

No. 654,759.

Patented July 31, 1900.

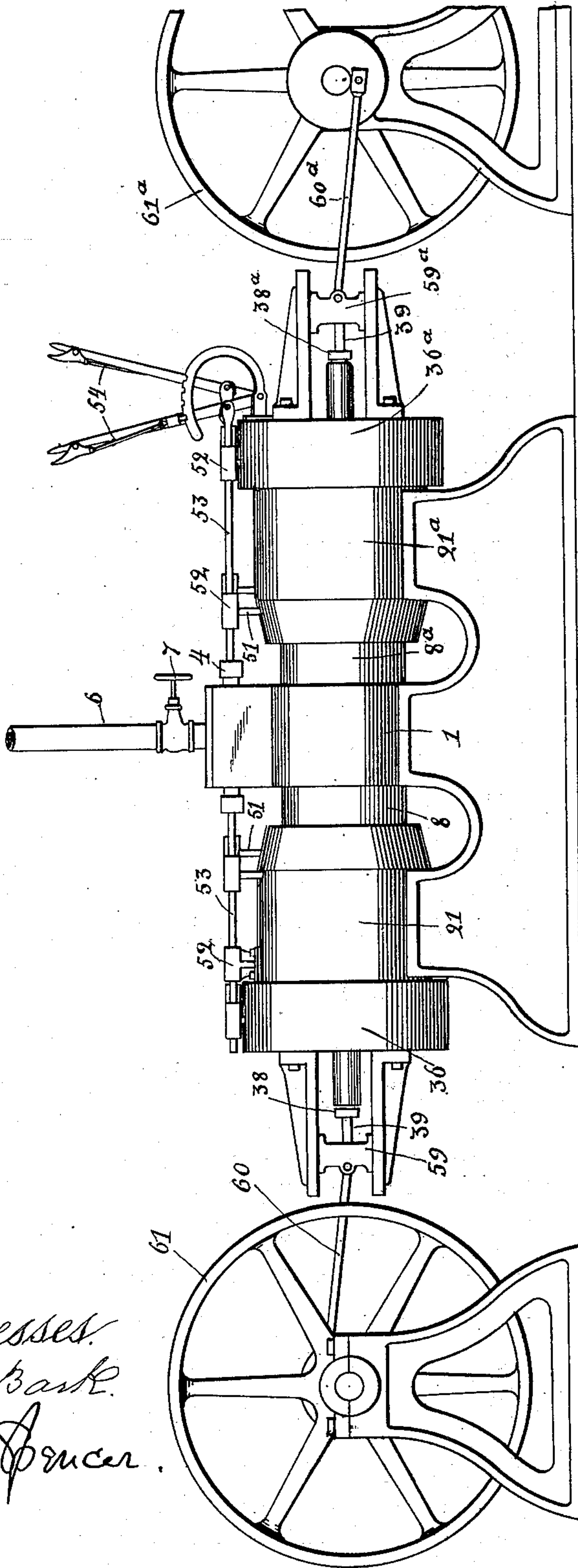
J. B. O'DONNELL.
DUPLEX STEAM ENGINE.

(Application filed Sept. 22, 1899.)

(No Model.)

3 Sheets—Sheet 1.

Fig. 1.



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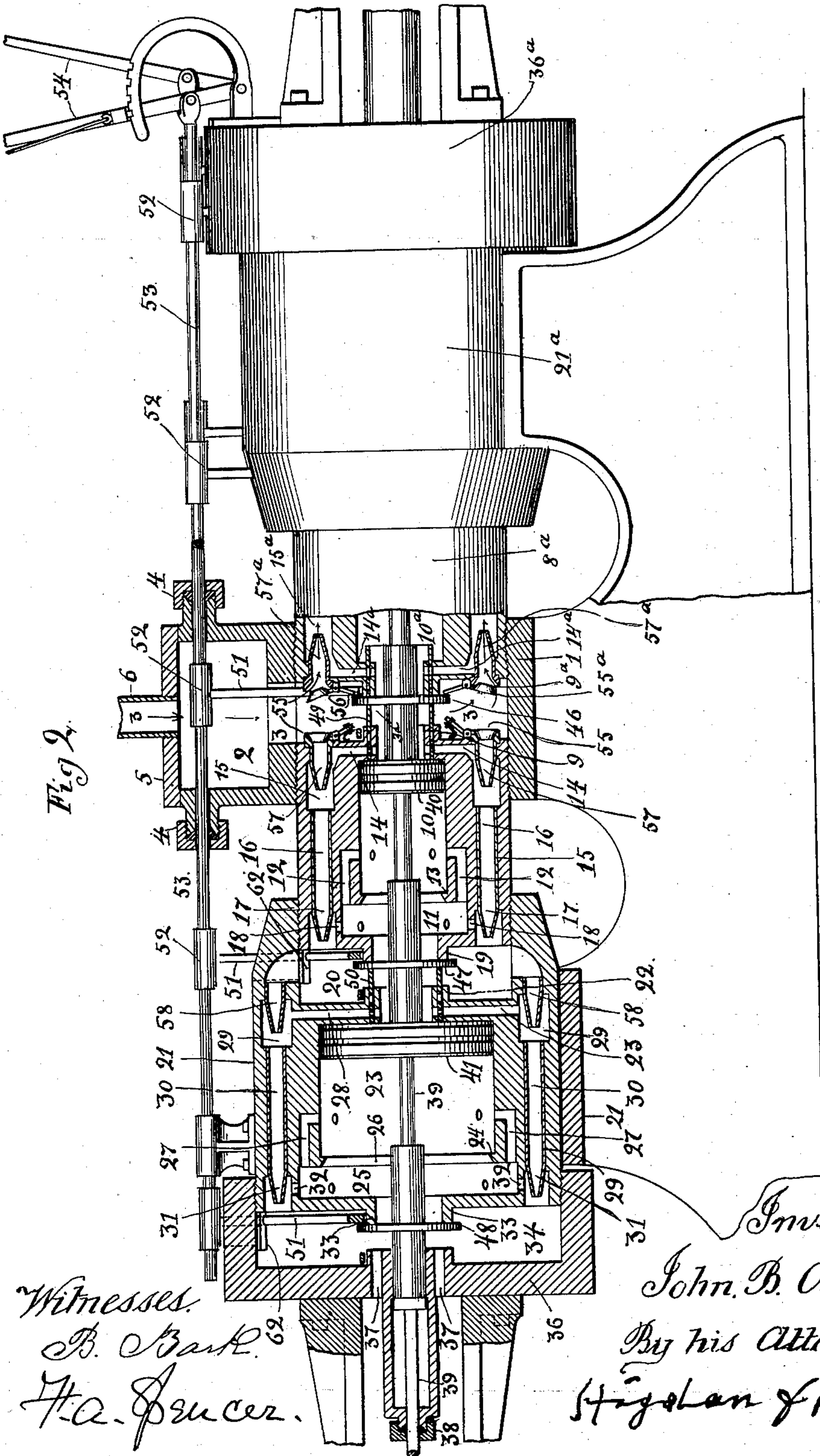
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3 Sheets—Sheet 2.

