of the connector 51 and out of the exhaust-opening 57. The exhaust from the low-pressure cylinder passes directly through port 45 into passage 56 and from thence out through passage 57. By shifting the compounding-valve 43 into the position shown in Fig. 4 that end of port 41 leading into chamber 42 is closed and the reduced portion 44 of valve 43 is brought opposite the end of passage 58. In this position of valve 43 the steam from the high-pressure cylinder, which is exhausted through port 37 into the outer end of chamber 38, passes through passage 58 into that portion of chamber 42 occupied by portion 44 of valve 43, from thence through passages 49, 55, and 50 into chamber 46, and from thence into the low-pressure cylinder, the exhaust from the low-pressure cylinder taking place in the manner already described. The outer end of the compounding-valve 43 in its passage cuts off direct communication between chamber 42 and the exhaust-passage 56 of the connector. It is to be noticed in this connection that all of the valves are identical and that the connector

which connects the high and low pressure cylinders is a single casting, thus very materially cheapening the cost of production. With the cranks set on the quarter, as shown in the drawings, and the crank-shaft turning in the direction indicated in Fig. 1, with the engine compounded, the steam from the high-pressure cylinder on one side of the crank-shaft must pass into the low-pressure cylinder on the opposite side. In order that this may be accomplished, I provide a pipe 61, which forms a direct connection between the two by-pass passages 49, so that for about one-fourth of a revolution the steam from the high-pressure cylinder on one side will pass from the adjacent valve-chamber 38 through passage 58 (see Fig. 5) and valve-chamber 42 into the adjacent by-pass 49 and from thence through pipe 61 into the other by-pass 49, passing from there through the passages 55 and 50 and valve-chamber 46 of that side into the adjacent low-pressure cylinder. When the engine is reversed or is run in the direction opposite to that indicated in Fig. 1, however, the steam from each high-pressure cylinder exhausts into the adjacent low-pressure cylinder, as will be readily apparent from an inspection of Fig. 1.

The valves 39 and 49 may be operated by any suitable valve-gear, but preferably by the gear described and claimed in my pending application, Serial No. 77,375. In this gear the crank-shaft is provided with two eccentrics 62 and 63, which are located between the two cranks 13 and 14, and mounted upon said eccentrics are eccentric-arms 62′ and 63′, respectively. Both valves 39 are connected to the eccentric-arm 63′ by links 64 64, and both valves 47 are connected to the eccentric-arm 62′ by similar links 65 65. The outer end of each of the eccentric-arms is provided with a slide-block 66, and both of said blocks are mounted in a single diametrical slot 67, formed in a circular plate 68, rotatably supported in bracket, hung upon the crank-shaft and held by a bracket 70. Plate 68 may be shifted in its support so as to reverse the engine or change the points of cut off by means of a pinion 71 engaging teeth on the periphery of the plate. The top of the body 10 is closed by a cover-plate 73. By this arrangement the entire mechanism, including all of the valve-gear, is inclosed, so that there is no opportunity whatever for dust to get into the working parts. The body 10 may be filled with oil, which oil being entirely protected from the air will be sufficient to supply the engine for a long period. For this reason there is no need for the operator to expose any of the moving parts of the engine for oiling or adjustment.

I claim as my invention—

1. In an engine, the combination of a box-like body, a crank-shaft extending therethrough, a pair of high-pressure cylinders, a pair of low-pressure cylinders, two of said cylinders being arranged upon each side of the crank-shaft and secured to said body, pistons mounted in said cylinders, connections between said pistons and crank-shaft, valves for controlling the passage of the motive fluid to and from said cylinders, valve-gear mounted inside of the body and connected to said valves, and means for closing said body so as to inclose the working parts of the engine.

2. In an engine, the combination with a high-pressure cylinder and a low-pressure cylinder, of a valve-chamber, a communication between said valve-chamber and the high-pressure cylinder, a second valve-chamber, a communication between said second valve-chamber and the low-pressure cylinder, a third valve-chamber, a communication between said first and third valve-chambers, a pair of passages independently connecting different points of the second and third valve-chambers, an exhaust-passage connecting with one of said pair of passages, a steam-inlet leading into the first and third chambers, a pair of valves mounted in the first and second chambers and adapted to open and close the passages leading into the high-pressure and low-pressure cylinders respectively, a valve mounted in the third valve-chamber and adapted to be shifted so as to open communication between the steam-inlet and one of the passages leading to the second valve-chamber and to simultaneously open the passage between the first valve-chamber and the exhaust-passage or to close the steam-inlet into the third chamber and simultaneously open communication between the first valve-chamber and the passage leading to the second valve-chamber through the third valve-chamber.

