(No Model.)

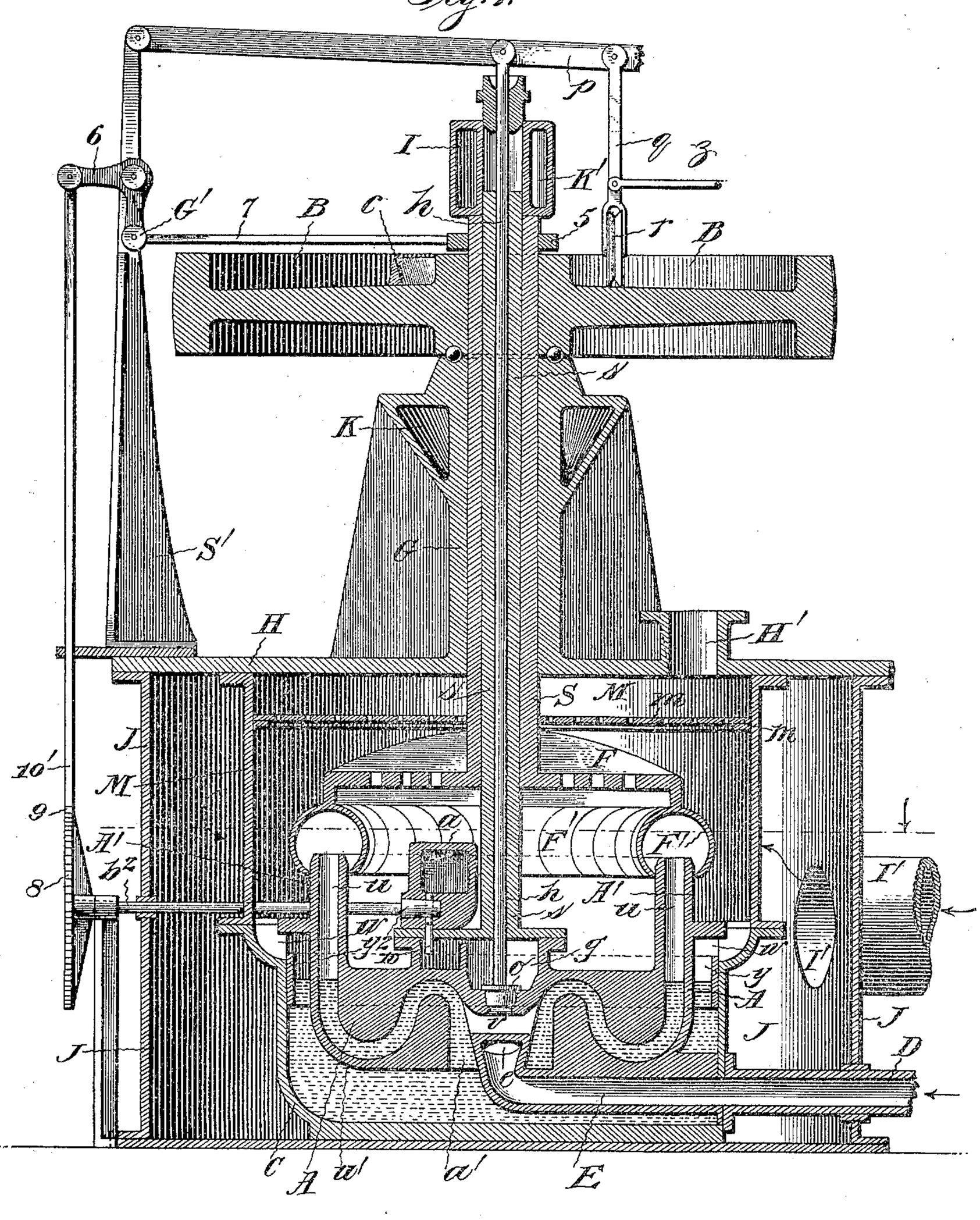
4 Sheets—Sheet 1.

O. TROSSIN.

STEAM TURBINE.

No. 604,507. Patented May 24, 1898.

Fig. 1.



Witnesses.
B. L. Olen
B. F. Sommers

Inventor.
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(No Model.)

4 Sheets—Sheet 2.

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Fig. 2.