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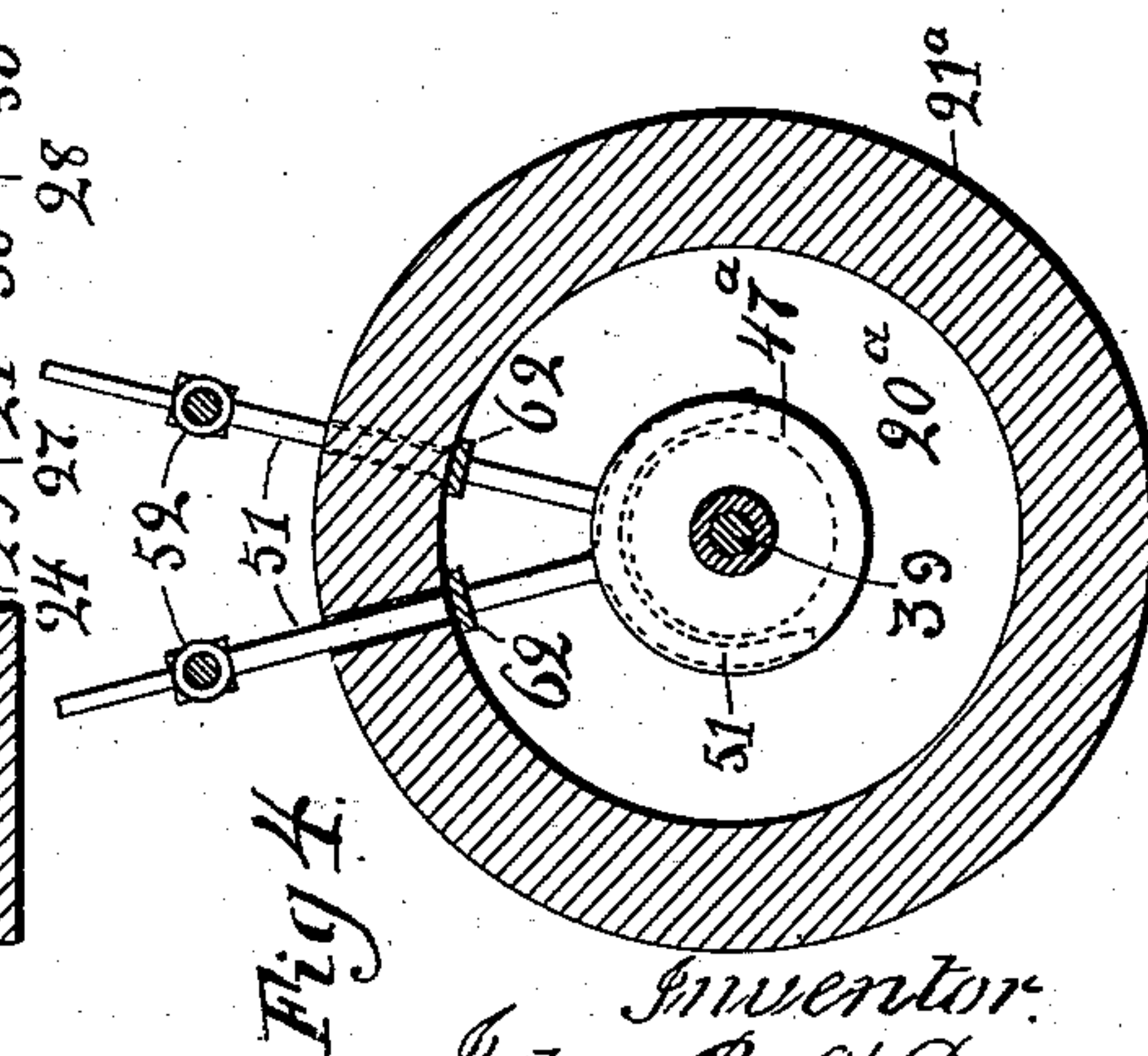
