(No Model.)

W. MAXWELL & T. V. HUGHES.

MERCURIAL PUMP EXHAUSTING APPARATUS.

No. 361,174. Patented Apr. 12, 1887.

FIG. 1.

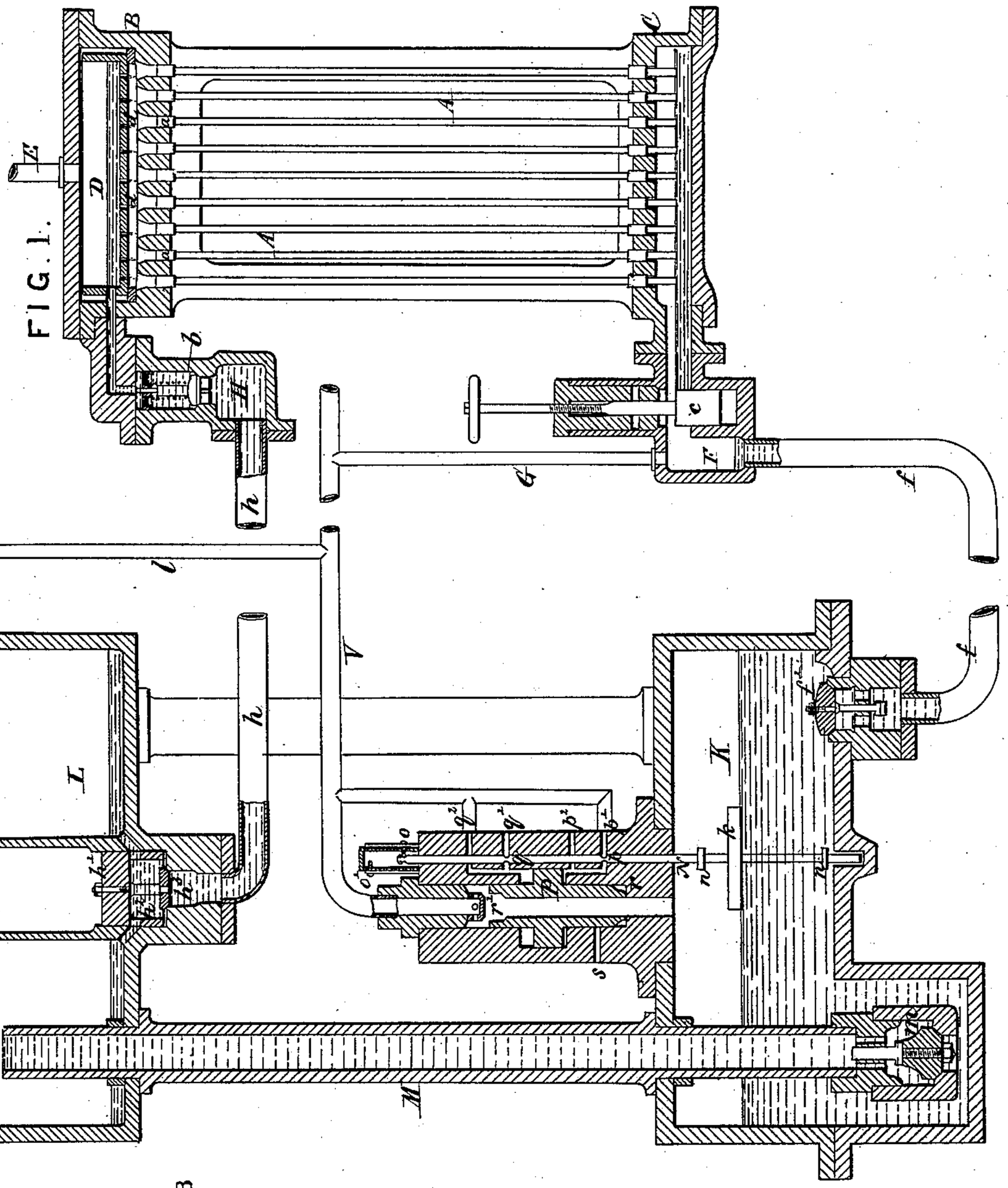
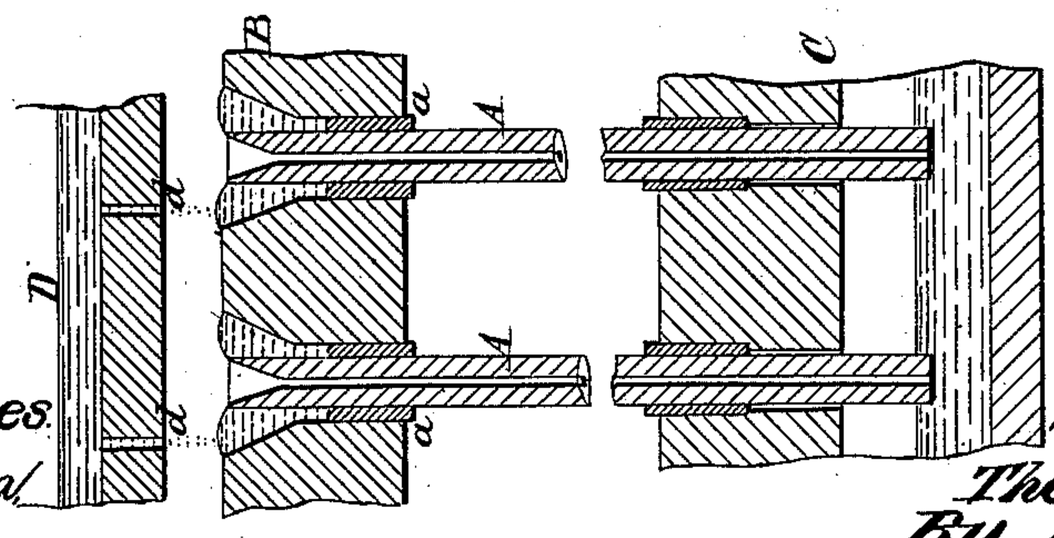


