(No Model.) 4 Sheets—Sheet 1.

J. H. DALE.

STEAM GENERATING APPARATUS.

No. 294,119. Patented Feb. 26, 1884.

Fig. I

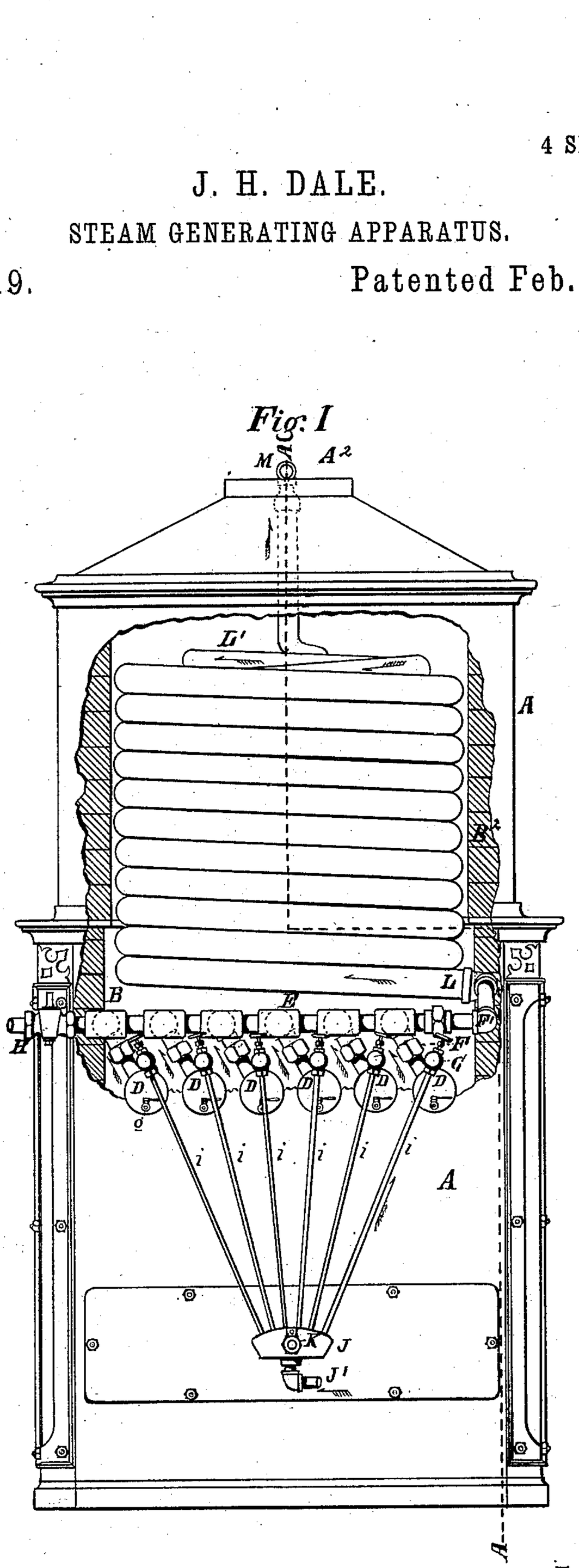

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