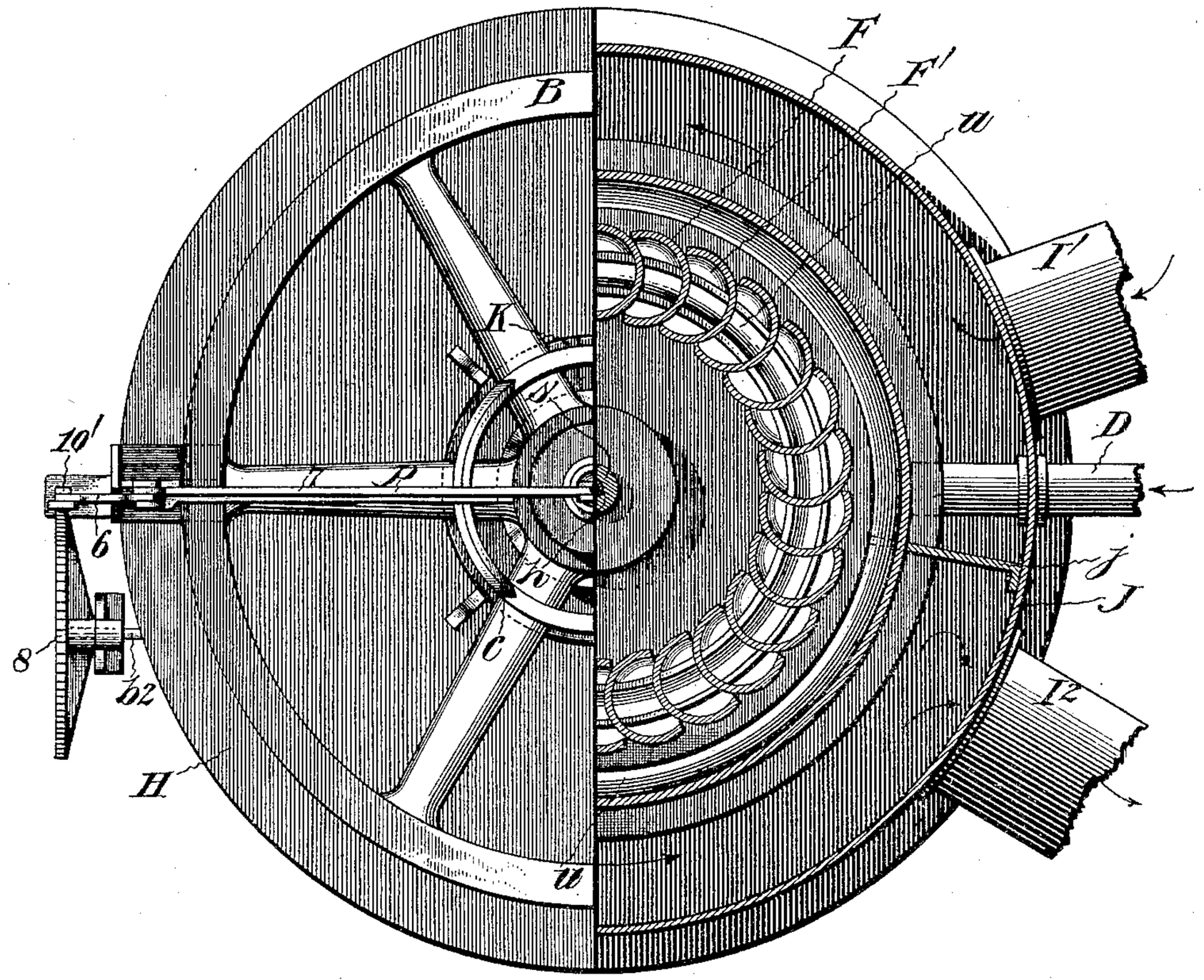


Fig. 3.