FIG. 3.

FIG. 2.



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UNITED STATES PATENT OFFICE.

WILLIAM MAXWELL, OF FULHAM, AND THEOPHILUS VAUGHAN HUGHES,
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MERCURIAL-PUMP EXHAUSTING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 361,174, dated April 12, 1887.

Application filed August 19, 1886. Serial No. 211,307. (No model.) Patented in England November 9, 1885, No. 13,571; in France August 9, 1886, No. 177,864, and in Belgium August 16, 1886, No. 74,235.

To all whom it may concern:

Be it known that we, WILLIAM MAXWELL and THEOPHILUS VAUGHAN HUGHES, citizens of England, residing, respectively, at Claybrook Road, Fulham, and at Westwick Gardens, West Kensington, both in the county of Middlesex, England, have invented a new and useful Improvement in Mercurial-Pump Exhausting Apparatus, (for which we have obtained a patent in Great Britain, dated November 9, 1885, No. 13,571; France, dated August 9, 1886, No. 177,864, and Belgium, dated August 16, 1886, No. 74,235,) of which the following is a specification.

In exhausting vessels, such as the bulbs of incandescent electric lamps, where a very high degree of exhaustion is required, it is usual to begin the exhaustion by the use of a mechanical air-pump, and after a certain degree of exhaustion has been thus attained to carry the exhaustion still further by means of apparatus known as "Sprengel" or "mercurial" pumps. These consist of vertical glass tubes of small bore, open at the top to the exhausted vessel, and having their bottom mouths dipping into mercury, which forms a liquid seal for them. Mercury is supplied in successive drops to the upper mouths of the tubes, and these drops form themselves into short columns that successively descend the tubes, each column acting like a piston, propelling down before it the small quantity of rarefied air that is interposed in the tube between it and the column that previously descended. The air thus forced down each tube escapes at the bottom through the mercury seal, and is withdrawn by the mechanical air-pump. Thus by using a number of tubes through each of which a large number of mercury columns successively descend, a very high degree of rarefaction can be attained in the upper vessel from which the tubes descend, or in a number of bulbs or other vessels that are in communication with it. After a time it is necessary to raise from the lower compartment the quantity of mercury that has descended the tubes and to restore it as a supply to the upper compartment, to be ready to feed the tubes again. It has been proposed to effect this raising of the mercury by the pressure of the atmosphere, and apparatus consisting mostly of glass has been sometimes made to act in this way; but, owing to the complexity and fragility of such apparatus, they have not become practically so useful as might be desired.