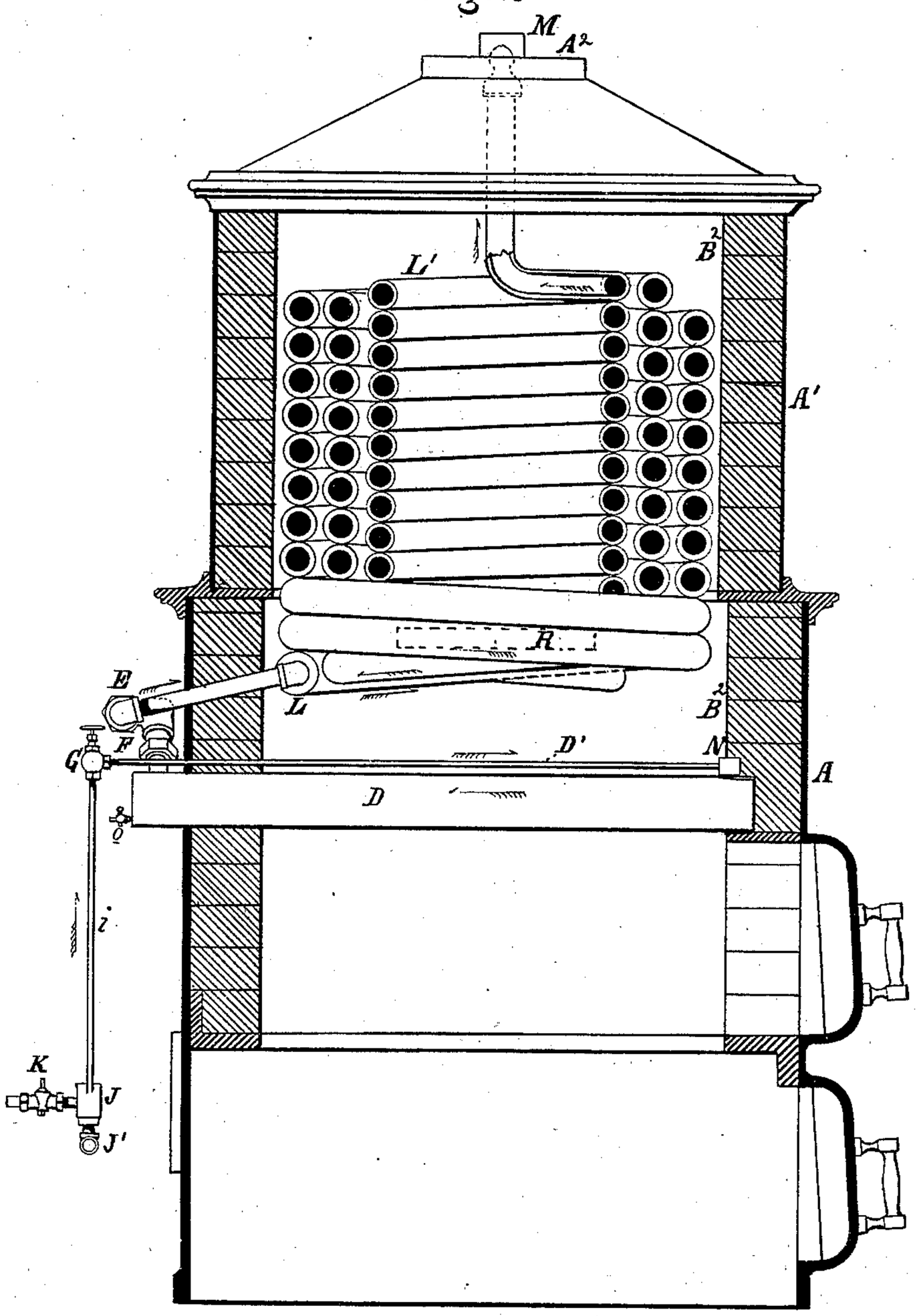
Fig: 2



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STEAM GENERATING APPARATUS.

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Fig. 3.

