

(No Model.)

2 Sheets—Sheet 1.

H. A. HOUSE.  
STEAM TURBINE.

No. 571,861.

Patented Nov. 24, 1896.

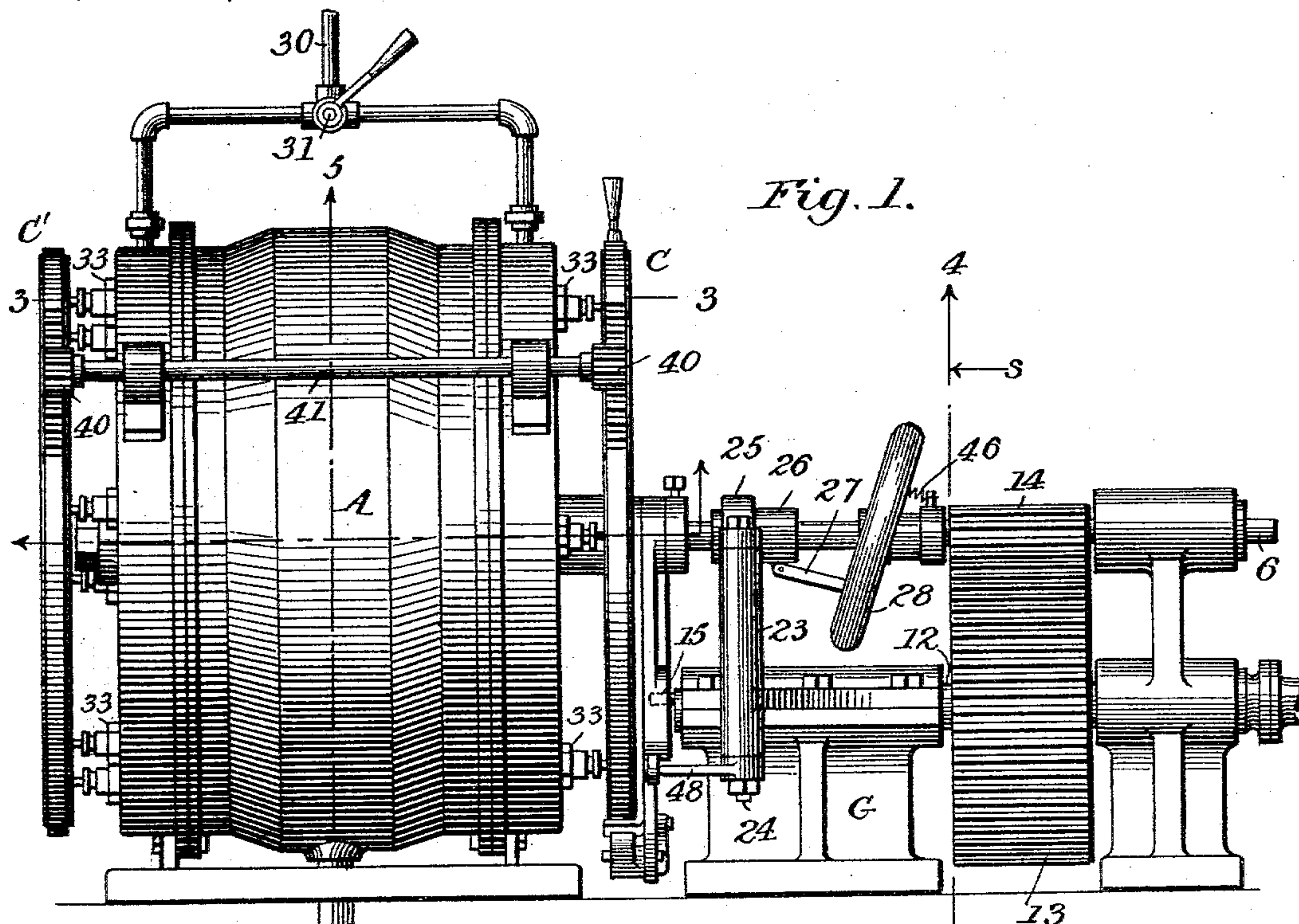


Fig. 1.