3. In an engine, the combination with a high-pressure cylinder, and a low-pressure cylinder, of a valve-chamber formed adjacent the high-pressure cylinder, a second valve-chamber formed adjacent the low-pressure cylinder, a by-pass leading from one point of said second chamber to another, a third valve-chamber, a by-pass leading from one point of said third chamber to another, a passage forming a connection between said by-passes, an exhaust-passage connecting the second and third valve-chambers independent of the by-passes, a passage connecting the first valve-chamber and the high-pressure cylinder, a passage connecting the second valve-chamber and the low-pressure cylinder, a steam-inlet communicating with the first and third valve-chambers, and valves mounted in said three chambers, substantially as and for the purpose set forth.

4. In an engine, the combination with a high-pressure cylinder and a low-pressure cylinder, of a valve-chamber formed adjacent the high-pressure cylinder, a second valve-chamber formed adjacent the low-pressure cylinder, a by-pass leading from one point of said second chamber to another, a third valve-chamber, a by-pass leading from one point of said third chamber to another, a connector

adapted to be secured to said second and third chambers, an exhaust-passage forming through said connector a connection between said second and third chambers, a second passage formed through said connector and arranged to connect the by-passes, a passage connecting the first valve-chamber and the high-pressure cylinder, a passage connecting the second valve-chamber and a low-pressure cylinder, a steam-inlet connecting with the first and third valve-chambers, and valves mounted in said three chambers, substantially as and for the purpose set forth.

5. In an engine, the combination with a crank-shaft having a pair of cranks one arranged in advance of the other, of a pair of high-pressure cylinders having their pistons connected to one of the cranks, a pair of low-pressure cylinders having their pistons connected to the other crank, suitable valves for each cylinder, suitable valve-gear for operating the valves, and a passage leading from each high-pressure cylinder to both low-pressure cylinders.

6. In an engine, the combination with a crank-shaft having a series of cranks arranged in different phases, of a pair of high-pressure cylinders each having its piston connected to a crank, a pair of low-pressure cylinders each having its piston connected to a crank of a phase different from the high-pressure crank, suitable valves for each cylinder, suitable valve-gear for operating said valves, and a passage leading from each high-pressure cylinder to both low-pressure cylinders.

7. In an engine, the combination with a crank-shaft having a pair of cranks one arranged in advance of the other, of a pair of single-acting high-pressure cylinders having their pistons connected to one of the cranks, a pair of single-acting low-pressure cylinders having their pistons connected to the other crank, a passage leading from each high-pressure cylinder to both low-pressure cylinders, suitable valves for each cylinder arranged in said passages, and suitable valve-gear for operating the valves.

8. In an engine, the combination with a crank-shaft having a pair of cranks, of a pair of opposed single-acting high-pressure cylinders, connections between the pistons thereof and one of the cranks, a pair of opposed low-pressure cylinders, connections between the pistons thereof and the other crank, a combined inlet and exhaust port communicating with each cylinder, a series of valves one for each of said ports, a reversing valve-gear connected to said valves, a suitable valve-chamber for each valve, a passage forming a communication between each high-pressure valve-chamber and one of the low-pressure valve-chambers, and a passage forming a communication between said passages, whereby the exhaust from the high-pressure cylinder may pass into either of the low-pressure cylinders.

9. In an engine, the combination of a crank-shaft and the crank thereof, a pair of oppositely-arranged single-acting cylinders and pistons therein, a pair of connecting-rods each attached to a piston, a segmental socket formed in the crank end of each connecting-rod and adapted to receive the wrist-pin whereby each rod may have a limited swing upon the wrist-pin with relation to the others, a pair of oppositely-extending segmental flanges carried by one of the connecting-rods concentric with its socket, and a yoke having its ends attached to the other connecting-rod and its middle encircling the said flanges.

10. In an engine, a single-acting piston therein consisting of a head having a chamber formed therein, an insulating material placed in said chamber, and a peripheral groove formed in said piston between the chamber and the connecting-rod connection.

11. In an engine, a single-acting piston consisting of a head having a chamber formed therein, an insulating material packed in said chamber, a pair of lugs projecting from the rear wall of said head, a pin mounted in said lugs, a connecting-rod carried by said pin between the lugs, a supplemental head secured upon said lugs, and means for maintaining the forward end of the supplemental head some distance from the rear wall of the chambered head so as to form a peripheral insulating-groove between the chambered head and the supplemental head.

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