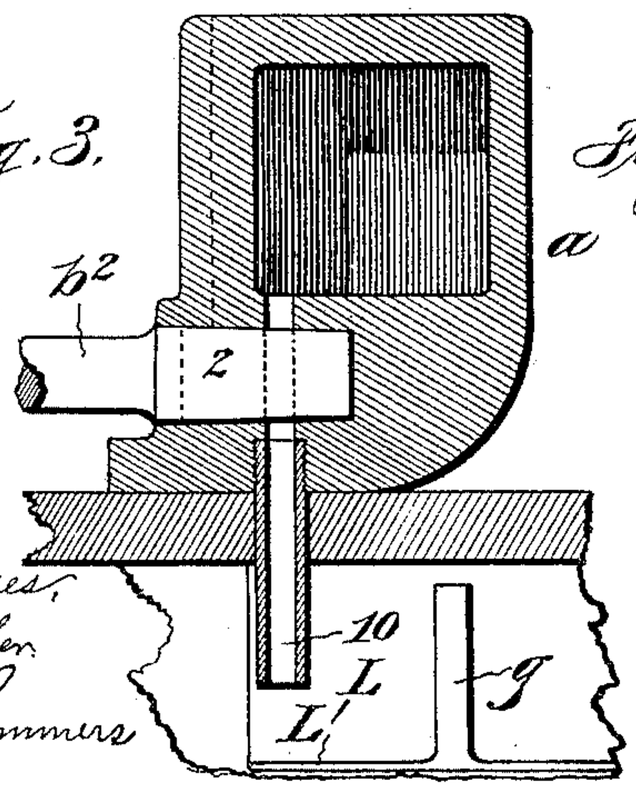
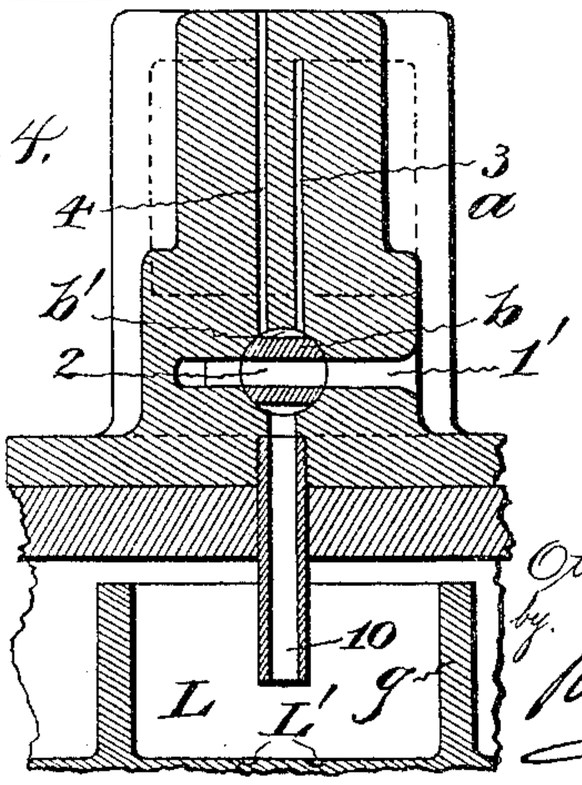


Fig. 4.