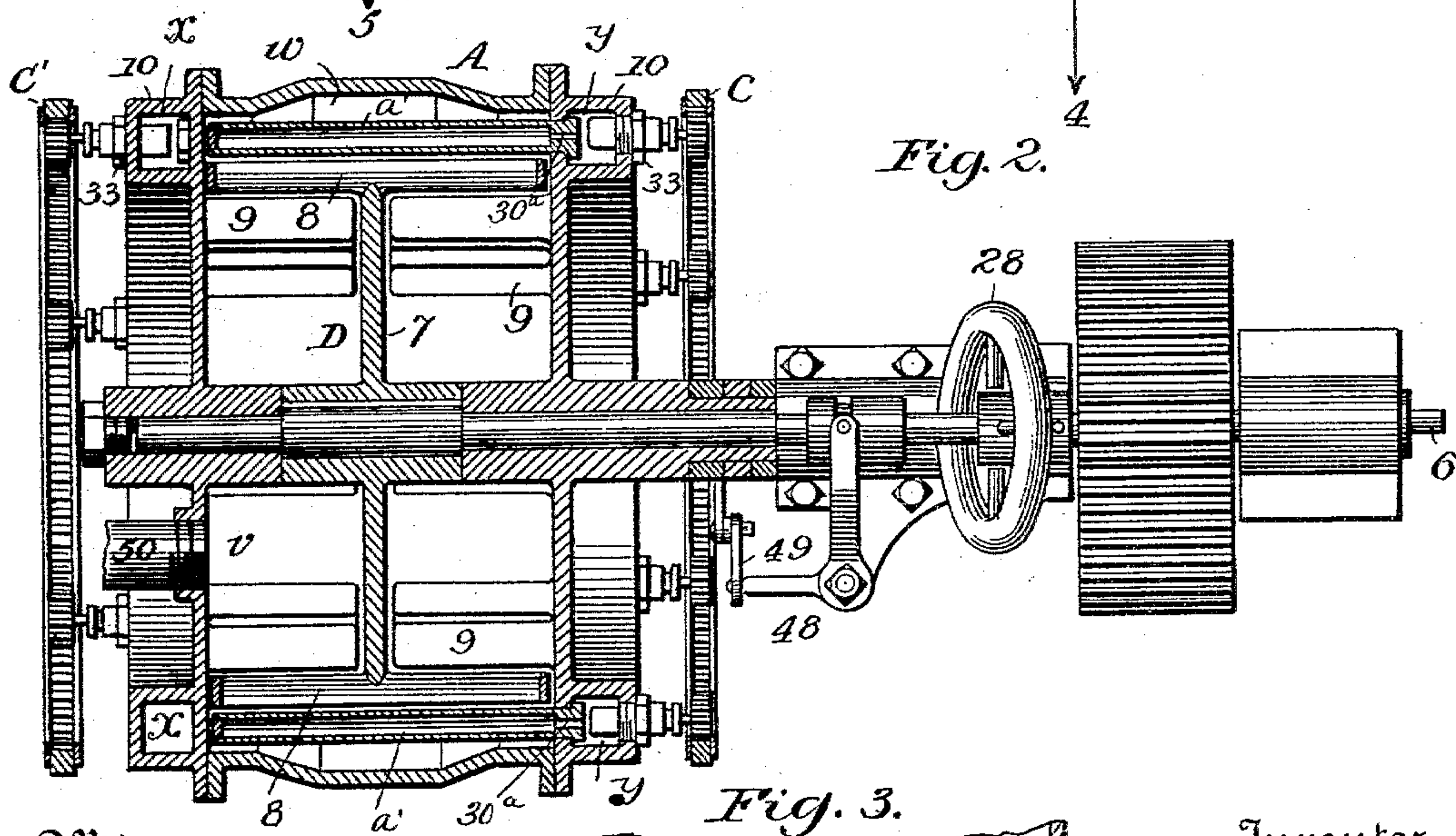


Fig. 2.

