No. 608,176. Patented Aug. 2, 1898.

F. M. F. CAZIN.

PENSTOCK AND SUPPLY PIPE.

(Application filed May 26, 1897.)

(No Model.) 2 Sheets—Sheet I.

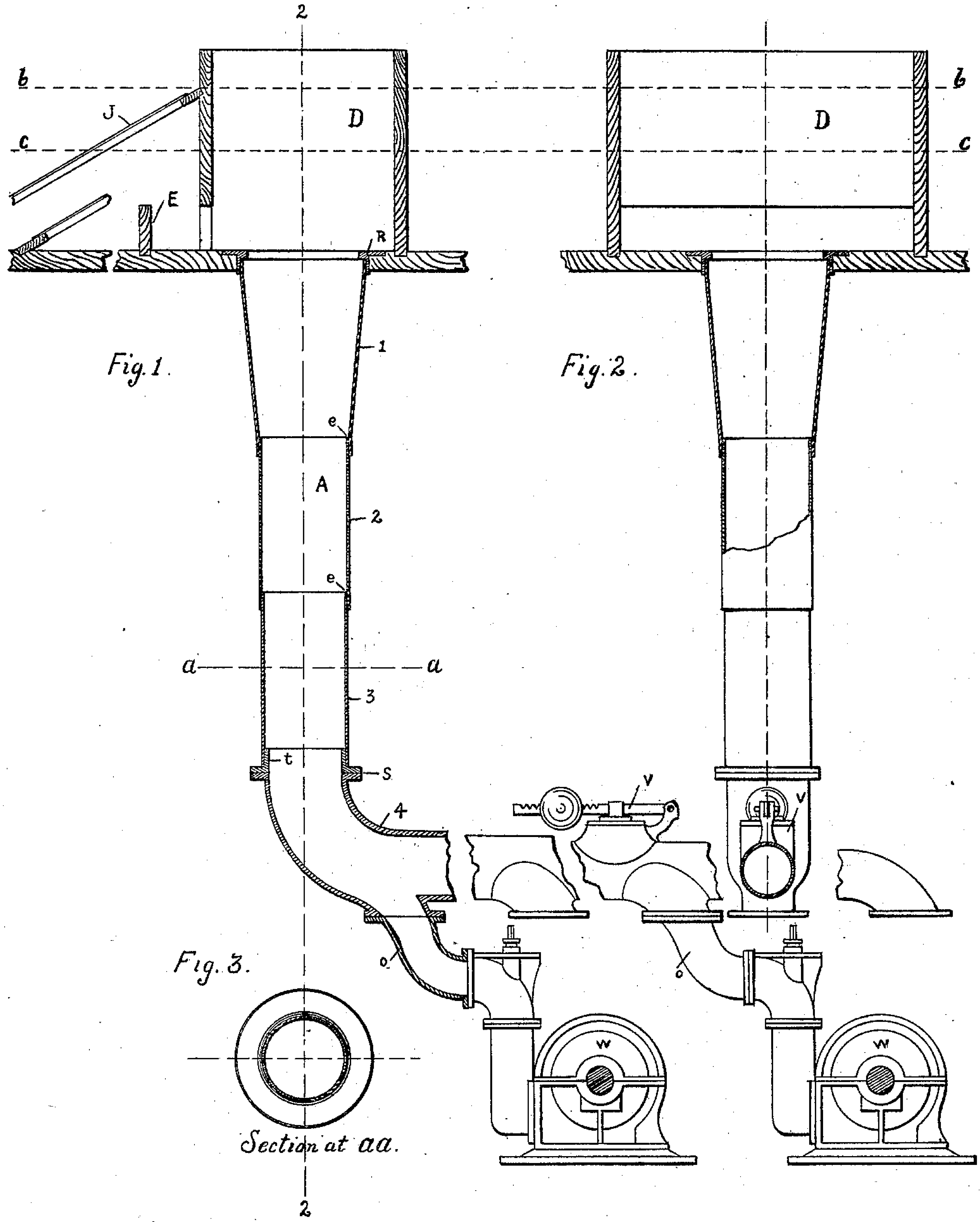

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Fig. 4.