Witnesses:
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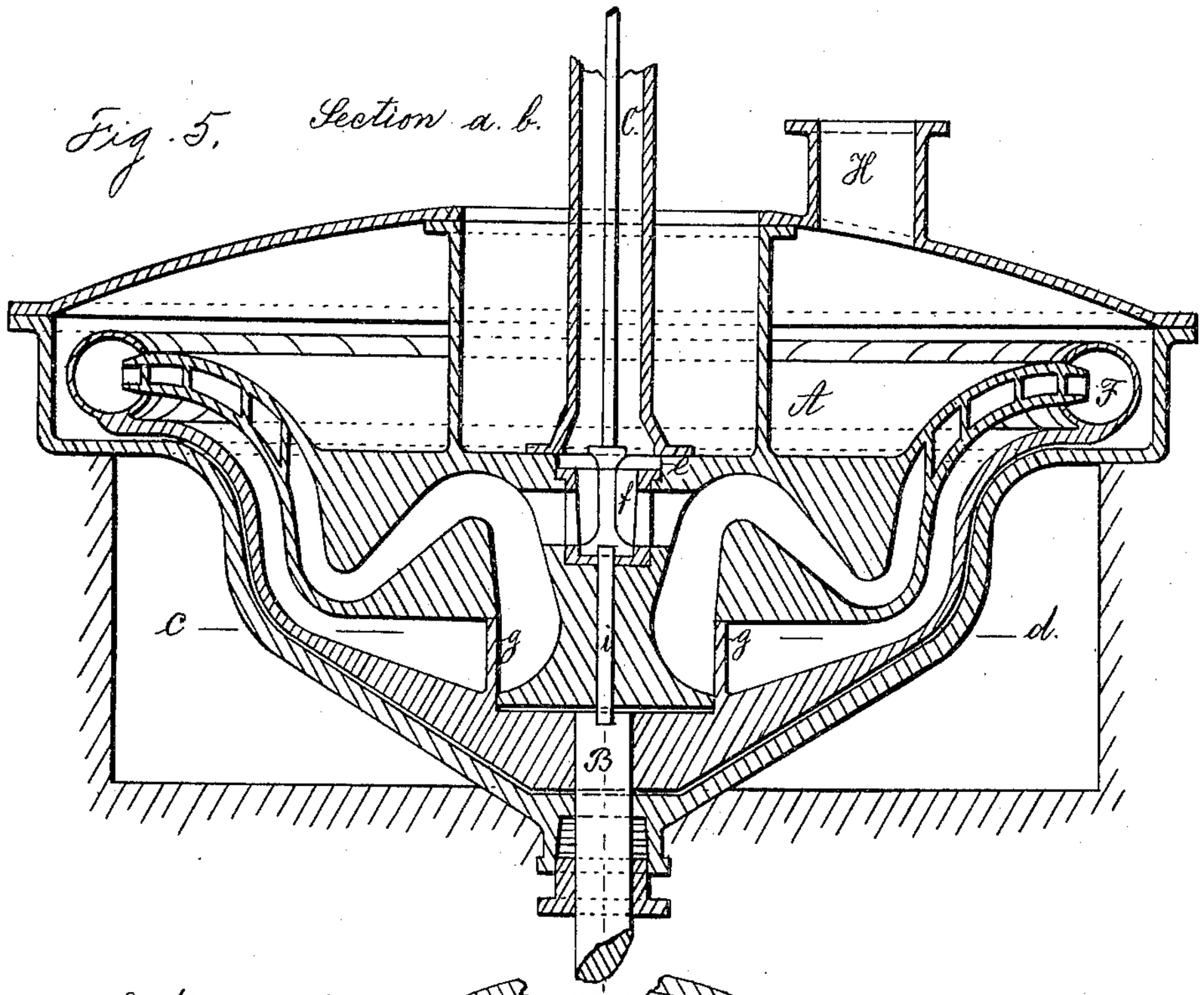
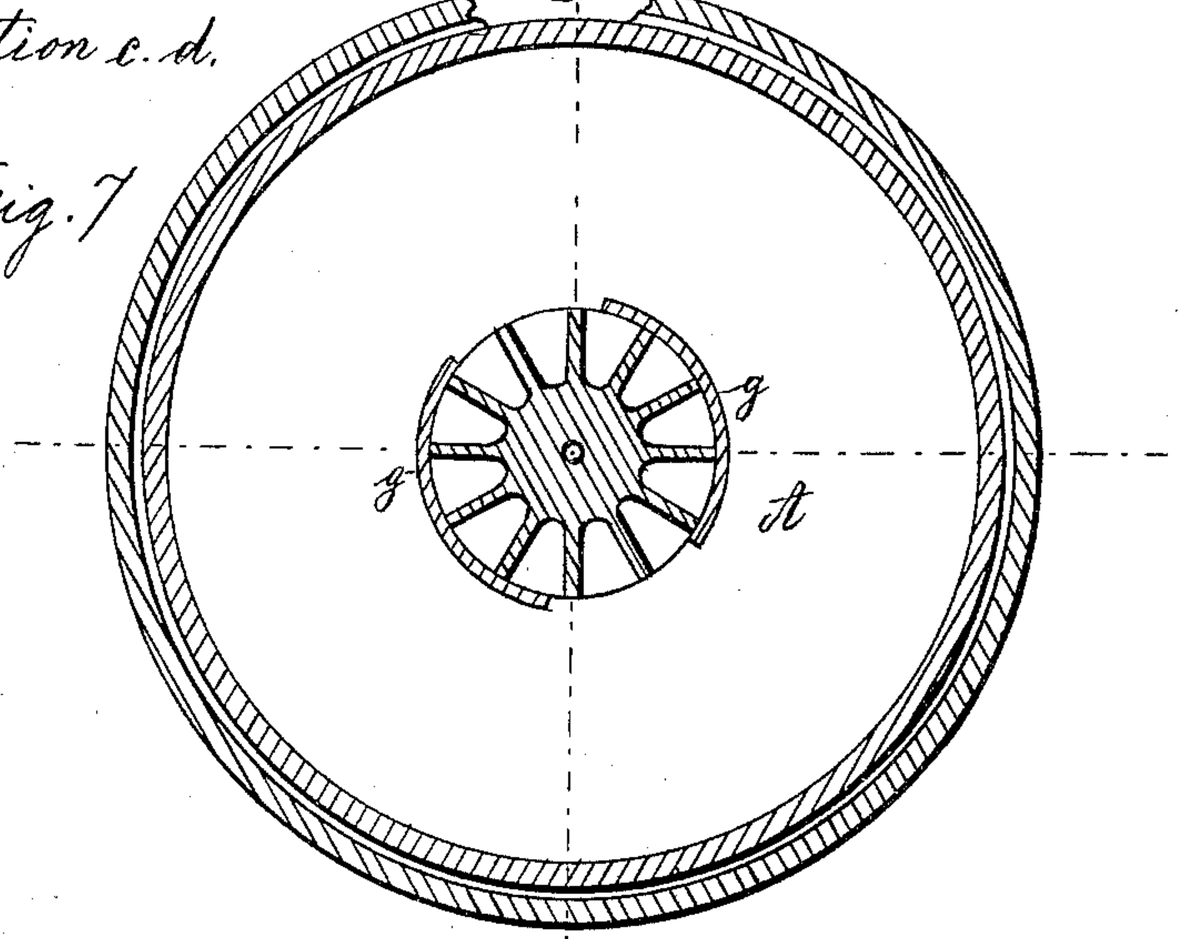
Fig. 5. Section a. b.