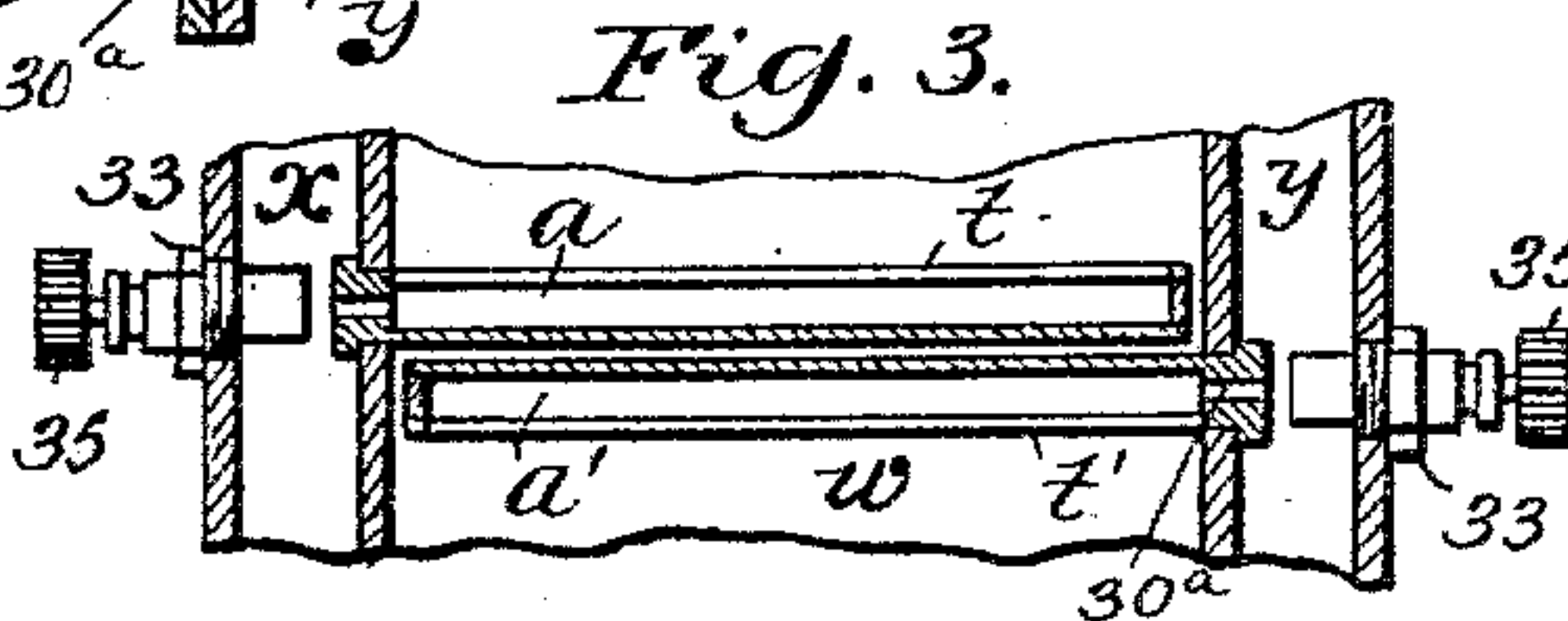


Fig. 3.