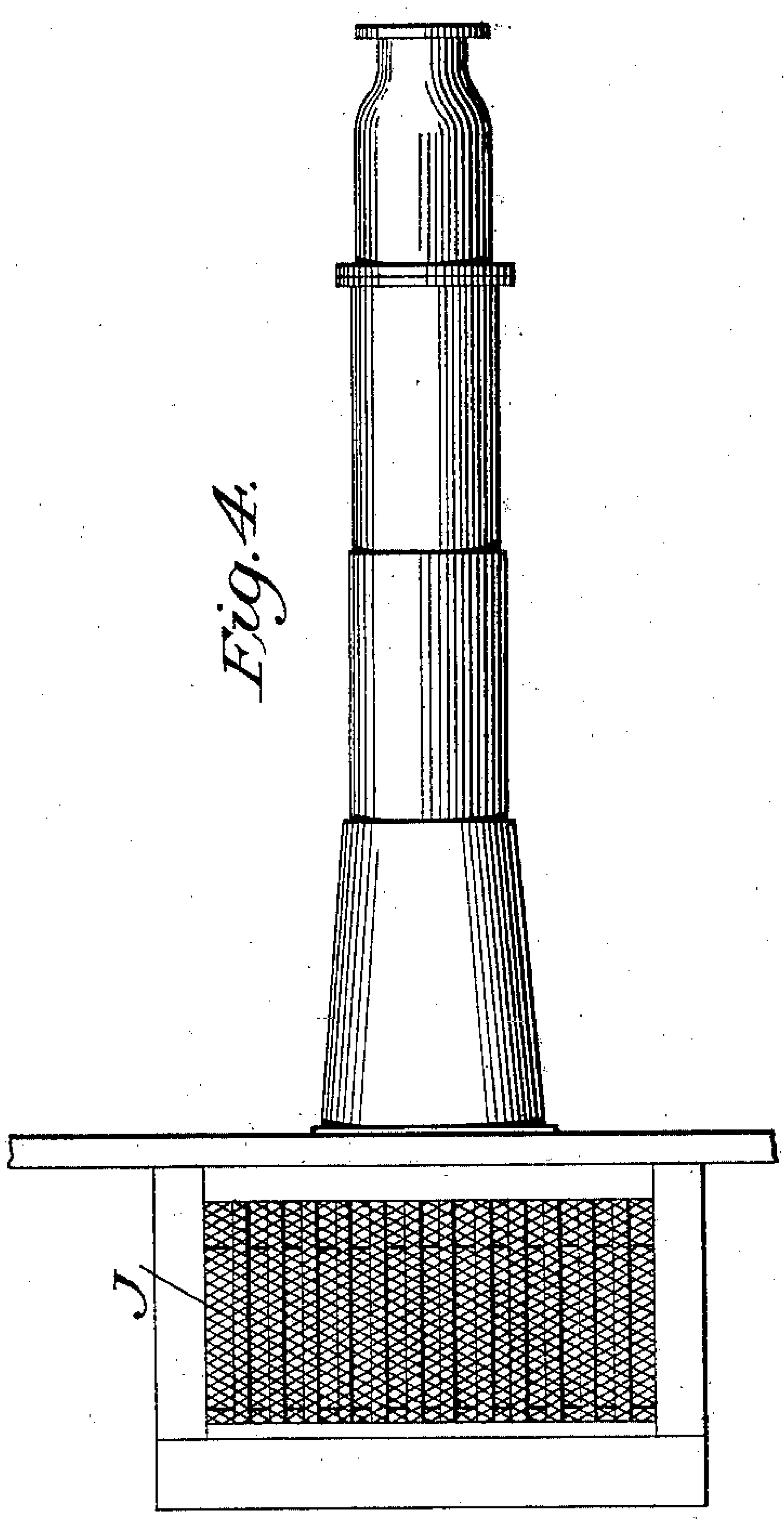