Section c. d.

Fig. 7



Witnesses.
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Alfred Reupcke

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(No Model.)

4 Sheets—Sheet 4.

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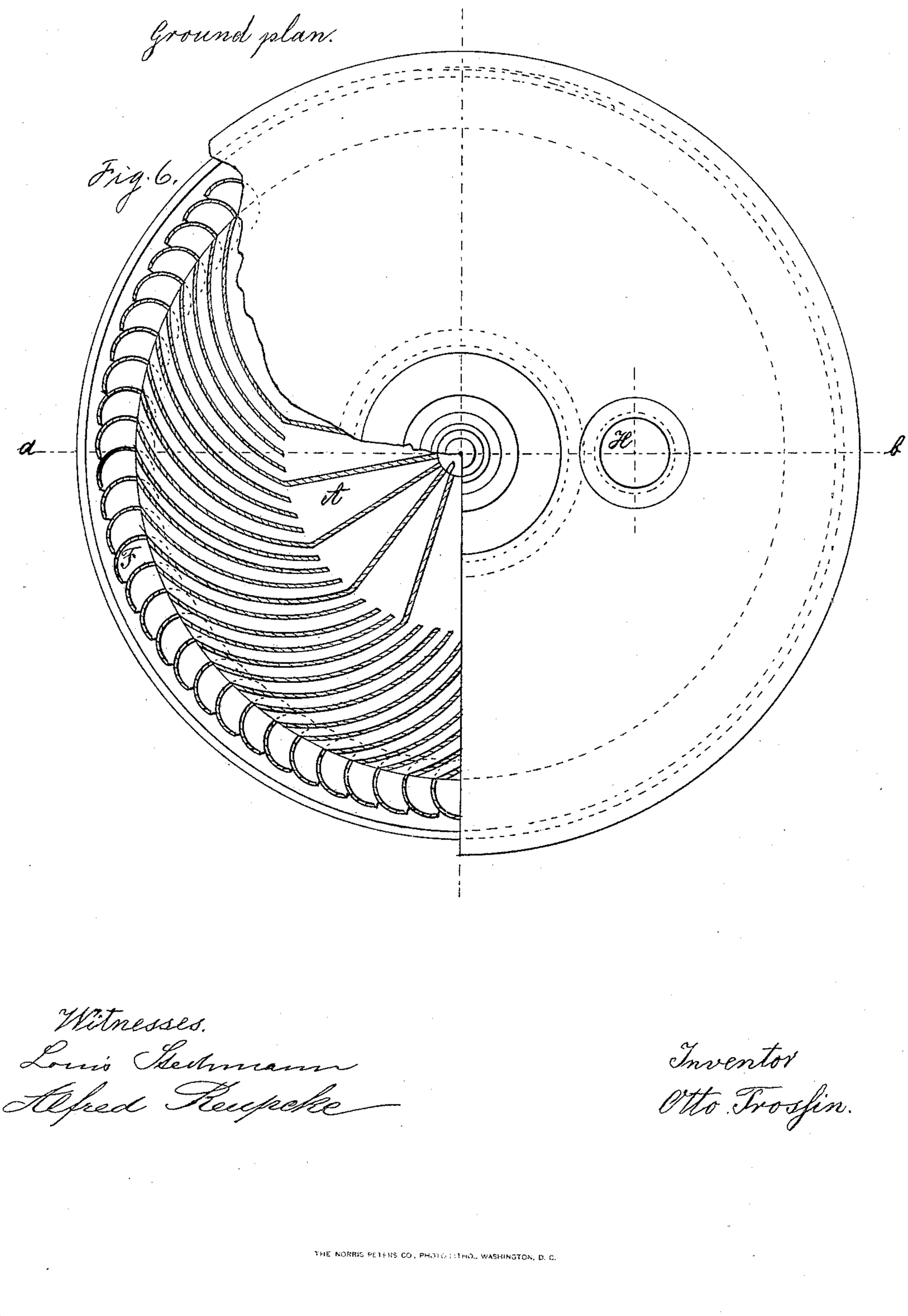
STEAM TURBINE.