Witnesses  
*Jno. G. Hinkel*  
*J. A. Fairgrieve*

Inventor  
*Henry A. House*  
*John J. House*  
Attorneys



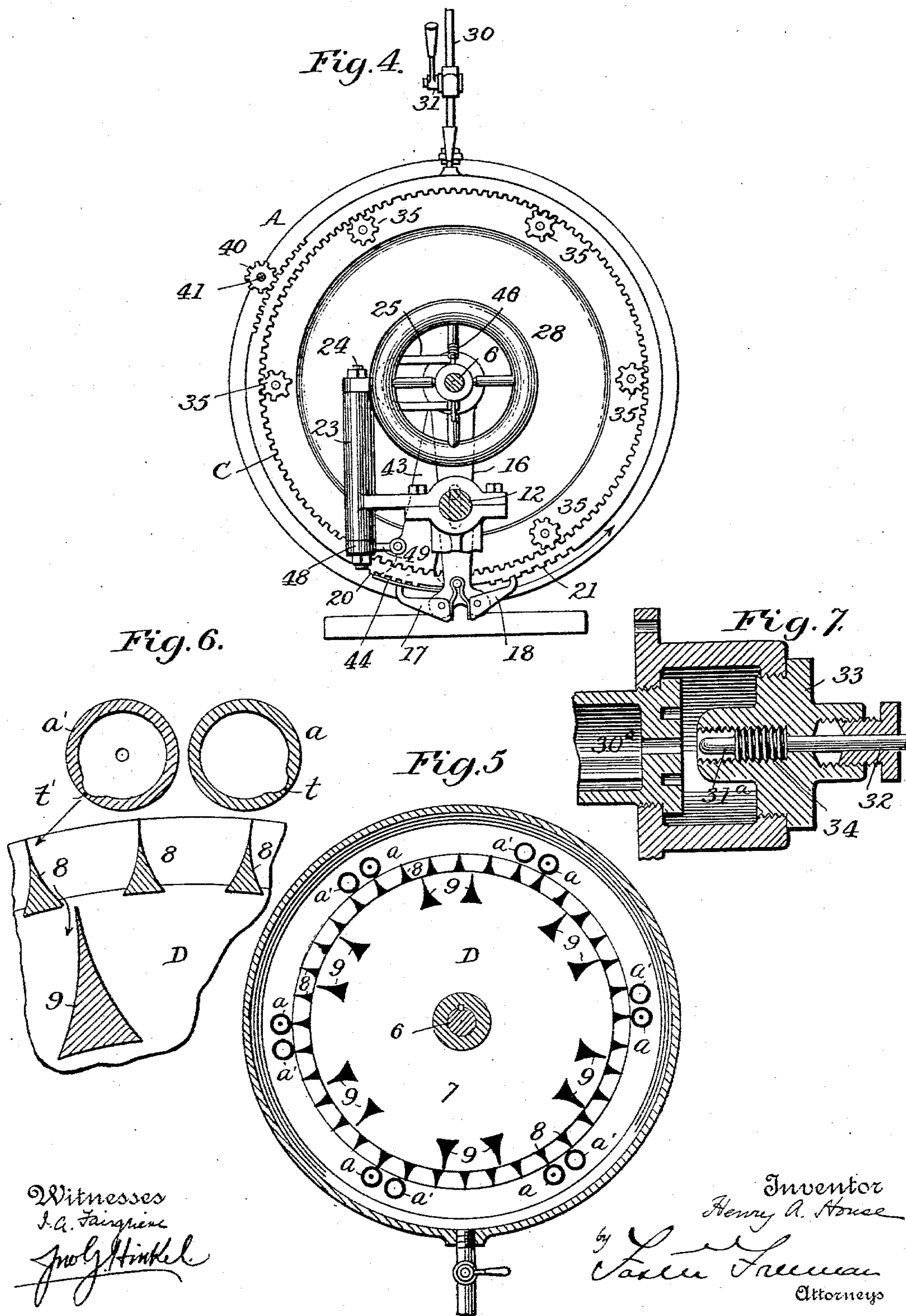
(No Model.)

2 Sheets—Sheet 2.

H. A. HOUSE.  
STEAM TURBINE.

No. 571,861.

Patented Nov. 24, 1896.



Witnesses  
J. A. Fairbank  
J. H. Hinkel

Inventor  
Henry A. House  
by  
Lester Freeman  
Attorneys



# UNITED STATES PATENT OFFICE.

HENRY A. HOUSE, OF BRIDGEPORT, CONNECTICUT.

## STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 571,861, dated November 24, 1896.

Application filed March 16, 1895. Serial No. 541,988. (No model.)

*To all whom it may concern:*

Be it known that I, HENRY A. HOUSE, a citizen of the United States, residing at Bridgeport, in the county of Fairfield and State of Connecticut, have invented certain new and useful Improvements in Steam-Turbines, of which the following is a specification.

My invention relates to that class of steam-engines operated under high pressure at rapid speed by the action of steam-jets upon a revolving wheel and generally known as "steam-turbines;" and my invention consists in constructing an engine of such character to facilitate the reversing of the same, to reduce the weight of the driving-wheel, automatically regulate the flow of steam, and secure other advantages, as fully set forth hereinafter and as illustrated in the accompanying drawings, in which—

Figure 1 is an external elevation of a steam-turbine embodying my improvements. Fig. 2 is a sectional plan through the center; Fig. 3, a part sectional view on the line 3 3, Fig. 1. Fig. 4 is a section on the line 4 4, Fig. 1, looking in the direction of the arrows; Fig. 5, a section on the line 5 5, Fig. 1; Fig. 6, an enlarged transverse section of part of the engine; Fig. 7, an enlarged longitudinal section of one of the valves.