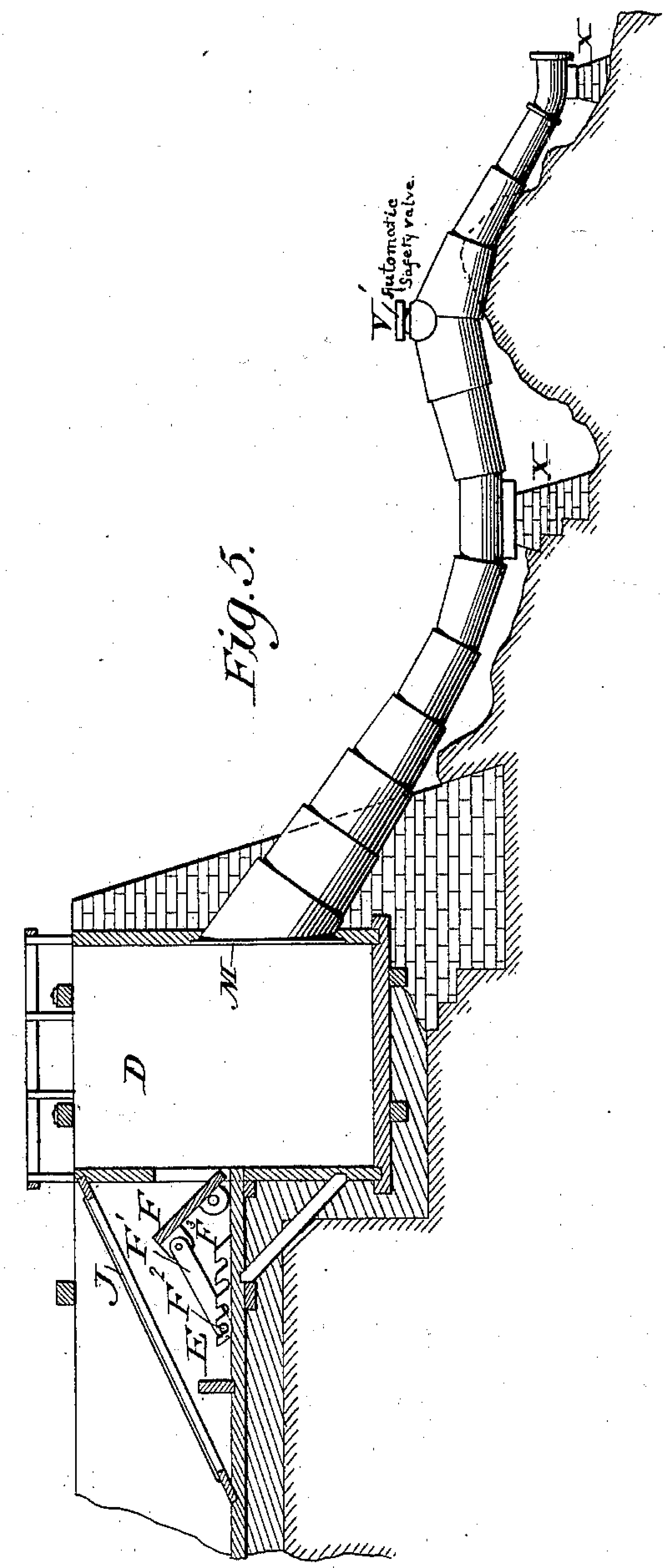