No. 604,507. Patented May 24, 1898.

Ground plan.

Fig. 6.



Witnesses.
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UNITED STATES PATENT OFFICE.

OTTO TROSSIN, OF HAMBURG, GERMANY.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 604,507, dated May 24, 1898.

Application filed September 23, 1896. Serial No. 606,763. (No model.)

To all whom it may concern:

Be it known that I, OTTO TROSSIN, a subject of the King of Prussia, Emperor of Germany, residing at Hamburg, Germany, have invented a new and useful Steam-Turbine, of which the following is a specification.

The present invention relates to improvements in steam-turbines, the object being to make such motive-power engines more effective by using the energy resulting from the action of superheated steam upon molten metal as motive power—that is to say, by transforming into mechanical work the *vis viva* imparted to molten metal by the action thereon of intermittingly-acting superheated steam; and with this end in view my invention consists of certain novel features of construction and combinations of parts, as will be hereinafter fully described with reference to the accompanying drawings, forming part of this specification, and in which—

Figure 1 is a vertical sectional elevation, and Fig. 2 a plan, partly in section, of my improved steam-turbine. Figs. 3 and 4 are detailed views of the means for effecting a fluid-tight closure of the steam-admission valve. Figs. 5 and 6 show in sectional elevation and plan, respectively, a modification of the steam-turbine shown in Figs. 1 and 2; and Fig. 7 is a sectional plan view of the turbine shown in Figs. 5 and 6.

Similar letters of reference refer to similar parts throughout the several views.

Referring more particularly to Figs. 1 and 2, it will be seen that the casing of the motor is composed of two parts, a lower part C and an upper part M, between which is arranged a substantially cylindrical ejector-body A in such manner as to be suspended in casing C, having below and around it sufficient space for the molten metal or alloy. This ejector-body A, whose annular nozzle portion A′ projects some distance into the upper portion M of the casing and sufficiently into the substantially spherical or globular buckets F′ of a turbine wheel F, presently to be referred to, to drive the same, is provided with a plurality of radially-disposed channels *u*, extending downward from the nozzle portion A′ into the ejector-body, then upwardly again, and then again downwardly in a general radial direction to the axial center of said body, where they communicate with one another through a suitable passage or central chamber *v*, and also with the casing C and the molten metal therein, said channels extending down through the bottom of the ejector-body, as shown at *a*′, Fig. 1, so that each of said passages forms a gooseneck which is normally filled with molten metal. The ejector-body A has a passage E, adapted to be connected by a pipe D with a source of superheated-steam supply, and in its upper face, within the annular nozzle of said body A, is arranged a steam-chest *g* in communication with the aforesaid passage E through lateral or radial passages *e*, Fig. 1.

Centrally of the bottom of the steam-chest *g* is a steam-port normally closed by a valve *o*, which port opens into the central intercommunicating space *v*, leading to the several radial channels *u*.

The arrangement of the ejector-body A relatively to what may be called the "metal-pot" C is such as to form a cover therefor, in the periphal flange of which are formed passages *w*, placing the pot in communication with the upper chamber M, and in said metal-pot is a ring-valve *y* of such specific gravity as to float in and rise and fall with the metal in C. The exterior diameter of this ring-valve *y* is substantially the same as the interior diameter of the pot or casing C and is adapted when the level of the metal rises to close the passages *w*, and thus cut off the communication between the chamber formed by the casing C and that formed by the casing M.

Axially within the casing M is arranged the turbine wheel F F′, which is provided with a long tubular hub S, that has its bearings in a suitable standard G, rising from the head or cover H of the casing M, which cover is also provided with a steam-exhaust branch H′, while the bearing-standard G is preferably surrounded at its upper end by a jacket K, through which a cooling agent is caused to circulate for obvious purposes.

The hub S of the turbine wheel, which projects beyond the standard G, carries a fly-wheel B, which has the form of a pulley and performs the function of a power-transmission pulley, said wheel revolving on ball-bearings in the upper face of the standard G.

Through the hub S of the turbine wheel F F′

extends a shaft which rises from the cover of the steam-chest *g*, and to the outer end of said shaft is secured a jacketed stuffing-box I, through which box and shaft passes the rod *h* of the steam-admission valve *o*, while a cooling agent is caused to circulate through the jacket *k'* of the stuffing-box I.

The upper end of the valve-rod *h* is pivoted to a lever *p*, fulcrumed to a standard S', rising from the casing-cover H, and to the free end of said lever is pivoted a rod *q*, whose lower end is forked and has a grooved wheel *r* journaled in its said fork, which wheel normally stands in the path of segmental cam surface or ridge *c* on the upper face of the pulley B, so that at each revolution of said pulley the wheel is caused to ride up onto and along said ridge, thereby unseating the valve *o* by lifting its rod *h* and holding it off its seat for a period of time depending on the length of the ridge and on the speed of revolution of the pulley B.