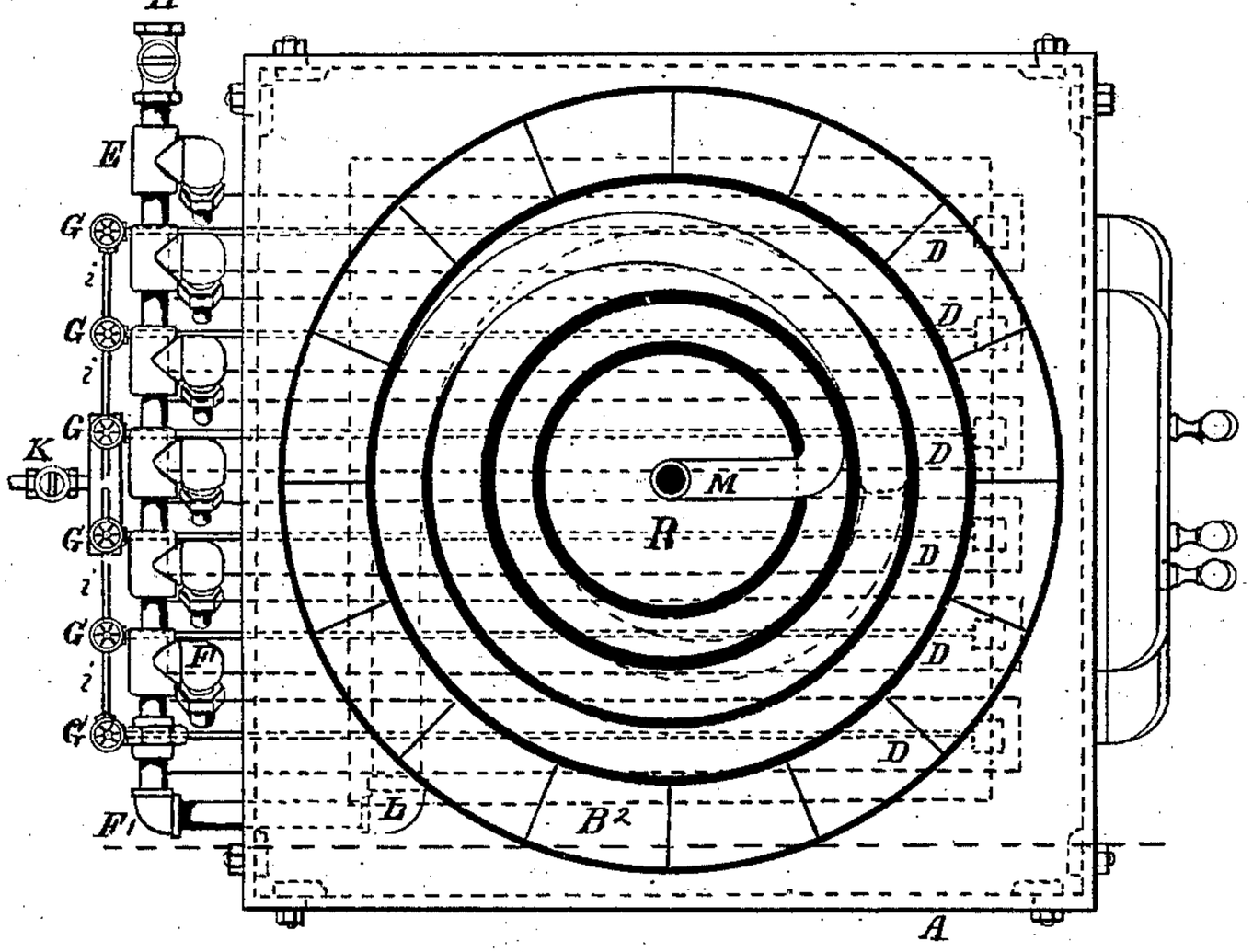


Fig. 4.

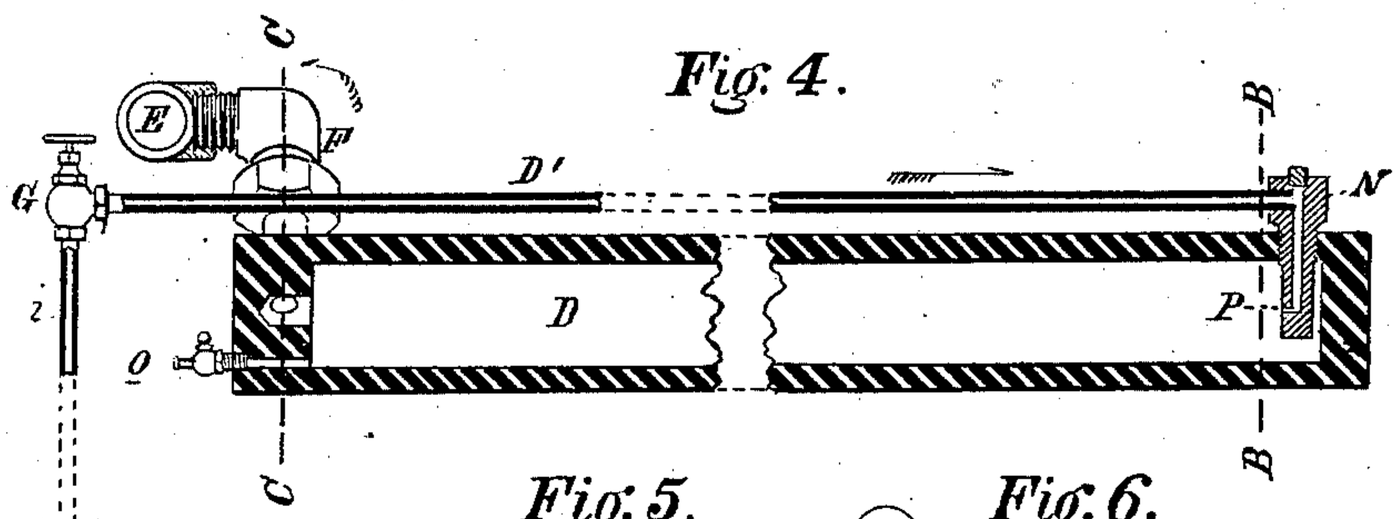


Fig. 5.