Fig. 5.



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UNITED STATES PATENT OFFICE.

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PENSTOCK AND SUPPLY-PIPE.

SPECIFICATION forming part of Letters Patent No. 608,176, dated August 2, 1898.

Application filed May 26, 1897. Serial No. 638,247. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS M. F. CAZIN, a citizen of the United States, residing at Hoboken, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Penstocks and Supply-Pipes; and I do hereby 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.

It is well known that when a body of water falls freely or without being confined different portions of such falling body at different distances from the point of initial fall, pass different distances (velocities) in a given unit of time—say a second—and that the distance so passed is in a known proportional relation to the total distance of the preceding fall, (head,) this action being the effect of gravity upon the moving liquid. It is also known to be true that if two points at different heights along the column be selected the same quantity of water will pass both points in a given period of time—say one second—though the velocity with which such quantity passes is different at different points, increasing as the distance of fall increases. The result is plainly that the column tends to contract from top to bottom in accordance with a determinable curve or taper—that is to say, inasmuch as just the same quantity of the more rapidly moving water toward the bottom of the column passes a given point in one second as passes another point higher up in the column at a slower rate per second it follows that the column at the selected point lower down is necessarily of smaller transverse section than the column higher up.

Now it often becomes of importance to make the best possible use of the power furnished by a falling column of water. Whenever use is to be made of a falling column of water, either a vertical penstock or an inclined head or stand pipe is made use of to confine therein the falling water, which is made to enter the same from a natural or artificial reservoir. Up to the present time no one, so far as I am aware, has in practice constructed a stand-pipe, head-pipe, pipe-line, or penstock with special relation to the natural laws above set forth, although I have myself published a formula for determining the diameter of a stand-pipe at any point in order to comply with the natural laws of the descent of water under gravity. Without the observance of the proper proportions in the construction of apparatus of this sort there is danger of impeding the fall of the water by not providing sufficient or adequate space for the water when falling in the shape that nature would give it were it to fall without being confined in a tubular conduit. Such sufficient or adequate space may be expressed by the transverse section of head-pipe or penstock, of which the former lies mainly on an incline and the latter stands mainly vertical; but aside from such sufficient or adequate space for the actually-falling liquid mass there is required a further or additional space surrounding the falling mass and also filled with water, which latter part of the liquid mass is intended to act as a lubricator between the falling liquid mass and the walls of the head-pipe or penstock.

It is not to be overlooked that a factor in the calculation of the required transverse section is the area of the current to be ejected and of the apertures of ejection at the lower end of the stand-pipe or penstock, which are, however, in general assumed as equivalent to the supply at the upper end thereof, though on account of less velocity of flow the latter must be larger than the former.

The object of my present invention is to provide a penstock, pipe-line, or head-pipe for hydraulic purposes of any sort, which head-pipe, pipe-line, or penstock shall present upon its interior approximately the lines of the true curve or taper, representing the gradual contraction of a column of freely-falling water as it descends. In order to secure the lubrication due to the presence of a sheet or film of comparatively still water outside the limits of this curve or taper, I not only increase the transverse section beyond the direct requirement of the falling liquid body, but I also prefer to construct the head-pipe, pipe-line, or penstock with internal shoulders, which accomplish the result desired, and these shoulders I preferably provide by inserting the following lower tube, with its end, into the preceding larger tube, as the one follows the other in enlarging the distance from the inlet.

To put the matter in another way, water which has an unimpeded fall moves under the law of gravitation in a conical form or in the form of an inversed frustum, constantly narrowing its transverse section and increasing its velocity, and to adapt the form of supply-pipe or penstock to the natural form in which water falls is the best method for preventing loss of forces; but aside from such adaptation of form the supply-pipe or penstock should leave, as stated, between the moving liquid mass or body and the solid wall of the pipe a comparatively non-moving sheet of liquid of sufficient thickness for neutralizing the greater part of the effect of adhesion between solid and liquid, leaving the effect of interhesion between the volumetric parts of the liquid exclusively as the cause of retardation. It is clear that the same law applies to stand-pipes which are inclined at an angle as to stand-pipes of the vertical or penstock type. Whenever it happens that the stand-pipe descends mainly upon an incline, but passes immediately over a higher elevation than that of the main line of inclination, then as the main head decreases the diameter of the stand-pipe will increase proportionately and again decrease after the intermediate higher level has been passed. The rule in such cases simply is that the pipe shall be of same diameter wherever the elevations are at the same distance below the main head.

In carrying my invention into practice I construct the supply-pipe or penstock in sections, each section being somewhat smaller than the section above in the completed structure. This is the general method which I employ in the manufacture, although if the succeeding sections should be very short I might make two or more of the sections of the same diameter. The succeeding sections of stand-pipe may be either cylindrical or tapering, according to circumstances. In general I find it to be convenient to insert the lower sections within the lower ends of the adjacent upper sections in such a manner as to leave an annular shoulder at or near the bottom of each section. This not only serves as a convenient method of joining the successive parts, but it also assists in maintaining, as above stated, just within the walls of each section a sheet or film of comparatively still water, which serves as a lubricator for the descending water in the interior of the pipe; and it is also an improved feature of the by-me-invented head or stand pipe or penstock that I adapt the strength or thickness of the material used in construction of the different parts thereof to the more or less strain to which they have to resist, as they are more or less distant from the lower end or outlet.