The casing M above the head of the turbine wheel F F' is partitioned off by a perforated partition *m*, giving free passage to steam, but serving as a guard against the splashing of molten metal to the head or cover of said casing.

The casing C contains a quantity of molten metal or a molten-metal alloys ufficient to partially fill the channels *u*, and in practice I preferably use lead, which is or may be kept in a molten state by the application of heat to the vessel C in any suitable or preferred manner. I may, for instance, inclose the apparatus in a heating-jacket J, divided vertically into two chambers by a partition *j*, and having the inlet I' for the heating agent on one side of said partition and the outlet I^2 on the opposite side for the purpose of causing the said heating agent to circulate around the apparatus, as shown in Figs. 1 and 2. Any suitable heating agent can be used for this purpose—as, for instance, the waste products of combustion from a furnace or other fuel-consuming apparatus, though I do not desire to limit myself to this mode of heating, as heat may be applied directly to the vessel C by mounting the same on a suitable fuel-consuming heater.

In starting the motor the valve-lever *p* is raised for a short time by hand to unseat the valve *o* and admit superheated steam under pressure to the axial chamber *v*. The action of the steam upon the metal, in view of the configuration of the radial channels *u*, is to divide the metal about on the line of the admission of the steam and force the major portion of it downward and consequently upward around the ejector-body A, while that portion of the metal contained in the channels *u* above the line of admission of the steam is driven out of said channels *u* into the buckets of the turbine wheel, causing the same to revolve. As the level of the metal rises in casing C the ring-valve *y* also rises and finally closes the passages *w*, thereby interrupting the communication between C and M and preventing the metal from being driven into M under the action of the steam. It will thus be seen that the molten metal in C is made to perform the function of a cushion, yielding under the steam-pressure until the inertia of the metal in the channels *u* has been overcome by the action thereon of the steam, thus avoiding too violent an action and injury to the apparatus.

As the pulley B revolves the grooved wheel *r* will ride up and along the ridge *c*, again admitting steam to the chamber *v*, and so on, keeping the motor in motion, the exhaust-steam passing out of the motor through branch H'.

It is obvious that through the medium of this periodical coöperation of the steam with the molten metal a uniform revolution will be imparted to the pulley B.

Should the speed of the pulley B increase beyond a desired speed, the grooved wheel *r* may be moved out of the path of the ridge *c* by means of a rod *z*, connected with a suitable governor or actuated by hand, and pivoted to rod *q*, Fig. 1, thereby interrupting the admission of steam to the motor until its speed has again been reduced to normal speed.

For securing a steam-tight closing of the valve *o* the latter when closed may be covered with molten lead. This is effected by means of a small apparatus on the cover of the steam-chest *g*, consisting of a box *a*, Figs. 3 and 4, which is adapted to communicate with the interior of the body A or the chamber M, respectively, by a channel 1', and with a chamber L of the steam-chest *g* by a tube 10. A plug-valve *b*, inserted in the channel 1', controls these connections.

Supposing the plug *b* to be in the position shown in Fig. 4, molten lead flows from outside through the channel 1' and plugway 2 into the box *a*, while steam and air contained in the box *a* escape through one of the transverse grooves *b'* in the plug *b* and thence through the small vertical channels 3 and 4 in the wall of the box, Fig. 4. When the box *a* is filled or nearly filled up with molten lead, the plug *b* is turned ninety degrees by means described later on, so that the channel 1' and the bores 3 and 4 are closed, and communication is established between the box *a* and the chamber L of the steam-chest. Steam from the steam-chest enters then into the box *a* and causes the molten lead contained therein to flow out into the chamber L. From here the molten lead flows along in grooves L' and down upon the stop-valve *o*, covering the latter, thus forming a luting so long as the valve remains seated. When, however, the valve *o* is unseated and again seated, the plug *b* is turned into the first position, Fig. 4, and the described operation is repeated, and so on, the molten lead, whenever the valve is unseated, flowing with the steam into the axial chamber *v*.

The means for actuating the plug *b* consist,

for instance, of an eccentric 5, arranged upon the hub S, Fig. 1, of the turbine wheel and adapted to impart a reciprocating motion to a rack-bar 9 at the lower end of a rod 10 through a bell-crank lever 6 and a rod 7 on the strap of the eccentric 5. This reciprocating motion is transmitted to the plug *b* by a gear-wheel 8 on the spindle b^2 of said plug-valve, the rotation of the wheel 8 being such that the plug-valve *b* is turned ninety degrees at each reciprocation of the rack 9 in order to move the plug-valve successively into the two positions shown in Figs. 4 and 3.