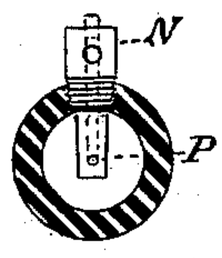
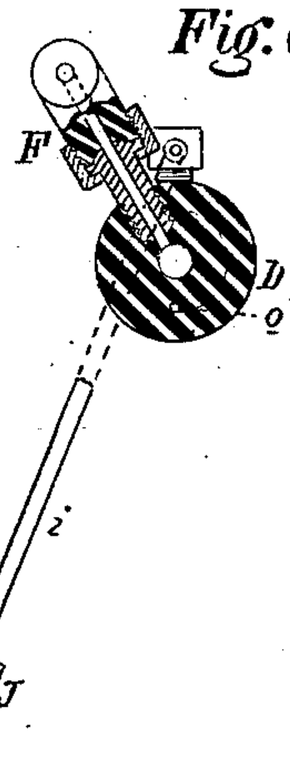
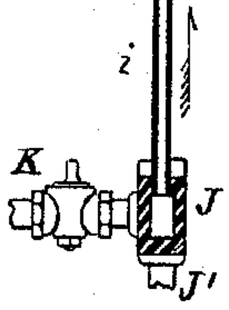


Fig. 6.





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STEAM GENERATING APPARATUS.

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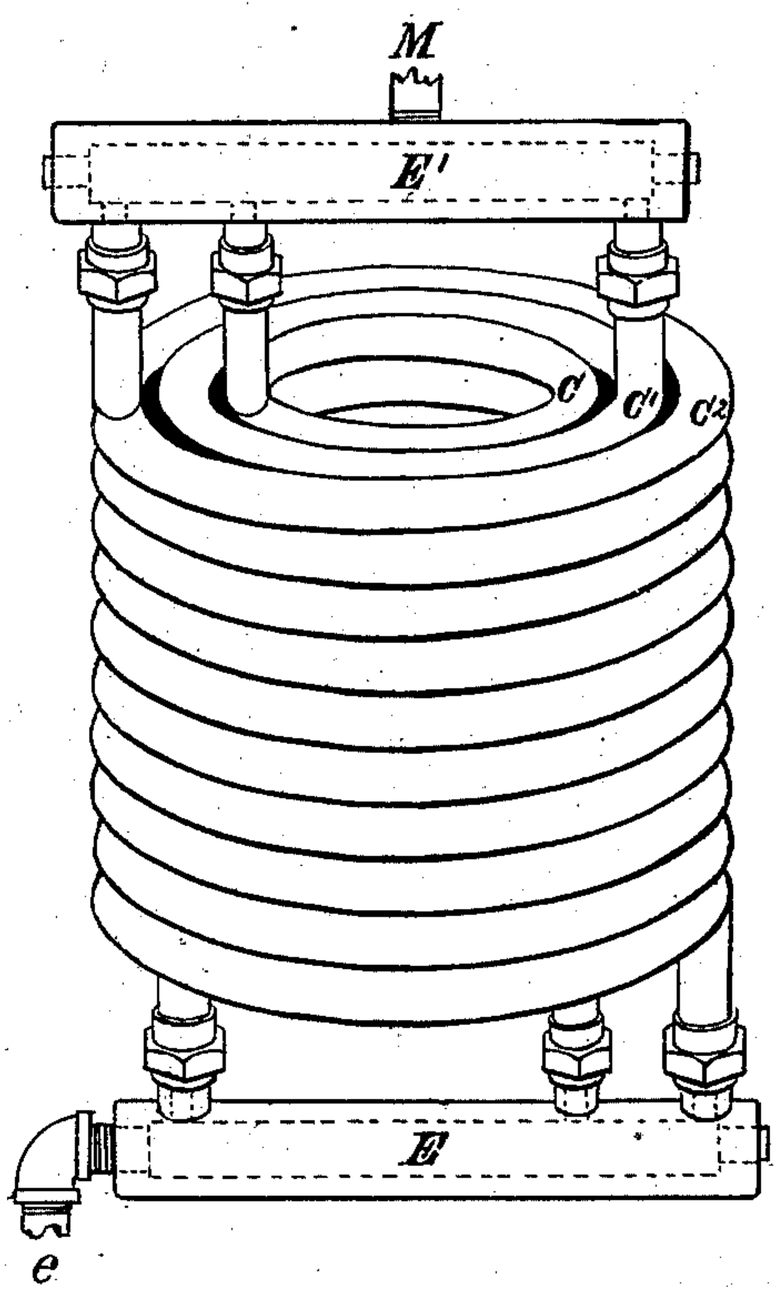
Fig: 7



