(No Model.)

L. D'AURIA.

METHOD OF OPERATING DIRECT ACTING STEAM PUMPING ENGINES.

No. 367,602. Patented Aug. 2, 1887.

FIG. 1.

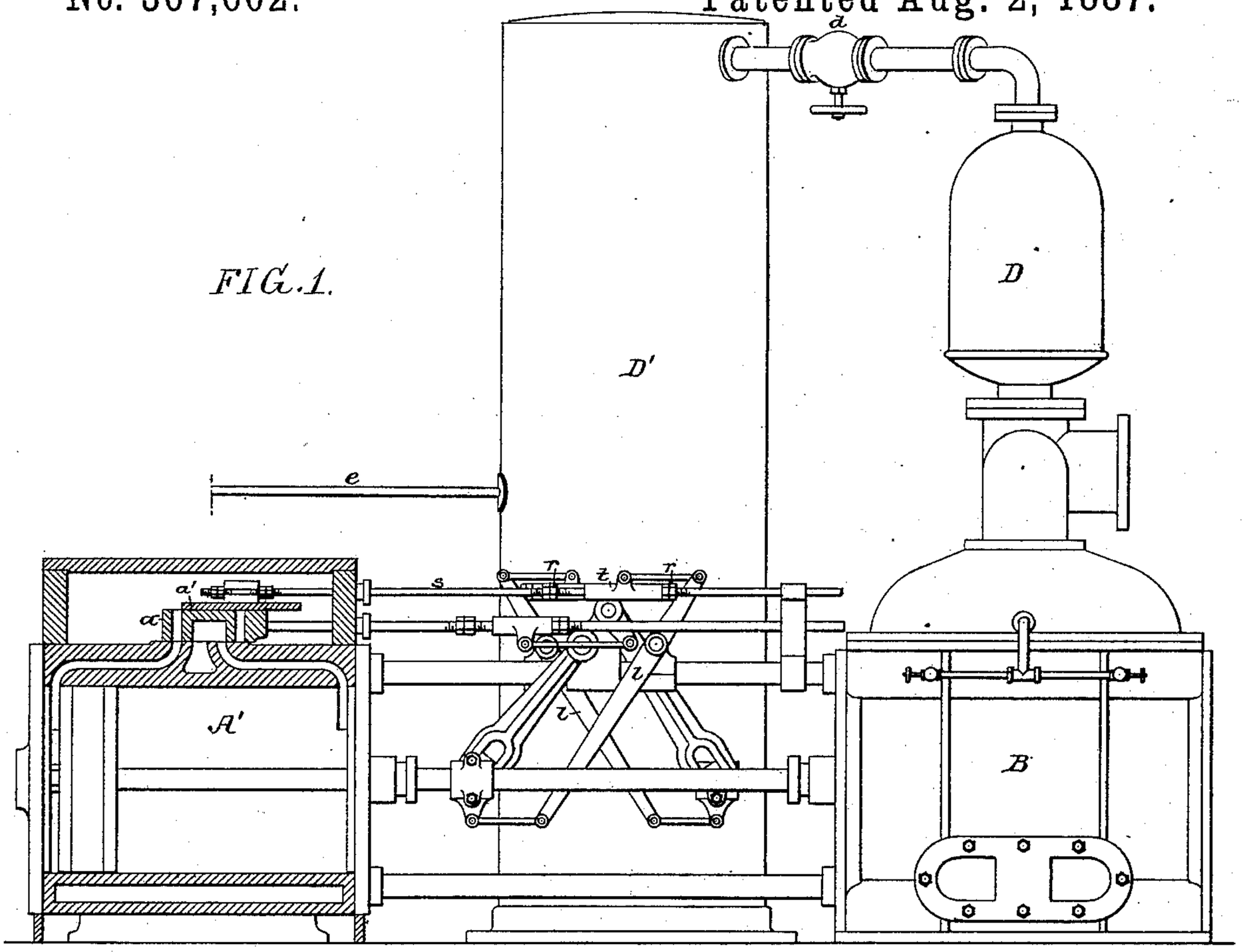