Our invention relates to a construction and arrangement of apparatus for operating in this manner, such that strong durable material—chiefly iron—is employed in its structure, and all parts can without difficulty be made and maintained sound and tight.

We will describe apparatus made according to our invention, referring to the accompanying drawings.

Figure 1 is a vertical section of a set of Sprengel or mercurial pumps, of which there may be many arranged in a row. Fig. 2 is an enlarged section of two of the mercurial tubes of Fig. 1. Fig. 3 is a vertical section of the apparatus for raising the mercury from the lower to the higher level.

Referring first to Figs. 1 and 2, A are the mercury-tubes, the upper ends of which pass through packings *a* in holes in the bottom of an upper compartment B, these holes and the mouths of the tubes being funnel-shaped. The lower ends of the tubes also pass through packings in holes in the upper side of a lower compartment, C, and extend down rather more than midway in the depth of C. In the compartment B there is an interior vessel, D, containing mercury, this vessel not fitting exactly within B, but leaving around it free passage from the upper part of B to the space under D for air coming by a pipe, E, from a set of lamp-bulbs or other vessels that have to be exhausted, such air being preferably dried on its way to D by being passed over absorbent materials in the usual way.

Through the bottom of the vessel D there are small holes *d*—one for each of the tubes A—immediately over some part of the annular space surrounding the tube. At one end of the compartment C there is a plug-sluice, *c*, which can be raised or lowered by a screw, so as to keep a certain level of mercury in C, or, when the plug is lowered quite down, to let it all flow into a passage, F. From the compartment C a pipe, G, communicates with a vacuum-pipe, V, exhausted by a mechanical pump. As mer-

cury issues in minute streams or successive drops through one of the holes *d*, it fills the conical annular space around the top of the tube A and assumes a convex surface, as shown in Fig. 2, after which a quantity of it overflows into the funnel-mouth of the tube and descends like a fluid-piston, propelling before it such air as was in the tube. The air thus forced down the tube bubbles through the mercury in C, and passes away by the pipe G. This action is repeated in each of the tubes A. It is to be understood that there may be a number of sets of the apparatus shown in Fig. 1 arranged in a row, all having their upper compartments, B, in communication with a supply-pipe, H, and having their lower compartments, C, in communication with a discharge-passage, F. The passage F communicates by a pipe, *f*, with the lower compartment, K, of the raising apparatus, (shown in Fig. 3,) and the pipe H communicates by a pipe, *h*, with the upper compartment, L, and the two compartments K and L communicate by a vertical pipe, M.

At the mouth of the pipe *f* there is a valve, *f'*, which prevents back-flow of mercury from K to F. In the passage from H to D, Fig. 1, there is a check-valve, *b*, held down by a light spring to prevent return of mercury from D. At the bottom of the pipe M, Fig. 3, there is a check-valve, *m*, to prevent back-flow down the pipe M.