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UNITED STATES PATENT OFFICE.

JOHN H. DALE, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF TWO-THIRDS TO ABRAHAM S. JENKS, OF SAME PLACE.

STEAM-GENERATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 294,119, dated February 26, 1884.

Application filed March 16, 1882. (No model.)

To all whom it may concern:

Be it known that I, JOHN H. DALE, of the city and county of Philadelphia, in the State of Pennsylvania, have invented certain new and useful Improvements in Steam-Generating Apparatus, of which improvements the following is a specification, reference being had to the accompanying drawings, which form part hereof, and in which—

Figure 1 is a rear elevation of my improved apparatus. Fig. 2 is a vertical longitudinal section on the line A A of Fig. 1. Fig. 3 is a plan or top view of the apparatus. Fig. 4 is a longitudinal section, on an enlarged scale, through one of the generators, (a middle section being broken out to save space in the drawings,) and showing in elevation the feed-pipes, (and attachments,) which also have sections broken out to save space. Fig. 5 is a transverse section at the line B B of Fig. 4. Fig. 6 is a transverse section at the line C C of Fig. 4, showing also the connection between the feed-supply and the generator; and Fig. 7 is a perspective view of the triple coil hereinafter described.

My invention relates to the class of instantaneous or injection steam-generators described and shown in Letters Patent of the United States, granted to John Everding and Abraham S. Jenks, numbered and dated, respectively, 213,556, March 25, 1879, 220,712, October 21, 1879, and 229,984, July 13, 1880; and it consists in certain improvements upon such steam-generators, as hereinafter specified, it being the object of my invention to simplify the construction of such apparatus, to enhance the efficiency of its operation and the facilities for controlling it, and to prevent its rapid deterioration from the action of the heat to which it is exposed.

My improved apparatus is represented in the accompanying drawings, and consists of a strong iron casing divided off by the grate-bars and generating-chambers into an ash-pit, a furnace, A, and a coil-chamber, A′. Above the coil-chamber the casing has a domed top, through the center of which the steam is conducted off from the steam-coil by a pipe leading to the point at which it is to be applied. The furnace and the coil-chamber are both properly lined with fire-brick or other refractory material, B′ B², and the furnace and the ash-pit have doors for the supply of fuel and the removal of ashes, Figs. 1 and 2. A smoke-stack is to be fitted in the domed top of the casing.

The generating-chambers or generators D are placed across the furnace side by side, as shown in Figs. 1, 2, and 3, their front ends being supported on the lining and their rear ends being supported in the casing, through which these ends project. In the drawings I have shown a series of six generators thus placed, each of them being constructed as shown in detail in Fig. 4—that is to say, my improved generating-chamber or generator D, Fig. 4, consists of a strong metal cylinder of sufficient length to occupy the position shown in Fig. 2, and of the proper diameter for the amount of steam to be made in it, the thickness of the metal being also proportioned to the pressure that the cylinder is liable to be subjected to. The best double extra-heavy, lap-welded, hydraulic tubing answers very well for these generators, the ends being closed by plugs welded into them. Through the upper side, at the forward end of this generator D, I drill a vertical hole, in which I fit a hollow plug, N, through which the water is injected into the generator through a lateral opening, P, Figs. 4 and 5, or directly through the plug. Through the lower side of the rear end of the generator I drill a horizontal hole, in which I fit a pet-cock, *o*.