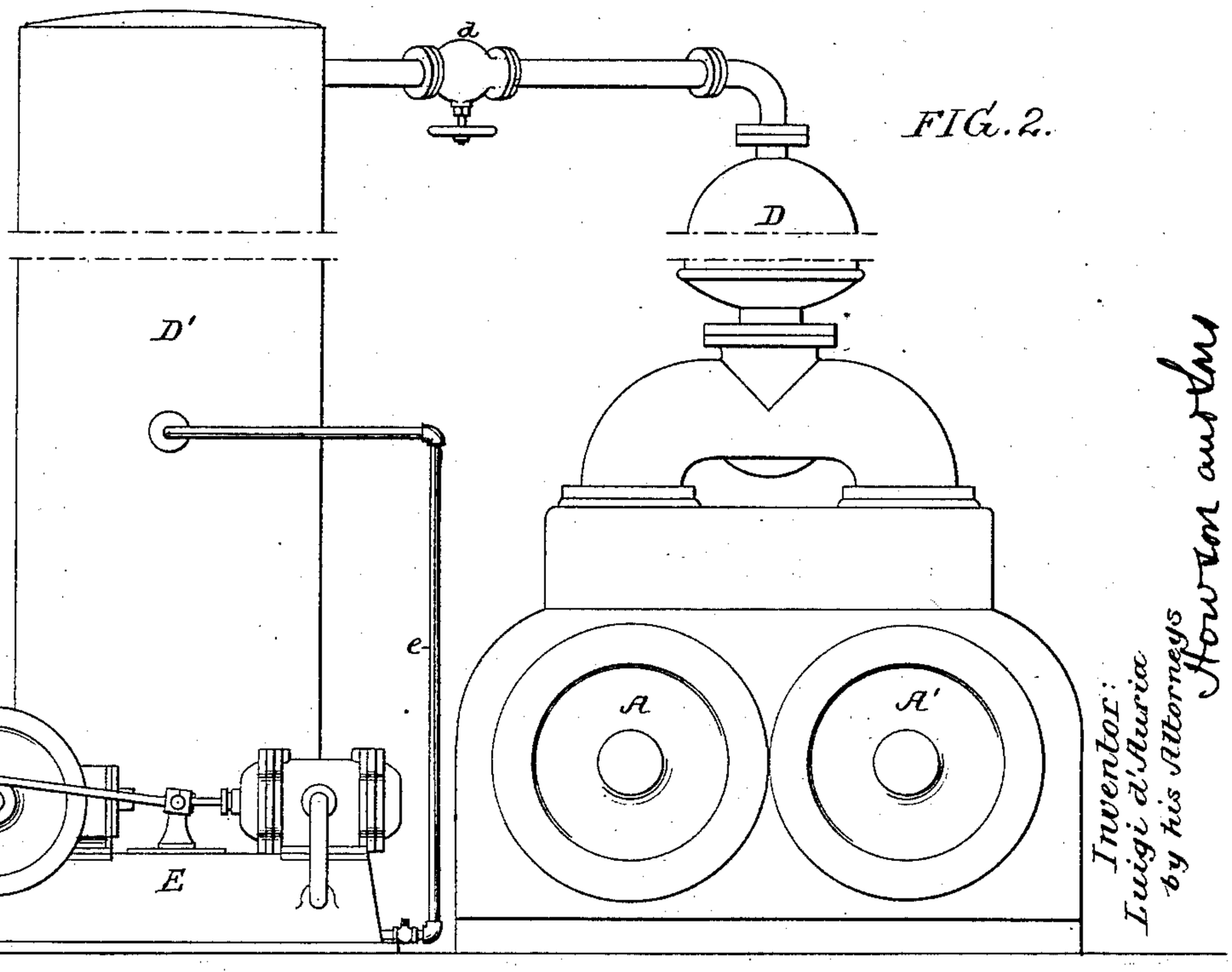


FIG. 2.



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UNITED STATES PATENT OFFICE.