The compartment L communicates by a pipe, *l*, with the vacuum-pipe V, so that in L, as well as in F, a partial vacuum is maintained. The mouth of the pipe *h* is fitted with a valve, h^3, which is attached to the stem of a piston, *h'*, having projecting down from it a rim, h^2, with holes through it. When the piston *h'* is down, as shown in Fig. 3, the pipe *h* being then closed by the valve h^3, the holes in the rim h^2 coincide with holes in the cylindrical casing of the piston *h'*, and mercury can thus flow into the space under the piston. When the piston *h'* floats up, it opens the valve h^3, allowing mercury to pass by the pipe *h* to H, but at the same time as the rim h^2 rises with the piston the passages from L are more or less closed, and only a portion of the mercury can pass to H. In this way the vessel D continues to be fed with mercury. In the compartment K there is a float, *k*, free to slide up or down on a rod, N, having on it two collars, *n n*. When the float rising meets the upper collar *n* and still farther rises it raises the rod N, and when the float descending meets the lower collar *n* and still farther descends it lowers the rod N. At the top of N are formed notches in which engages the one or the other of two spring-studs, *o o'*, exerting some force to hold the rod in either its raised or lowered position, but not sufficient to resist the action of the float *k* in raising or lowering the rod. As shown in Fig. 3, the rod N is in its lowest position, in which it is held by the spring-stud *o*. The rod N has two grooves cut circularly round it at *p* and *q* which, when N is down, coincide with passages—namely, *p'* communicating with the vacuum-pipe V, and *q'*, which is open to the air. When N is raised, *p* coincides with a passage, p^2, leading to the open air, and *q* with a passage, q^2, leading to the vacuum-pipe V. Thus N operates as a slide-valve, putting the two sides of a piston, P, alternately in communication with the air and the vacuum. As shown in Fig. 3, the piston P is kept down by the atmospheric pressure above it communicated by *q'*, caused by the vacuum below communicated by *p'*, and while the piston is in this position a valve, *r*, at the lower end of its stem is closed; but a valve, *r'*, at the upper end is open, so that the vessel K is in communication with the vacuum-pipe V, and mercury from the channel F flows into it. When the float K, acting on the upper collar *n*, raises the rod N, the ports *p'* p^2 and *q'* q^2 become alternated, and the piston P is now subjected to the pressure of the atmosphere on its under side and to vacuum on its upper side. The piston P thereupon rises, closing the valve *r'* and opening *r*, also uncovering a side opening, *s*, by which air enters, and, pressing on the mercury in K, causes it to flow up the pipe M to the upper compartment, L. When the compartment K is thus emptied, the float *k* again, pressing on the lower collar *n*, lowers the rod N and restores the parts to the condition shown in Fig. 3.

Having thus described the nature of our invention and the best means we know of carrying it out in practice, we claim—

1. The combination, with a mechanical exhausting-pump, of the upper and lower chambers, B and C, the former having its bottom provided with openings funneled at their upper ends, and the mercurial exhaust-tubes A, packed at their lower ends in the upper side of the lower chamber and having their upper ends funneled and extending into the funneled upper ends of the openings in the bottom of the upper chamber, substantially as described.

2. The combination, with a mechanical exhausting-pump, of the upper and lower chambers, B and C, the former having its bottom provided with openings funneled at their upper ends, the mercurial exhaust-tubes A, packed at their lower ends in the upper side of the lower chamber and having their upper ends funneled and extending into the funneled upper ends of the openings in the bottom of the upper chamber, and the mercury-containing vessel D in the said upper chamber, having in its bottom wall a series of holes, *d*, arranged to deliver the mercury into the funneled ends of the openings in the upper chamber, substantially as described.

3. In combination with a number of exhaust-tubes, A, an upper compartment, B, which contains a mercury-vessel, D, and is connected by a pipe, E, with vessels under exhaustion, and a lower compartment, C, which contains mercury maintained at desired level by an adjustable sluice-plug, *c*, and is connected by a pipe, G, with a vacuum-pipe, V.

4. In the lower compartment, K, a float-valve

apparatus consisting of a float, *k*, rod N, with its collars *n* and grooves *p q*, and governing-ports p' p^2 q' q^2, in combination with piston P and its valves *r r'*, air-port *s*, and vacuum-pipe V.

5. The combination, with the upper compartment, L, of the mercurial raising apparatus, of the connecting-pipe *h*, the valve h^3 in the mouth thereof, and the float-piston *h'*, having the rim h^2, provided with holes adapted to register with holes in the casing of the piston, substantially as described.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, this 30th day of July, A. D. 1886.

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