Above the generator and parallel therewith I place a horizontal pipe, D′, of small diameter, supporting this feed-pipe at the rear end in the casing and fitting its forward end in the hollow plug N at the forward end of the generator. The rear end of this pipe D′ projects through the casing a sufficient distance to be fitted with a stop-valve, G, for regulating the flow of water through the feed-pipe D′. This valve forms a connection between the feed-pipe D′ and a pipe, *i*, which extends downward to a tank or other water-supply, and a similar connection is made between each of the generators D and the water-supply, these connections *i* being independent of each other and radiating from the water-supply to the generators severally, as seen in Fig. 1. constituting what I have designated as my "dis-

tributing-manifold," and marked J in the drawings. Each of the generators is provided with a petcock, to show how much water is passing to the generator. This distributing-manifold J is connected through the pipe J′ with a pump, which forces up the water-supply, and I also provide a blow-off cock, K, Fig. 1, through which I can drain out the generators and the coil. Into the outer end of each of the generators D, I securely insert the lower end of an elbow-joint, F, Figs. 4 and 6, the other end of this elbow being fitted properly into a strong pipe, E, which extends across the furnace at right angles to the line of generators, (so that this pipe E receives the steam from each of the generators through this connection F, Fig. 6,) and the pipe E extends so much farther than the generators as is necessary for the connection of one end of it by an elbow-joint, F, Figs. 2 and 3, with the lower end, L, of the coiled steam-pipe, the diameter of the pipe E being properly the same as that of the coiled steam-pipe, Figs. 1, 2, and 3. Upon the opposite end of the pipe E, I attach a blow-off cock, H, through which the contents of the steam-coil can be blown off in a few seconds, thoroughly cleaning the coil and freeing it from all accretions of foreign matters. This pipe E, with the above-described adjuncts, constitutes what I have designated as my "collecting-manifold." In the drawings I have shown this pipe E as made up of short joints connected by sleeves; but in practice I contemplate making it of a single length of strong lap-welded hydraulic tubing, or of copper pipe of suitable strength and weight.

The superheating steam-coil L is also properly to be made of lap-welded hydraulic tubing, or of drawn copper, or of seamless drawn steel. I start with a smaller pipe, L′, Fig. 2, for example, of one and a quarter inch diameter, which I wind upon a mandrel into the inner coil, having an interior diameter of about thirteen inches, Fig. 2, and to the end of this coil I weld on the reduced end of a similar pipe, L, of larger diameter—for example, one and a half inch—which larger pipe is coiled upon the inner coil and then coiled again upon itself, as seen in Figs. 2 and 3, which gives a good length, as I have found in practice. One end of this continuous triple coil is then carried up through the dome of the casing and connected with the pipe that leads to the engine. The other end of the continuous coil L being connected with the collecting-manifold E, as already described, it will be seen that I have a free course for the steam from the manifold E outside of the casing through the triple coil in the steam-chamber to the engine.

As this completes the apparatus, we may now follow its operation, which is as follows: A fire being started in the furnace, a small quantity of water is forced by the pressure from the tank into the distributing-manifold J, and into the pipes D′, and injected through the hollow plugs N, into the forward ends of the respective generators D. As soon as the heat is sufficient to form steam, the pump is started slowly, so as to establish the feed-supply through the distributing-manifold. The feed-pipes D′ will meanwhile have become heated up, and the feed-supply passing across the furnace through these pipes will be hot when injected through the plug N into the front ends of the generators. These generators being now also heated, the injected feed-water will rapidly be converted into steam, and the pressure of this steam will increase with its volume and with the heat of the forward part of the generator, so that its tendency toward the outlet into the collecting-manifold E (shown in Fig. 6) will be increased at each moment, and after reaching the manifold the movement of the steam toward the coil will receive a fresh impulse from the increasing supply coming from the several generators and from the accession of heat, and the coil itself having meanwhile been heated up, the steam will, by the time it has traversed the entire length of the triple coil, be exceedingly dry and of very high temperature, so that it will issue from the coil under great pressure.

To insure a better distribution of the heat about the coil-pipe, I secure a deflecting-plate, R, Figs. 2 and 3, beneath the open center of the coil, and thus counteract the tendency of the heat toward this open space, and prevent the inner coil from being unduly heated, as well as insure a uniform diffusion of the heat about all the coils. If it be found that any one of the generators is overheated, thus indicating some deficiency in the supply of water thereto, such deficiency can readily be supplied by partially opening the valve G of the obstructed generator and partially closing the corresponding valves of the others, thereby increasing the supply to the former and diminishing the supply to the others. Once thus adjusted, the supply will continue as regulated until some new obstruction again impedes it.