The casing A has a circular body and two heads 10 10, inclosing the chamber *w*, and the heads are formed to inclose two annular chambers *x y*, the chamber *x* communicating with a series of pipes or passages *a* and the chamber *y* with a series of intermediate pipes or passages *a'*. The steam-pipe 30 has branches communicating with the two chambers *x y*, and a two-way valve 31, which may be turned to control the steam into one chamber or the other at the will of the operator.

A shaft 6 extends through bearings in the heads of the casing and carries a central disk or web 7, which supports a series of blades or vanes 8, arranged in a circle so as to constitute a driving-wheel which rotates within the circle of pipes *a a'*, and in the pipes *a* are made fine ports *t*, and in the pipes *a'* are made like ports *t'*, the ports of the two sets of the pipes are inclined in opposite directions. The steam from one set of ports will strike the blades 8 at an angle, as illustrated in Fig. 6, to propel the driving-wheel D in one di-

rection, while the steam from the other set of ports will strike the opposite sides of the blades to propel the wheel in the opposite direction. It will therefore be seen that by admitting the steam to one set or the other of the two sets of pipes *a a'* the driving-wheel may be driven in the one direction or the other, and the reversing of the engine will be effected without altering the position of any part except the position of the valve 31. It will be evident that these supply-pipes may be connected with the pipes *a a'* in different ways, but I prefer to make use of the intermediate chambers *x y* to permit the use of the regulating-valve, as described herein-after.

The blades or vanes 8 may be of any suitable form, but I prefer to provide them with faces curved and converging toward the periphery of the wheel, as shown.

In order to secure some of the advantages resulting from the expansion of the steam, which is used at a very high pressure in engines of this character, I arrange within the chamber *w* the blades 9, extending from the heads 10 on opposite sides of the web 7 and below the blades 8 in such position that as each blade 8 comes into position to receive the impact of the jet of steam from one of the openings the heel of the said blade 8 will begin to pass the edge of the blade 9, so that the steam will be directed downward over the face of the blade 8, and then pass into contact with the proximate face of the stationary blade 9, and tend by its reaction to facilitate the movement of the driving-wheel. The blades 9 may be of any suitable cross-section. As shown, they correspond in form to the blades 8, but are larger.

It is desirable in this class of engines to automatically regulate the speed and power, and to this end I provide a series of valves controlling the flow of steam to the pipes *a a'*, with means whereby the said valves may be closed, preferably in succession, as the speed of the engine increases. Different arrangements of valves and control devices may be employed, and the valves may be of different construction. As shown, each of the said pipes has at the end a central port or opening 30<sup>a</sup>, to which is adapted a plug-valve 31<sup>a</sup>, carried by a stem 32, projecting through



a suitably-packed opening in a plug 33, adapted to an opening in the head of the casing A, so that by moving the stem 32 inward or outward the port or opening 30<sup>a</sup> may be closed or opened. The stems 32 may have a direct sliding motion, but preferably have threaded enlargements 34, adapted to threaded sockets in the plug 33, so that by rotating the spindles 32 the plugs or valves 31 may be carried to or from the ports.

Each of the stems 32 carries a pinion 35, which gears with an annular rack C, so that by turning the said wheel or rack all of the stems 32 may be simultaneously turned. As it is best to cut off the flow of the steam to the pipes *a a'* successively, I so adjust the valves in the first instance or so proportion the length of the plugs 31<sup>a</sup> that as the rack C is turned first the ports of two diametrically-opposite pipes will be closed, and then the ports of the next pair of pipes, and so on until all are closed, and it will be seen that the continued movement of the rack will permit this action, as after a plug 31<sup>a</sup> enters its port and closes the same its longitudinal movement may be continued as the other valves are closed, which would not be the case if the valves were so constructed as to close by being brought directly against a seat. When the motion of the ring is reversed, the valves are carried successively from their ports. I combine with the above-described devices any suitable form of automatic governor whereby the ring or rack is turned in one direction or the other, according to the speed of the engine. The ring or rack C controls the valves of one series of delivery-pipes so as to regulate the flow of steam when the driving-wheel is rotating in one direction, and to regulate the flow of steam to the other series of pipes I use a like series of valves and ports controlled by a like annular rack or ring C', and in order that both rings may be operated from a single governor or regulating device I provide the rings with external racks gearing with pinions 40 40 upon a connecting-shaft 41 in bearings mounted on the casing A, so that when one ring is driven the other will move with it.