LUIGI D'AURIA, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO HENRY MARTYN ROBERT, OF SAME PLACE.

METHOD OF OPERATING DIRECT-ACTING STEAM PUMPING-ENGINES.

SPECIFICATION forming part of Letters Patent No. 367,602, dated August 2, 1887.

Application filed August 14, 1886. Serial No. 210,866. (No model.)

To all whom it may concern:

Be it known that I, LUIGI D'AURIA, a subject of the King of Italy, residing at Philadelphia, Pennsylvania, have invented a certain Improved Method of Operating Direct-Acting Steam Pumping-Engines, of which the following is a specification.

It is well understood that the most economical way of operating steam-engines is to allow the steam to expand in the cylinders; but this necessarily produces a varying propelling force and piston speed. In direct-acting non-rotative steam pumping-engines—that is, those without fly-wheels—however, experience has shown that a practically-uniform piston speed is absolutely necessary in order to obtain satisfactory results. In other words, a nearly-constant propelling force must be maintained upon the pump-piston throughout its stroke; and for this reason, when steam is to be used expansively, a device is required to equalize the varying force of the engine.

Expanding steam in compound cylinders without cut-off and using considerable receiver-space is a well-known method to reduce the variations of the propelling force of the engine under expansion. This has been adopted in duplex direct-acting non-rotative pumping-engines, where, to obtain a practically-constant propelling force, the remaining inequalities of the latter are balanced by a varying back-pressure caused upon the piston of the low-pressure cylinder by cushioning-valves placed in the exhaust-passages of the same; but expansion under such restrictions can afford but a very little economy, and other devices have been sought for to equalize the propelling force in non-rotative direct-acting pumping-engines, both single and duplex, under any grade of steam expansion, in simple as well as compound cylinders. Means to this effect are described in Letters Patent No. 292,525, granted January 29, 1884, to C. C. Worthington, in connection with duplex direct-acting pumping-engines, in which a portion of the power at the beginning of the stroke is absorbed and afterward partially utilized to assist the piston toward the end of the stroke. This is sufficient to show that in non-rotative direct-acting pumping-engines, whether single or duplex, simple or compound, steam expansion, without a device to equalize the power propelling the pump-piston, is considered impracticable, if not impossible. In fact, whenever it has been attempted, a peculiarly spasmodic action of the piston has been observed, accompanied by very dangerous concussions upon the pump.

The object of my invention is to dispense with the devices or mechanisms now employed to equalize the varying power propelling the pump-piston in single or duplex non-rotative direct-acting pumping-engines using steam expansively in simple or compound cylinders, and avoid the spasmodic action and concussions under any grade of steam expansion by a simple and economical method.

In non-rotative direct-acting pumping-engines using steam expansively, without device to equalize the propelling force which acts upon the pump-piston, the motion of the latter is accelerated for the first part and retarded for the second part of the stroke, while the large body of water in the discharging-main preserves, by virtue of its inertia, a practically-uniform velocity corresponding to the mean velocity of the pump-piston. Under such conditions the level of water in the air-chamber must oscillate about a mean level at each stroke of the pump. I have ascertained that this oscillation, in the case of a uniformly accelerated and retarded stroke, will cause alternately condensation and expansion of the air volume in the air-chamber to the extent of one-fourth of the volume displaced by the pump-piston per stroke; or, in other words, the air volume will vary from its mean volume at each stroke by an amount equal to one-eighth of the pump-piston displacement per stroke, and in actual practice this proportion varies but slightly.

With the ordinary air-chamber used in non-rotative direct-acting pumping-engines the above condensation and expansion would cause dangerous variation of pressure upon the pump, and I have satisfied myself that to this variation of pressure are due the results of spasmodic motion and concussions experienced in such pumping-engines, and that these inconveniences can be avoided by maintaining a practically-constant pressure in the air-chamber. This can be done by greatly enlarging said chamber over the ordinary capacity,

and in practice I prefer to employ this plan of obtaining the desired constant pressure.