In the foregoing description I have given the best form of the apparatus as I have it in practice, and have only to add that I contemplate making the generators of copper, which can be cast with closed ends, and the coil also of drawn copper; or I may make both the generators and the coil of seamless drawn steel pipes or tubes.

I also contemplate introducing the jet of feed-water through the forward end of the generator, instead of through the top, as shown in the drawings, it only being necessary for this purpose to carry the feed-pipe D′ past the forward end of the tube D and downward far enough to fit into a hollow plug inserted horizontally through this end of the generator. I have sometimes found that under exceptional conditions the feed-pipes D′ become so highly heated that the small quantity of water flowing through them is converted into steam before it reaches the plug N. To correct this it is only necessary to slip over the pipe D another pipe

of so much larger size as to leave a small annular space around the feed-pipe, which will by this means be kept at a temperature such as will not generate steam therein.

I also contemplate changing the positions of the distributing and collecting manifolds—that is to say, I may place the distributing-manifold at the front of the casing and the collecting-manifold at the opposite side; but as this change would merely demand a corresponding change in the relative arrangement of the details, I need not describe it more particularly than to say that in all cases the feed-water is to be injected at one end and the steam to be take out at the end opposite to that at which the water is injected, as already described, and in order to retain the advantages of this system already mentioned.

I contemplate also using, instead of a single continuous coil, as shown in Figs. 1, 2, a multiple coil, such as is shown in Fig. 7 of the drawings. In this case each of the coils C C′ C^2 is separate, and each has an independent receiving-connection with the manifold E and an independent discharging-connection with the pipe M. The coils are in this case wound separately on mandrels, and are fitted one into another, as shown in this figure. The lower end of each coil is carried down and connected with the collecting-manifold E, which receives the steam from the generators through one end, as shown at *e*, Fig. 7. The upper end of each coil is carried up and connected with a second collecting-manifold, E′, from which the pipe M delivers the steam to the conduit-pipe leading to the engine. This second manifold is closed at both ends, and only has the three connections with the coils respectively, and those, being in the upper part of the casing, will not be subjected to any destructive temperature. The operation is simply modified, in that the steam will pass from the lower collecting-manifold, which thus becomes also a steam-distributer, through each of the coils separately, and issues in a separate current from each of the coils into the upper manifold, E′, where these several currents will unite and pass off through the pipe M. The advantage of this arrangement is chiefly that by having separate coils instead of a continuous coil, one coil can be removed and replaced without removing the entire nest, and, further, the number of coils can be greater than would be practicable where one continuous coil is used, and a greater capacity can thus be obtained in the apparatus. It is obvious that in this arrangement the upper ends of the coil may be connected with the ends of the upper manifold; or this upper manifold may be substituted by a hood-connection of the ends of the coils directly with the exit-pipe M.

Having thus described the nature and objects of my invention, what I claim therein as new, and desire to secure by Letters Patent, is—

1. The combination, substantially as hereinbefore set forth, of the furnace, the water-distributing manifold, the series of feed-pipes connected therewith, the generators extending transversely through the furnace, each connected with its respective feed-pipe and interposed between it and the furnace, the steam-outlets at the opposite end of each generator from its feed-inlet, and the steam-collecting manifold, with which all the generators are connected.

2. The combination, substantially as hereinbefore set forth, of the furnace, the water-distributing manifold, the feed-pipes connected therewith, extending transversely through the furnace, the generators, each connected with its respective feed-pipe and interposed between it and the furnace, the steam-outlets at the opposite end of each generator from its feed-inlet, the steam-collecting manifold, with which all the generators are connected, and the continuous superheating-coil, through which the products of combustion pass from around the generators interposed between the furnace and the superheating-coil.

3. The combination, substantially as hereinbefore set forth, of the furnace, the water-distributing manifold, the feed-pipes, the generators connected therewith, the steam-collecting manifold, the superheating-coil, and the deflector interposed between the central opening of the coil and the generators to diffuse the heat among the coils.

4. The combination, substantially as hereinbefore set forth, of the furnace, the water-distributing manifold, the feed-pipes, the generators, the lower steam-collecting manifold, E, the series of independent concentric or multiple superheating-coils connected therewith, and the upper collecting-manifold, E′, with which all the superheating-coils are connected.

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