One form of governor which may be employed consists of a vibrating arm 16, carrying two spring-pawls 17 18, engaging in opposite directions two short racks 20 21 on the periphery of the ring C, and with these pawls I combine means for throwing one or the other out of engagement with its rack. Thus an arm 43, swinging loosely on the shaft 6, carries a curved guard 44, which may be swung between either pawl and its rack. When thrown to the left, as shown in Fig. 4, the pawl 17 is thrown out of action, but the pawl 18 engages the rack 21, so that as the arm 16 swings in the direction of the arrow the ring C will be carried in the same direction, being fed one step at each reciprocation of the arm and pawl until the short rack

passes beyond the pawl and the latter slides on the plain surface of the ring, which will not be moved any farther, all of the valves being fully opened. If the engine should now acquire an undue speed, the guard 44 will be swung to the right between the pawl 18 and the rack 21, and the reciprocation of the arm 16 will bring the pawl 17 into engagement with the rack 20 until the ring C is turned around sufficiently to close some of the ports, when the speed will slow down and the guard 44 will again come between the pawl 17 and rack 20. Of course in such case the pawl 18 again engages the rack 21 and opens the ports to a certain extent; but if undue speed is gained the ports will again be closed in like manner.

The pawls may be driven from any suitable source of movement connected with the machine. As shown, a counter-shaft 12, driven slowly from the shaft 6 by reducing-gear 14 13, carries an eccentric 15, projecting into a slot in the arm 16.

The governor consists of a heavy-rimmed wheel 28, pivoted upon two spokes on the shaft 6, a spring-joint 46, tending to turn it at an angle to the shaft, while in proportion as the shaft rotates with increased rapidity the wheel tends to approach a vertical plane. The wheel is connected by a link 27 to a sleeve 26, sliding upon the shaft 6, and having an annular groove receiving pins upon a fork 25, connected to a vertical rock-shaft 24, turning in a bracket 23 upon a standard G. At the lower end of the shaft 24 is an arm 48, connected by a link 49 with the swinging arm 43, carrying the guard 44, so that as the wheel 28 assumes a vertical position the guard will be carried to the right.

In order to permit the ready escape of the steam after it has acted upon the blades 8 and to permit the use of the reaction stationary blades 9, the blades 8 are arranged separate from each other upon the disk 7, the steam passing from the blades 9 to the interior of the chamber *w*, and thence through an exhaust-port *v* to the exhaust-pipe 50. The exhaust-pipe ought to be of such dimensions as to permit a very free escape of the steam. I thus exhaust the steam from the center of the driving-wheel, withdraw it from the blades as soon as its effective force is expended, and am enabled to make the wheel lighter in construction than heretofore used.

It will be evident that when the engine is not required to be reverse-acting the control devices specified may be used in connection with a single series of pipes and passages.

Without limiting myself to the precise construction and arrangements of parts shown, I claim—

1. The combination with the casing of a steam-turbine, of a driving-wheel provided at its periphery with a single series of separated blades arranged in the same circular plane and extending transversely across the



casing, a series of stationary blades, two series of delivery-pipes extending transversely across the casing in proximity to the blades of the driving-wheel, said pipes being provided with steam-ports opening in different directions, adapted to direct steam upon opposite faces of the blades, and means for directing steam to one or the other series of said delivery-pipes, substantially as described.

2. The combination of a casing containing a driving-wheel, two sets of delivery-pipes each having a port at one end, and the pipes being disposed in pairs about the periphery of the wheel, means for directing steam into one or the other sets of pipes, valves adapted to enter the ports and being adjustable in varying degree to open and close the ports successively, and a governor for automatically controlling the position of the valves in accordance with the speed of the engine, substantially as described.