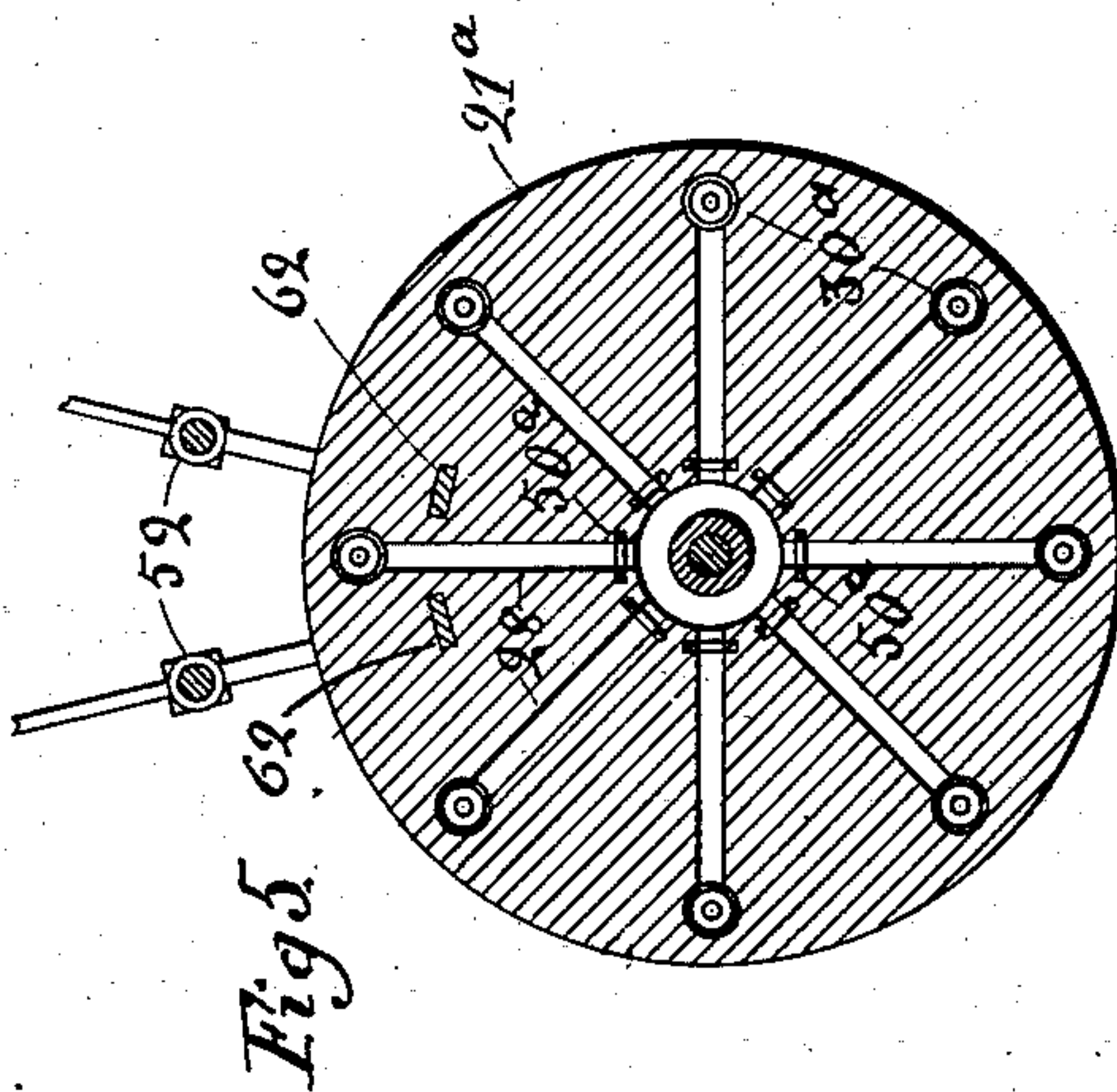
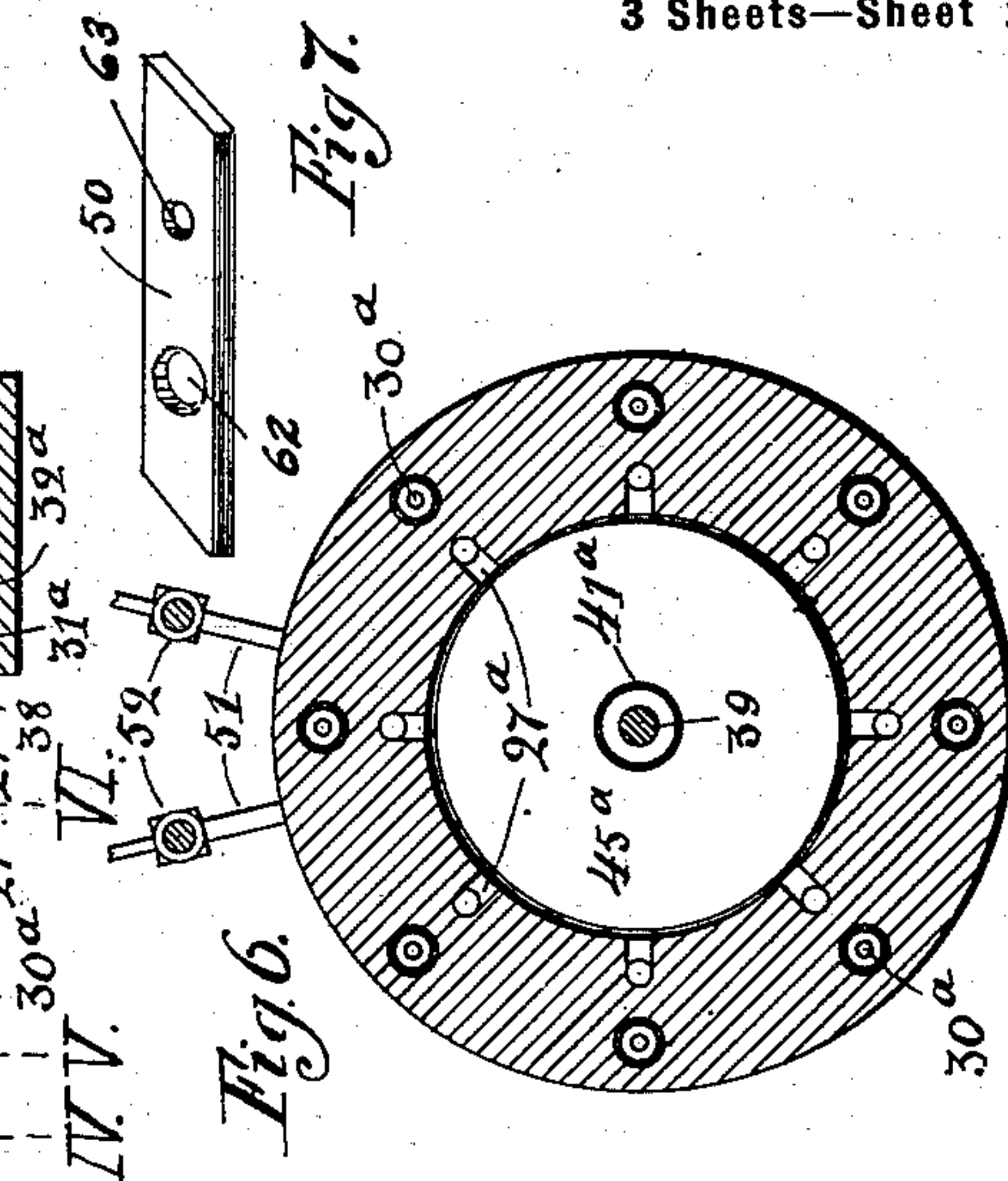