Besides the improvement indicated in the foregoing paragraph I have also provided means for keeping floating particles, as well as gravel, sand, or all bodies of other specific gravity than that of water, from entering the stand-pipe.

These improvements will be clearly understood by reference to the accompanying drawings, in which—

Figure 1 is a section of one form of stand-pipe with the parts appertaining to the system as a whole. Fig. 2 is a partial section along the line 2 2 in Figs. 1 and 3; and Fig. 3 is a cross-section along the line *a*, as in Fig. 1, looking upward. Fig. 4 is a rear view of the stand-pipe shown in Fig. 1; and Fig. 5 illustrates both a head-pipe, being mainly on an incline, and a modified form of head-pipe, in which the single sections as well as the entire pipe are tapering.

Referring to the drawings by letter, A is a penstock—that is to say, a vertically-placed head or stand pipe made up of sections 1, 2, 3, and 4, of steel or other sheet metal or of cast metal of sufficient strength. The uppermost section 1 is a piece of tapering pipe, growing smaller toward the bottom, where it is joined by rivets or otherwise to the top of section 2, so as to leave an annular shoulder *e* near the bottom of section 1. Section 2 is a cylindrical pipe somewhat smaller than the section 1, as is plainly seen in the drawings. It is joined to section 3 by rivets or otherwise, and a similar shoulder *e* is formed near the bottom of section 2. The third section (marked 3) is still smaller, and the section marked 4 is again smaller, this section being made of a casting of metal, the said casting being secured by a flanged joint *s* to a ring *t*, which fits within the lower end of section 3 and is riveted or otherwise secured thereto.

The section marked 4 is suitably connected with ejection-pipes *o o*, through which the descending water has an operative connection with water-wheels *w w*, as shown in Fig. 1. In connection with the system of pipes I prefer to employ safety-valves V V, as shown in Figs. 1 and 2. Other safety-valves V′ are employed at the summit of ascending portions of the pipe, as shown in Fig. 5, which aside from providing against an excess of pressure breaking the pipe also provide for causing the escape of air accumulating in the pipe.

At the top of section 1 the said section enters a metallic ring R and is suitably secured thereto by rivets or otherwise, the said ring R being secured to and forming a part of the floor (or side, as in Fig. 5) of the head-box D, constituting the terminus of the sluiceway, flume, or bed for the water-supply current. The said head-box is usually of wood, and it forms the entrance to the penstock or head-pipe proper. The normal height of high water in the head-box D is represented by the line *b b* and that of low water by the line *c c* in Fig. 1.

To prevent the introduction of gravel or other heavy matter into the head-box D and ultimately into the stand-pipe and the machinery operated by the hydraulic column, I introduce into the path of the water just before it reaches the head-box D a solid submerged weir E, which prevents the heavy particles from being carried over, to the injury of the apparatus and the machinery which it operates. Moreover, I keep out floating particles of light material by placing a shed or frame in front of the box D and over the cross-piece E, which shed or frame is provided with openings covered by a screen J, as shown in Figs. 1, 4, and 5, leaving ample room for the admission of the water, but retaining floating particles and preventing them from entering the apparatus. The screen is usually secured in place by being fastened to the shed or frame.

In Fig. 5 I have illustrated an inclined stand or supply pipe provided with the general features described above, but having tapering sections throughout instead of sections which are most of them cylindrical, as in the structure illustrated in Fig. 1. The said stand-pipe of Fig. 5 is suitably supported upon piers X X X, and it differs in no essential particular from the vertical stand-pipe already described. In order to form the proper connection with the first or uppermost section of the stand-pipe, I provide a casting M, suitably shaped to receive the upper end of the highest section of the stand-pipe and also suitably shaped to be connected by bolts or otherwise to the side of the head-box.