The extent of variation of the air volume in the air-chamber having been ascertained to be what I state, the desired or necessary size of the enlarged air-chamber to carry out my invention can then be determined according to the work required of the pump. For example, if it were desired to make the pressure so uniform that the variation from the mean pressure would not be more than about one per cent., then the enlarged air-chamber should have an air volume about thirteen times as large as the displacement of the pump-piston per stroke.

In ordinary non-rotative direct-acting pumping-engines the air-chamber does not exceed in volume twice the displacement of the pump-piston per stroke. Moreover, owing to the uniformity of speed under which these pumping-engines are operated, no air-chamber is in reality required, and for this reason no provision is ordinarily made for keeping the chamber supplied with air, so that the chamber becomes filled with water and inoperative.

My invention may be carried into effect with various constructions of apparatus; but in the accompanying drawings I have illustrated one construction which may be used, although I do not confine myself to the details illustrated.

Figure 1 is a side view, partly in section, of a non-rotative direct-acting simple cylinder duplex pumping-engine with my improvements, and Fig. 2 is an end view of the same, illustrating also the auxiliary air-pump.

A A′ are the steam-cylinders, and B the pumps, the corresponding pistons of the steam-cylinders and the pumps being mounted at opposite sides of the piston-rods, as usual. In fact, the steam-pump illustrated is, with the exception of the cut-off, substantially the same as the well-known "Blake direct-acting simple cylinder duplex pumping-engine," and the steam-valves *a* of the steam-cylinders are operated by the usual mechanism from the piston-rods, the steam-valve of one cylinder being operated from the piston-rod of the other cylinder in the ordinary way.

Any convenient form of cut-off valve may be employed; but in the drawings I have shown a simple form which may be used. The cut-off valve *a′* is a plain slide, which is operated by its own engine by means of a lever, *l*, and tappet *t*, acting on the stem *s* of the slide, the tappet *t* or stops *r* on the stem being adjustable to cut off at any fraction of the stroke.

D is the ordinary air-chamber of the steam-pumps, which may itself be made of enlarged size to carry my invention into effect; but I prefer in practice to provide for the enlargement of the chamber by connecting with the ordinary chamber, D, a supplementary air-chamber or tank, D′, and a valve, *d*, may be provided between the two. To feed this enlarged air-chamber with the amount of air which may be absorbed by the water passing through the pump, and also to fill such chamber with air at a certain pressure before the engine is started, I use in connection with it an auxiliary air-feed pump or compressor, E, which can be operated intermittently or otherwise to supply air to the chamber or tank through the pipe *e*.

I am well aware that in hydraulic elevators a reservoir has been used in connection with the steam-pump to maintain a constant pressure on the elevator; but so far as I am aware the steam-pumps for working these elevators have always been constructed to work with a uniform propelling force upon the pump-piston. My invention, however, involves the novel principle of working a non-rotative direct-acting steam pumping-engine expansively with a varying propelling force and piston speed, and preventing consequent spasmodic action and concussion by maintaining a constant air-pressure upon the water in the pump.

I claim as my invention—

1. The mode herein described of operating direct-acting non-rotative steam pumping-engines, said mode consisting in working the said engine expansively with a varying propelling force upon the pump-piston, and preventing spasmodic action and concussions by maintaining a constant air-pressure upon the water in the pump, substantially as set forth.

2. A direct-acting non-rotative steam pumping-engine adapted to use steam expansively with a varying propelling force upon the piston-pump, and provided with means to prevent spasmodic action and concussions, said means consisting of an enlarged air-chamber equal to more than twice the displacement of the pump-piston per stroke, substantially as set forth.

3. A direct-acting non-rotative steam pumping-engine adapted to use steam expansively with a varying propelling force upon the pump-piston, and provided with an enlarged air-chamber having a volume more than twice the displacement of the pump per stroke to prevent spasmodic action and concussion, and having a pump to supply air to said chamber, substantially as described.

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

LUIGI D'AURIA.

Witnesses:
CHARLES W. SPARHAWK,
HUBERT HOWSON.