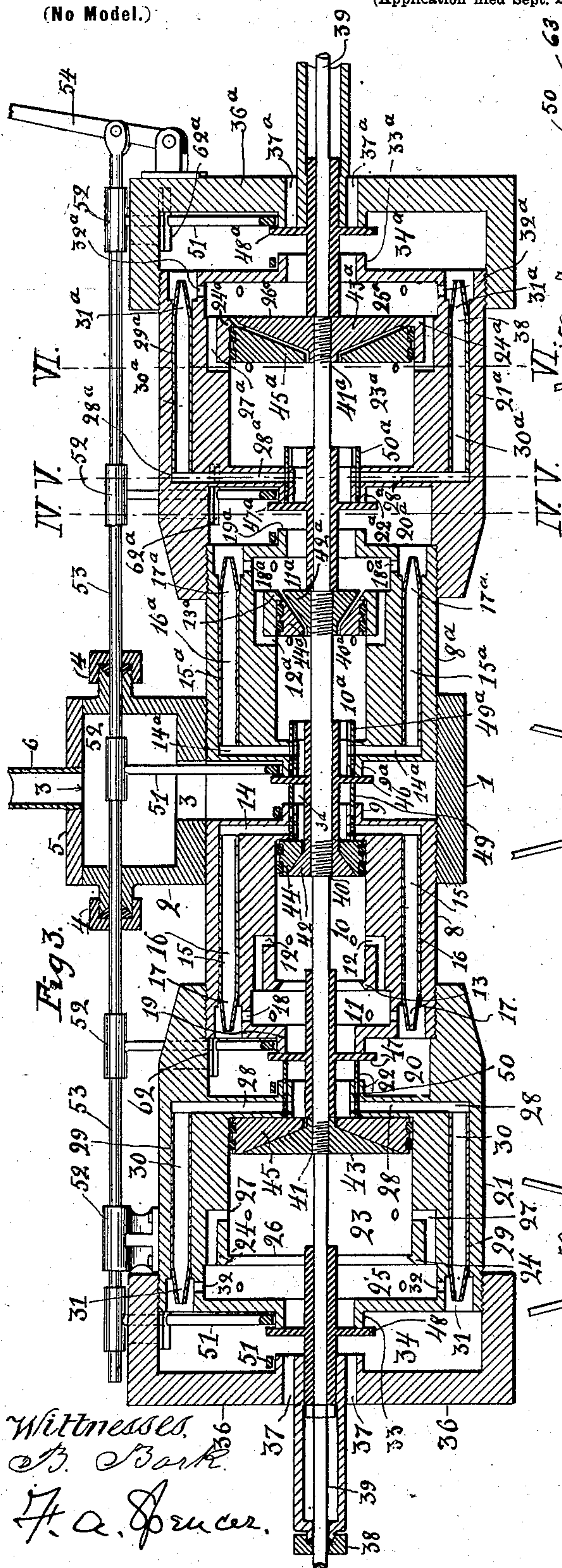
J. B. O'DONNELL.