It makes no difference whether the term "head-pipe" be applied solely to the structure which is made up of the metallic sections, as described, or is made to include the box formed at the end of the race or sluice way. In the foregoing specification I have for the sake of clearness applied the term "stand-pipe," "head-pipe," or "penstock" to the main metallic structure described, which term may also include the wooden structures, such as the head-box or wooden pipes or penstocks.

It will be noted that wherever a straight line and a curve join each other in the interior of my penstock or stand-pipe the straight line is a tangent to the curve, and this arrangement extends throughout the entire system. It characterizes, in fact, also the structure of the buckets, which I make use of in my water and steam wheels, and I desire that this combination of lines conducive to free and natural flow of liquids and fluids be considered a feature of my system as a whole.

Referring again to Fig. 5, it will be seen that I provide in some instances an additional safeguard at the entrance to the head-box—namely, a door F, hinged at the bottom and connected by a pivoted brace F' to a rack F^3.

In the lower end of the brace F' is a pin F^2, engaging with the teeth of the rack. By means of the described door and its attachments the opening or openings into the head-box may be closed to any desired extent. When the door is completely closed, the pressure of the water will be sufficient to keep it closed.

Having described my invention, I claim—

1. A penstock, supply or stand pipe, the interior of which, in the direction of its length, presents approximately the curve or taper representing the natural contraction of a column of water which has the same head and the same area at the top of the column.

2. A penstock, supply or stand pipe, the interior of which, in the direction of its length, presents approximately the curve or taper representing the natural contraction of a column of falling water which has a certain head, and definite areas of entrance and ejection apertures.

3. A penstock, supply or stand pipe, the interior of which, in the direction of its length, presents approximately the curve or taper representing the natural contraction of a column of falling water which has the same head and the same area at the top of the column, a space being left, however, between the inner walls of the pipe and the area representing the true curve or taper.

4. A penstock, supply or stand pipe, the interior of which, in the direction of its length, presents approximately the curve or taper representing the natural contraction of a column of falling water which has the same head and the same area at the top of the column, the inner wall of the said penstock or pipe being shouldered, as shown, so as to cause outer sheets or films of the water to be held comparatively motionless and so to form a lubricator for that part of the water having the natural fall or descent.

5. An inclined supply or stand pipe, having descending and ascending portions, all below the main head, the interior of the said stand-pipe, from end to end, presenting approximately, in its descending portion or portions, the curve or taper representing the natural contraction of a column of falling water, and, in its ascending portion or portions a broadening curve or taper, representing the larger volume of falling water nearer the main head.

6. In a stand-pipe apparatus, a flume or sluiceway terminating at the top of the said stand-pipe, in a suitable head-box a frame or shed extending from the front of the said head-box into the path of the entering liquid, an opening in the said shed or frame, the said opening being covered by a suitable screen, as and for the purposes set forth.

7. In a stand-pipe apparatus, a sluiceway terminating at the top of the said stand-pipe, in a suitable head-box, and a screen standing in the path of the liquid as it enters the head-box.

8. In a stand-pipe apparatus, a sluiceway terminating at the top of the said stand-pipe in a suitable head-box, a screen entering the said sluiceway in the path of the water, and a solid cross-piece at the bottom of the sluiceway, for stopping the heavy material, as and for the purposes set forth.

9. A penstock, or supply-pipe, the interior of which, in the direction of its length, pre-

sents approximately the curve or taper representing the natural contraction of a body of falling water under gravity, the said penstock, head-pipe or stand-pipe having a suitable ejection aperture or apertures leading to one or more water-wheels, and being provided with one or more automatic valves as set forth.

10. An inclined supply-pipe having descending and ascending portions, all below the main head, the interior of the said pipe, from end to end, presenting approximately, in its descending portion or portions, the curve or taper representing the natural contraction of a column of falling water, and, in its ascending portion or portions, a broadening curve or taper, representing the larger volume of falling water nearer the main head, an automatic valve being placed at the summit of each ascending portion, as set forth.

In testimony whereof I have signed my name, in the presence of two witnesses, this 20th day of May, A. D. 1897.

FRANCIS M. F. CAZIN.

Witnesses:

J. R. VANDYCK,

R. SHIPPEN.