3. The combination with the casing and the drive-wheel of a series of delivery-pipes *a, a'*, equably disposed in pairs about the circumference of the wheel, and the pipes of each pair having inlet and discharge ports, valves arranged opposite the inlet-ports and adapted to enter the same, said valves being adjustable in varying degree to open and close the ports successively, and means for simultaneously operating the valves, substantially as described.

4. In a steam-turbine, the combination with the casing of the driving-wheel provided at its periphery with blades extending practically the full length of the casing, of the delivery-pipes substantially equal in length to the blades and provided with ports opening in opposite directions whereby steam may be directed upon opposite faces of the blades, valves for controlling the flow of steam to said pipes, and a speed-governor connected to automatically adjust said valves according to the speed of the engine, substantially as described.

5. The combination with the delivery-pipes *a, a'*, having the inlet and discharge ports, of the valves adapted to enter the inlet-ports and being adjustable in varying degree to open and close said ports successively, a series of pinions for the valves, and a toothed ring engaging all of said pinions, a governor, and connections intermediate the governor and ring whereby the latter is automatically moved in different directions accordingly as the speed of the engine increases or diminishes, substantially as described.

6. In a steam-turbine, the combination with the casing, of a driving-wheel having blades extending practically the full length of the casing, delivery-pipes equably disposed in pairs about the periphery of the wheel, the pipes of each pair having discharge-ports opening in opposite directions and extending substantially the length of the blades, valves adapted to the inlet-ports of said pipes in

varying degree, and means for moving said valves into and out of said ports to open and close the same, substantially as described.

7. In a steam-turbine, the combination with the casing, and a driving-wheel, of the delivery-pipes *a, a'*, each provided with an inlet-port at one end, valves adapted to enter the ports and being adjustable in varying degree to open and close the ports successively, and means for simultaneously operating said valves, substantially as described.

8. In a steam-turbine, the combination with the casing having an annular steam-chamber, of a driving-wheel, delivery-pipes *a, a'*, therefor each having an inlet-port leading into said chamber, means for supplying the chamber with a motor fluid, valves adapted to enter the inlet-ports and being adjustable in varying degree to open and close the ports successively, and means for simultaneously operating the valves, substantially as described.

9. In a steam-turbine, the combination with the casing, of a driving-wheel, delivery-pipes *a, a'* therefor each provided with an inlet-port, valves for entering the ports and adjustable in varying degree to open and close said ports successively, and means for automatically and simultaneously operating said valves, substantially as described.

10. In a steam-turbine, the combination with the casing, of a driving-wheel, delivery-pipes *a, a'*, therefor each having an inlet-port, valves for entering the ports and being adjustable in varying degree for opening and closing the ports successively, and a governor and connections between the governor and valves whereby the latter are simultaneously operated, substantially as described.

11. In a steam-turbine, the combination with the casing, of a driving-wheel, delivery-pipes therefor each having an inlet-port, valves for entering the ports and being adjustable in varying degree to open and close the ports successively, and each valve having a stem provided with a pinion, a circular rack engaging said pinions, a governor on the shaft, and connections between the governor and rack whereby the valves are operated, substantially as described.

12. The combination with the inlet-ports of a steam-turbine, of controlling-valves adapted to enter the ports and being adjustable in varying degree for opening and closing the ports successively, a ring for operating all of the valves and provided with racks, reciprocating pawls, means for throwing the pawls into and out of engagement with said racks, and a governor controlling said means, substantially as described.

13. The combination with the casing of a steam-turbine, of the driving-wheel provided at its periphery with separated blades extending transversely across the casing, two series of delivery-pipes arranged in a circular plane and extending transversely across the casing in proximity to the edges of the blades of the



driving-wheel, said pipes or passages having  
steam-ports opening in different directions  
adapted to direct steam upon opposite faces  
of the blades, and means for directing steam  
5 to one or other series of said delivery-pipes,  
substantially as described.

In testimony whereof I have signed my

name to this specification in the presence of  
two subscribing witnesses.

HENRY A. HOUSE.

Witnesses:

GEORGIA P. KRAMER,  
I. A. FAIRGRIEVE.