DUPLEX STEAM ENGINE.

(Application filed Sept. 22, 1899.)

3 Sheets—Sheet 3.

(No Model.)



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UNITED STATES PATENT OFFICE.

JOHN B. O'DONNELL, OF LEE'S SUMMIT, MISSOURI.

DUPLEX STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 654,759, dated July 31, 1900.

Application filed September 22, 1899. Serial No. 731,275. (No model.)

To all whom it may concern:

Be it known that I, JOHN B. O'DONNELL, a citizen of the United States, residing at Lee's Summit, in the county of Jackson and State of Missouri, have invented a new and useful Improvement in Duplex Steam-Engines; and I 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 duplex steam-engines; and my object is to produce an engine of the type having a plurality of cylinders disposed end to end, duplicated on opposite sides of the machine, and operated by a common piston-rod. I aim to obtain the maximum amount of power at the minimum cost, this result being effected by the repeated use of the steam and the reinforcement of partially-expanded steam by live steam, thus securing a constant and equal pressure in all the cylinders simultaneously.

My invention also relates to providing means for creating an exhaust from in front of the pistons by passing currents of live steam around the cylinders, projecting the same through contracted nozzles into steam-spaces at the outer ends of said cylinders, thereby also supplying live steam to the outer cylinders during the direct stroke and, in the preferred form of my engine, to all the cylinders during the return stroke, a system of reciprocating valves mounted on the piston-rod being also provided for controlling the course of the steam, deflecting it to the live side of the pistons, and excluding it, in coöperation with the blast from said nozzles, from the exhaust side.

In the accompanying drawings, Figure 1 represents a side elevation of an engine constructed in accordance with my invention. Fig. 2 is an enlarged vertical longitudinal section of one half of the same, the other half being an elevation. Fig. 3 is a vertical longitudinal section of a modified form, showing both ends of the machine. Fig. 4 is a cross-section taken on the line IV IV of Fig. 3. Fig. 5 is a cross-section taken on the line V V of Fig. 3. Fig. 6 is a cross-section taken on the line VI VI of Fig. 3. Fig. 7 is a detached view of one of the slide-valve bars controlling

the radial ports leading from the steam-entrances of the cylinders.

In constructing my engine I employ a centrally-located casting 1, provided at its upper portion with a steam-chest 2, having a port 3, leading to a central admission-chamber 3^a. Said steam-chest is also provided at its opposite ends with stuffing-boxes 4 and closed by a removable top plate 5, bored and threaded to receive the induction-pipe 6, through which the steam-supply is admitted and controlled by a throttle-valve 7. The opposite ends of the casting 1 are internally threaded to receive the externally-threaded ends of castings 8 8^a, respectively, the adjacent ends of which are provided with tubular bosses or shoulders 9 9^a, of small bore, communicating with the primary cylinders 10 10^a, in which the pistons 40 40^a operate. Said cylinders also communicate with larger circular chambers 11 11^a, and the walls of said cylinders 10 10^a also have a series of small right-angled passages 12 12^a, affording communication between said cylinders 10 10^a and chambers 11 11^a, respectively. 13 13^a indicate inwardly-projecting annular flanges formed integral with the walls of the cylinders between chambers 10 10^a and 11 11^a. Castings 8 8^a are also provided with a series of radial steam-ports 14 14^a, communicating at their inner ends with the tubular opening through bosses 9 9^a and at their opposite ends with longitudinal steam-passages 15 15^a, enlarged at their outer ends and fitted with tubes 16 16^a, terminating in nozzles 17 17^a within the enlarged portions of passages 15 15^a. As shown in Fig. 2, means are provided for admitting live steam into the tubes 16 direct from the adjoining admission-chamber 3^a during the return stroke of the pistons without passing it through the radial passages 14 14^a. For this purpose a series of openings is provided between the steam entrance 3^a and passages 15 15^a, in which openings are pivotally-mounted valves 55 55^a, having projecting spring-pressed arms 56 56^a extending into the path of the central sliding disk 46. Also in said Fig. 2 two sets of steam-pipes and nozzles are shown instead of one in each of the passages 15 15^a, the operation of which will be described. Chambers 11 11^a are also provided with a series of radially-

extending ports 18 18^a, leading from said chambers to the enlarged portions of passage-ways 15 15^a. Said ports 18 18^a are equal in number to the nozzles 17 17^a, and are approximately at right angles to and in the same radial planes with said nozzles, the latter projecting outward slightly beyond the orifices of said ports, and being so related thereto that a blast of steam issuing from said nozzles will produce a suction or exhaust outwardly through said ports from cylinders 10 10^a and steam-spaces 11 11^a. Castings 8 8^a terminate at their outer ends in bosses 19 19^a, bored to provide passage for the rod and communication between chambers 11 11^a and chambers 20 20^a, formed in the adjoining castings 21 21^a, attached endwise to castings 8 8^a by screw-threads. Castings 21 21^a are larger in diameter than 8 8^a and contain steam-chambers of greater capacity.

22 22^a designate projecting bosses or shoulders, bored to provide passage for the rod and to provide in the steam-space around the rod communication with the secondary cylinders 23 23^a, provided at their opposite ends with annular flanges 24 24^a, formed integral with the walls of the cylinders. Said cylinders also communicate endwise with chambers 25 25^a of larger diameter through openings 26 26^a, and have further communication with said chambers by means of right-angled passage-ways 27 27^a.

28 28^a indicate radial passage-ways, a series of which extend from the tubular bores of bosses 22 22^a and communicate at their outer ends with longitudinal passage-ways 29 29^a, enlarged at their further ends, where they terminate at the ends of the castings. As shown in Fig. 2, said passage-ways 29 29^a are also enlarged at their inner ends, where they communicate by means of openings in the inner wall of casting 21 directly with steam-chambers 20, in which openings are placed short tubes terminating in nozzles 58, projecting outwardly slightly beyond the orifices of passage-ways 28 and in radial alinement therewith. In the engine as shown in Fig. 3 said nozzles 58 are omitted. Said passage-ways 29 29^a are provided with tightly-fitting tubes 30 30^a, terminating at their outer ends in nozzles 31 31^a, which project into the enlarged terminals of passage-ways 29 29^a. 32 32^a are radially-extending ports leading from chambers 25 25^a to the enlarged terminals of passage-ways 30 30^a. Said ports 32 32^a have the same position relatively to nozzles 31 31^a that ports 18 18^a have to nozzles 17 17^a, as before described, the object in both cases being, in part, to effect by means of a blast of steam from said nozzles an exhaust action through said ports from the steam-spaces with which they communicate.