In the modification shown in Figs. 5 to 7 the turbine wheel F^2 has a globular form and is fixed upon a shaft B′. Within the hollow of the turbine wheel F^2 there is arranged the body A′, containing the steam-chest *g′* and the channels u^2. The admission of steam is regulated by means of a cock-valve *f*, rotated by a suitable rod or shaft *i*, passing through the steam-pipe C′ and operated in any suitable manner. As the cock *f* is constantly rotated, steam flows from the steam-chest *g′* through the ways of the cock into the channels u^2 and produces the same effect upon the molten lead contained therein and in the vessel C^2 as in the apparatus, Fig. 1, already described. While the steam is acting in the respective channels u^2 the lower openings of the latter are closed by segmental valves *y′ y′*, attached to the turbine wheel F^2, in order to prevent backflow of the molten lead.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a motor such as described, the combination with a vessel adapted to contain a liquid, an ejector device partly immersed in said vessel and having radial fluid-ejecting channels whose inlets open into said vessel, and a turbine wheel into which the outlets of said channels open, and means for periodically admitting steam under pressure to said channels to drive the liquid therefrom into contact with said wheel, of means for preventing the displacement of the liquid in the vessel beyond a normal level, and a power-transmitting shaft on which the turbine wheel is secured, for the purpose set forth.

2. In a motor such as described, the combination with a vessel adapted to contain a liquid, a revoluble power-transmitting shaft extending into said vessel, a turbine wheel secured to said shaft, and an ejector device partly immersed in the liquid in said vessel and provided with radially-arranged liquid-ejecting channels whose inlets and outlets open into the vessel and turbine wheel respectively; of a valve-controlled steam-supply passage in communication with said channels, means for unseating and seating the valve, and means for admitting liquid from the vessel to the valve when on its seat, for the purpose set forth.

3. In a motor such as described, the combination with a vessel adapted to contain a liquid, a revoluble power-transmitting shaft extending into said vessel, a turbine wheel secured to said shaft, and an ejector device partly immersed in the liquid in said vessel and provided with radially-arranged liquid-ejecting channels whose inlets and outlets open into said vessel and turbine wheel respectively; of a valve-controlled steam-supply passage in communication with said channels, means for alternately unseating and seating the valve controlled by the rotation of the turbine, and similarly-controlled means for admitting liquid from the vessel to the steam-passage on the inlet side of the valve-seat to seal the same.

4. In a motor such as described, the combination with a vessel divided into two chambers by a partition provided with normally open ports or openings, one of said chambers containing a liquid, a revoluble power-transmitting shaft extending into the other chamber, a turbine wheel secured to said shaft and an ejector device partly immersed in the liquid in one of said chambers and provided with radially-arranged liquid-ejecting channels having their inlets and outlets opening into the liquid-containing chamber and the turbine wheel respectively; of means for periodically admitting steam under pressure to the ejecting-channels, and a float-valve in the liquid in one of the chambers adapted to close the ports leading to the other chamber when the level of said liquid is displaced by the pressure of the steam, for the purpose set forth.

5. In a steam-turbine in which superheated steam acts upon molten lead, the combination of a suitably-heated vessel, a body arranged in said vessel and provided with a steam-chest and conducting-channels, the latter and the vessel being partially filled with molten lead, an intermittingly-operated stop-valve for regulating the admission of the superheated steam into the said conducting-channels, a suitable valve for preventing backflow of the molten metal under the pressure of the superheated steam; of a turbine wheel adapted to be rotated by the molten lead thrown out through the conducting-channels, and a fly-wheel or pulley connected with the turbine wheel and adapted to transmit the rotation imparted to the turbine wheel, substantially as described.

6. In a steam-turbine in which superheated steam acts upon molten lead, the combination of a suitably-heated vessel, a body arranged in said vessel and provided with a steam-chest and conducting-channels, the latter and the vessel being partially filled with molten lead, an intermittingly-operated stop-valve for regulating the admission of the superheated steam into the said conducting-channels, a suitable valve for preventing backflow of the molten metal under the pressure of the superheated steam, of a turbine wheel

adapted to be rotated by the molten lead thrown out through the conducting-channels, a fly-wheel or pulley connected with the turbine wheel, a box in communication with the interior of the vessel and the steam-chest, a cock for changing the said communications alternately and means for actuating the said cock from one position into the other, substantially as specified.

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