Castings 21 21^a terminate in bosses or shoulders 33 33^a, bored to provide passage for the rod and also in the space around the rod communication between chambers 25 25^a and cir-

cular chambers 34 34^a of still larger diameter formed in the end castings or caps 36 36^a, attached to castings 21 21^a by screw-threads. Said caps 36 36^a have exhaust-ports 37 37^a and are also provided with outwardly-projecting stuffing-boxes 38 38^a, through which operate the opposite ends of the piston-rod 39, which extends through all the cylinders from end to end of the machine. Rigidly mounted upon said piston-rod are a plurality of piston-heads 40 40^a 41 41^a, respectively, which fit into the above-mentioned cylinders and have the customary packing-rings to prevent the escape of steam. Said piston-heads consist of conical-shaped parts 42 42^a 43 43^a, rigidly secured to the piston-rod and other annular members 44 44^a 45 45^a, which are loosely mounted upon the conical parts, conical recesses in the rings fitting the surfaces of said parts.

Slidably mounted on the piston-rod within the admission-chamber 3^a and steam-spaces 20 20^a and 34 34^a are a series of tappet-valves 46, 47 47^a, and 48 48^a, which alternately open and close the tubular openings leading to and from the adjacent cylinders. Each of said valves consists of a tubular sleeve portion mounted slidably on the rod and a circular disk portion preferably integral with the sleeve and extending outward radially therefrom somewhat beyond the openings leading to or from the cylinders or steam-spaces. The sleeves of these valves extend into the adjacent cylinders and steam-spaces far enough to contact with the piston-heads at the end of their strokes, either forward or return, and so make the disks alternately open and close the entrances of the cylinders and control the direction of the steam.

The admission of steam to radial passages 14 14^a 28 28^a is controlled by slide-valves 49 49^a 50 50^a, Figs. 5 and 7. Said valves consist of a series of flat bars, rectangular in cross-section, slidably mounted in correspondingly-shaped longitudinal passages in the shoulders of the castings near to and parallel with the rod and crossing the radial steam-passages 14 14^a 28 28^a. Said bars or valves are provided each with two circular openings, one, 62, of the full size of the radial passages which they cross, so as to register therewith, and the other, 63, of lesser size, so as to partially close said passages. Said longitudinal passages extend through the castings from the respective cylinders to the adjoining steam-chambers. These bars are projected alternately into the cylinders and said chambers, being actuated in one direction by contact with the piston-heads on the return stroke and in the other by contact with the tappet-disks on the outward stroke. Said slide-bars and the openings therein are so arranged that the small openings 63 therein will register with the radial passages 14 28, &c., during the direct stroke and the larger openings 62 during the return stroke, as hereinafter explained.

51 indicates bifurcated arms which straddle

the bosses on the adjacent ends of the cylinders and extend upwardly to integral sleeve portions 52, rigidly secured to longitudinal rods 53, which pass through the steam-chest and are operated by levers 54, pivotally connected to caps 36^a. The forks of said arms contact with the tappet-disks, as in Fig. 4, so that the engine may be reversed by the manipulation of the lever 54. There are two sets of these arms, operated by separate rods and levers, as shown in Fig. 1, for reversing the engine in either direction. Said arms reciprocate in slots in the casing, the escape of steam through said slots being prevented by plates 62, which surround said arms and press against the inner surfaces of the chambers into which the arms extend.

The operation is substantially as follows: As shown in Figs. 2 and 3, steam enters at port 3 and passes through the admission-chamber 3^a into the cylinder 10 on the left side in said figures. The piston moves outwardly in the cylinder until it passes the openings of the radial passages 12, through which steam from behind the head is then free to pass. When the piston-head nears the end of its stroke, the edge of the annular portion 44 thereof contacts with the flange 13, stopping the movement of said annular portion, while the conical portion being fixed on the rod continues to the end of the stroke, thus opening passage-ways between the two parts of the piston-head, through which steam passes outwardly into space 11 beyond said cylinder. Similar action occurs simultaneously in the secondary cylinder 23, the live-steam supply for said cylinder passing through the small holes in slide-valves 49 into radial ports 14 through pipes 16 and out of nozzles 17 into chamber 20 and thence into cylinder 23. The action of the piston-head in said cylinder is the same as that in cylinder 10, the construction of the two cylinders and related parts being substantially identical. Also during the direct stroke a portion of live steam passes through the small holes in slide-valves 50, radial passages 28, tubes 30, and out of nozzles 31 into steam-space 34. The effect of the blast of steam from nozzles 17 and 31 is to create a strong suction out of the adjacent radial ports 18 and 32 and the steam-spaces with which they communicate, drawing out all exhaust-steam and tending to create a vacuum and so lessening resistance to the outward stroke of the pistons. It will be noted that the tappet-valves 46 47 48 cover the outer ends of the cylinders during the direct stroke and that this condition is essential to the described action of the nozzles. It will also be observed that all exhaust-steam forced or drawn out of the cylinders and connected steam-spaces during the direct stroke is immediately mixed with live steam issuing from the nozzles, thereby becoming regenerated, so that at the end of the direct stroke the steam which has passed through or around the cylinders has almost its original expan-

sive force. As the pistons in cylinders 10 23 near the end of their direct stroke they contact with the sleeves of the tappet-valves 47 48 and move them over, so as to close the exhaust 37 and the inner end of cylinder 23 and uncover the outer ends of cylinders 10 23. The inner end of cylinder 10 is covered in a similar manner by valve 46 being moved over against it by the return stroke of the piston in cylinder 10^a on the opposite side of the engine. The return stroke in the engine as constructed in Fig. 3 is effected by the live steam which has been passed around the pistons through the radial passages 14 28, tubes 16 30, &c., and mixed with partially-expanded steam in the steam-spaces beyond the cylinders. Under my construction this steam has sufficient expansive force to effect the return stroke without aid from the direct stroke on the other side of the engine. As shown in Fig. 2, however, live steam is supplied to the cylinders and spaces beyond them during the return as well as the direct stroke through the valves 55, nozzles 58, &c., making the pressure during the back stroke equal to that in the forward stroke. This is true as to all the cylinders. Said valves 55 are opened for the admission of steam by contact of the sliding tappet-valve disk 46, which is moved over at the end of the direct stroke on that side of the engine. At the beginning of the return stroke the two parts of the piston-heads are first forced together, closing the passages between them. As the heads near the end of the return stroke they actuate the slide-valve bars 50, making their small holes register with the radial passages 14 28, &c., ready for the entrance of steam on the next stroke. They also actuate the tappet-valves 46 47, &c., moving them over to cover the entrances to the opposite cylinders. These valves also are affected by the suction of the nozzles 17 31 57 58, which would throw the disks over without the contact with the piston-heads, but the latter insures uniformity of action. During the return stroke in the construction shown in Fig. 2 live steam is continually passing through nozzles 57, tubes 16, and nozzles 17, 58, and 31 and acting on the outer side of the pistons. Nozzles 17 and 31 have no exhaust action during the return stroke for the reason that the outer ends of cylinders 10 23 are not at that time covered by the tappet-valves 47 48; but nozzles 57 58, Fig. 2, have exhaust action at this time withdrawing exhaust-steam, &c., from in front of the returning pistons through radial passages 14 28, &c., as will be readily understood. It will be noted that the operation of the engine is largely effected by the employment of the suction from these nozzles during both the direct and return strokes, which suction tends to produce a vacuum in front of the pistons and so lessens resistance.

The sliding valve-bars 49 49^a 50 50^a have, as stated, their small ports 63 registering with radial passages 14 28, &c., during the direct

stroke and their larger ports 62 registering therewith during the return stroke, the object being to limit the amount of live steam passing through said radial passages during the direct stroke to what is necessary for producing by means of the nozzles the described exhaust action out of the cylinders and in the case of the slide-valves controlling passages 14 14^a to supply live steam for operating the outer cylinders 23 23^a. On the other hand, during the return stroke it is desirable that passages 14 28, &c., should be fully open to permit exhaust-steam from the cylinders to pass out through said passages. If desired, the nozzles 58 may be fitted with valves 55 in the same manner as nozzles 57, so that no steam will pass through nozzles 58 except during the return stroke. Such valves would be operated by the tappet-disks 47, as will be readily understood. While a small portion of live steam mixed with exhaust passes out of exhaust-ports 37 37^a during each direct stroke, the amount thus lost is not sufficient to impair the efficiency of the engine, the amount of steam allowed to pass through radial ports 28 28^a not being over one per cent.

It is of course understood that the parts duplicated at the opposite end of the engine act alternately with those described.

The outer ends of the piston-rod are secured to cross-heads 59, attached to connecting-rods 60 and fly-wheels 61 in the usual manner.

My engine is to be distinguished from the ordinary type of compound engines in which steam is first used under high pressure in a small cylinder and afterward used expansively in a larger cylinder. In my machine the steam is used expansively, but only after being mixed with live steam admitted to the inner steam-spaces through the longitudinal passages surrounding the cylinders, so that an equality of pressure is preserved during the direct and return strokes without reference to the comparative size of the cylinders.

While duplicate sets of cylinders are shown, it is obvious that said cylinders may be arranged in any multiple desired. On the other hand, the engine would still be operative if all outer cylinders were removed, leaving only the primary cylinders 10 10^a with the end caps 36 36^a, reduced in size, attached directly to them.

I claim as my invention and desire to secure by Letters Patent—

1. In a duplex engine having a pair of cylinders disposed end to end and operated alternately by a common piston-rod, and pistons on said rod, a steam-entrance, a central admission-chamber into which both cylinders open, two outer steam-chambers in the casing beyond each of said cylinders and opening into each other centrally, radial ports for exhaust-steam leading from said cylinders to the first of said outer steam-chambers, radial ports leading from the entrances of said cylinders, longitudinal passages connecting with

said radial ports and leading into the second outer steam-chamber, reciprocating slide-valves mounted in the casings, transverse to said radial ports and having openings registering therewith, nozzles in the outer ends of said longitudinal passages, radial ports leading from the first outer steam-chamber and opening into said longitudinal passages immediately behind the orifices of said nozzles, tappet-valves slidably mounted on the piston-rod, and extending radially therefrom, within said central steam-chamber and the second outer steam-chambers, and adapted to alternately open and close the entrances to the cylinders and the openings connecting said outer chambers, and exhaust-ports in said second outer chambers, substantially as set forth.

2. In a duplex steam-engine, the combination of a pair of cylinders disposed end to end, open at their outer ends and operated by a common piston-rod, divisible pistons on said rod, consisting of conical portions, fixed to the rod, and annular portions surrounding said conical portions and separable therefrom, inwardly-projecting flanges at the head ends of the cylinders, against which said annular portions impinge, to divide the piston-head at the end of the direct stroke, a steam-entrance, a central admission-chamber into which both cylinders open, two outer steam-chambers in the casing, beyond each of said cylinders, opening into each other centrally, radial ports leading from the entrances of said cylinders, longitudinal passages connecting with said radial ports and leading into the second outer steam-chambers, reciprocating slide-valves mounted in the casings transverse to said radial ports and having openings registering therewith, nozzles in the outer ends of said longitudinal passages, radial ports leading from the first outer steam-chamber and opening into said longitudinal passages immediately behind the orifices of said nozzles, tappet-valves slidably mounted on the piston-rod and extending radially therefrom, within said central steam-chamber and the second outer steam-chambers, and adapted to alternately open and close the entrances to the cylinders and the openings connecting said outer chambers, and exhaust-ports in said second outer chambers, substantially as set forth.

3. In a duplex engine the combination of a pair of cylinders disposed end to end, and operated by a common piston-rod, pistons on said rod, a central admission-chamber between said cylinders and connecting therewith, two outer steam-chambers at the head of each cylinder, communicating with each other by central openings through which the rod passes, exhaust-ports in the outermost of said chambers, means for passing expanded steam around or through the pistons into the first of said outer chambers at the end of the direct stroke, tappet-valves slidably mounted on the rod within the admission-chamber and

the second outer chamber, adapted to alternately open and close the entrances to the cylinders and the openings between said outer chambers, valve-rods mounted on the casing and having arms extending through the same into the path of said tappet-valves, for reversing the engine, valve-controlled radial and longitudinal steam-passages leading around the cylinders, from the entrances thereto to said second outer chambers, said longitudinal passages terminating in nozzles adapted to produce a blast to draw expanded steam from the cylinders and first outer chambers, and project it into said second outer chambers substantially as set forth.

4. In a duplex steam-engine, the combination of a pair of cylinders axially in line, open at both ends and operated by a common piston-rod, pistons on said rod, a central admission-chamber between said cylinders and connecting therewith, two outer steam-chambers, concentric with the rod, at the head of each cylinder, and connecting with each other by central openings through which the rod passes, exhaust-ports in the outermost chambers, means for passing expanded steam around or through the pistons at the end of the direct stroke, tappet-valves slidably mounted on the rod within the admission-chamber and the second outer chambers, adapted to alternately open and close the entrances to the cylinders and the openings between said outer chambers, radial ports leading from said entrances and connecting with longitudinal passages opening into said outer chambers, slide-valves reciprocating transversely across said radial ports and having openings registering therewith to regulate the admission of steam to said ports, openings in the inner walls of the cylinder-casings, between the admission-chamber and said longitudinal passages, in alinement with said passages, nozzles fitted in said openings and projecting into said passages beyond said radial ports, valves for admitting steam to said nozzles and means for opening said valves during the return stroke, other nozzles in the outer ends of said longitudinal passages, radial ports opening from the first outer steam-chambers into said longitudinal passages, behind the orifices of said last-mentioned nozzles, whereby live steam is supplied to the cylinders during the return stroke, and expanded steam drawn out of the path of the pistons during both the return and direct strokes, substantially as set forth.

5. In a duplex engine, the combination of a central steam-entrance, a central admission-chamber, a plurality of cylinders on each side said chamber, all said cylinders being arranged axially in line and operated by a common piston-rod, and having openings at each end, through which the rod passes, the outer cylinders being of greater capacity than the inner cylinders, pistons on the rod in each of said cylinders, means for passing expanded steam around or through said pistons at the

end of the direct stroke, two outer steam-chambers in the casing, at the head end of each cylinder, connected by central openings through which the rod passes, exhaust-ports in the outermost chambers at each end of the engine, radial ports leading from the entrances of said cylinders, longitudinal passages connecting with said radial ports and leading into the second outer steam-chambers, nozzles in the outer ends of said longitudinal passages, radial ports leading from the first outer steam-chamber adjacent to each cylinder and opening into said longitudinal passages immediately behind the orifices of said nozzles, tappet-valves slidably mounted on the piston-rod and extending radially therefrom, within said admission-chamber and the second outer steam-chambers, adapted to alternately open and close the entrances to the cylinders and the openings connecting said outer chambers, substantially as set forth.

6. In a duplex engine, the combination of a central steam-entrance, a central admission-chamber, a plurality of cylinders on each side said chamber, all said cylinders being arranged axially in line and operated by a common piston-rod, and having openings at each end, through which the rod passes, pistons on the rod in each of said cylinders, means for passing expanded steam around or through said pistons at the end of the direct stroke, two outer steam-chambers in the casing at the head of each cylinder, connected by central openings, through which the rod passes, exhaust-ports in the outermost of said chambers, at each end of the engine, tappet-valves slidably mounted on the rod, within the admission-chamber and the second outer chambers, adapted to alternately open and close the entrances to the cylinders and the openings between said outer chambers, radial ports leading from said entrances and connecting with longitudinal passages opening into said outer chambers, openings in the inner walls of the cylinder-casings, in alinement with said passages, nozzles fitted in said openings and projecting into said passages beyond said radial ports, valves for admitting steam to said nozzles during the return stroke, and means for operating said valves, other nozzles in the outer ends of said longitudinal passages, radial ports opening from the first outer steam-chambers into said longitudinal passages behind the orifices of said last-mentioned nozzles, whereby live steam is supplied to the cylinders during the return stroke, and expanded steam drawn out of the path of the pistons during both the return and direct strokes, substantially as set forth.

In testimony whereof I affix my signature in the presence of two witnesses.

JOHN B. O'DONNELL.

Witnesses:

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M. L. LANGE.