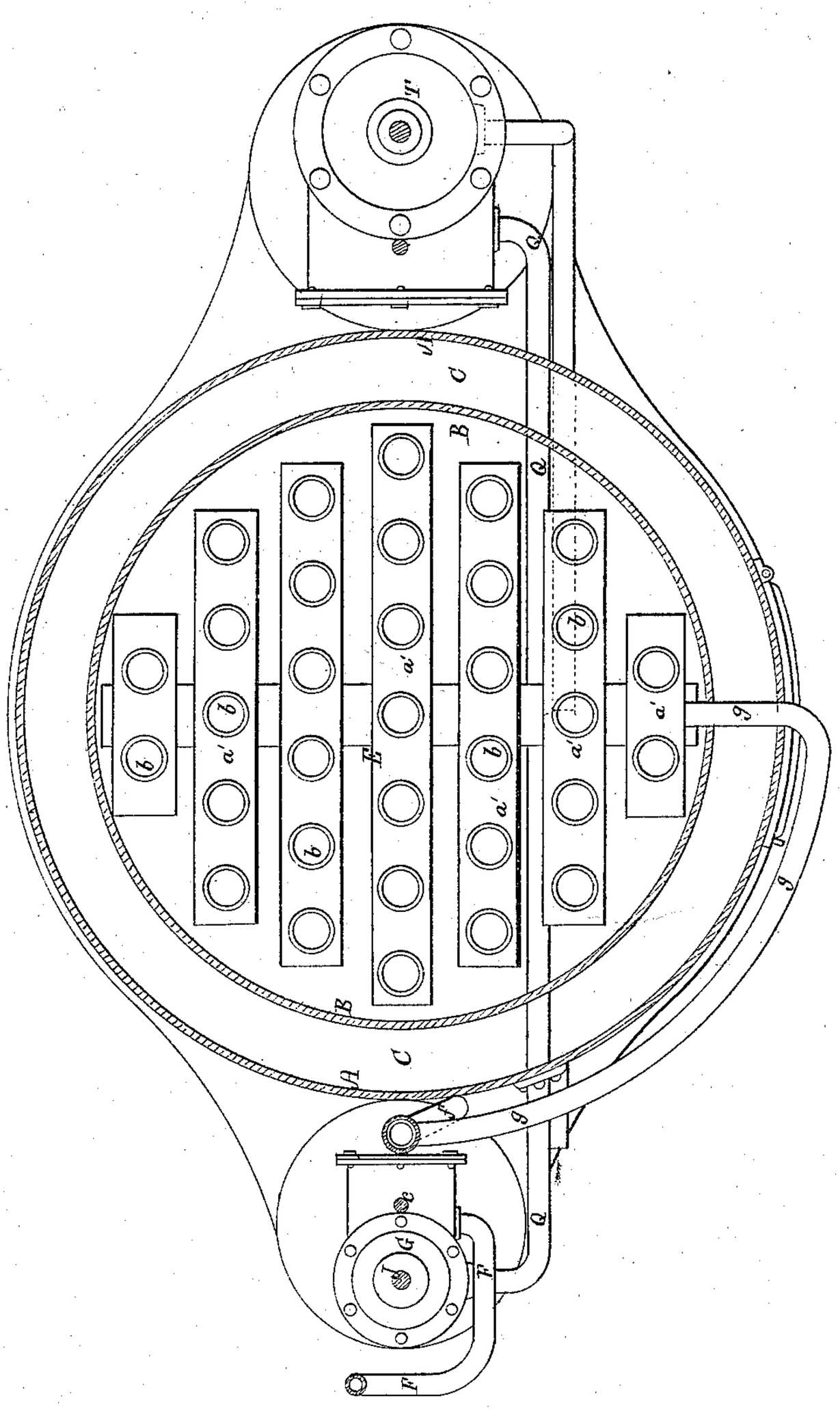
2 Sheets--Sheet 1.

J. H. MILLS.

Steam-Generators.

No. 138,269. Patented April 29, 1873.



Witnesses.
H. C. Saunders
W. E. Boardman.

John H. Mills.
P. Curtis. Att'y.

2 Sheets--Sheet 2.

J. H. MILLS.

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Fig. 3.

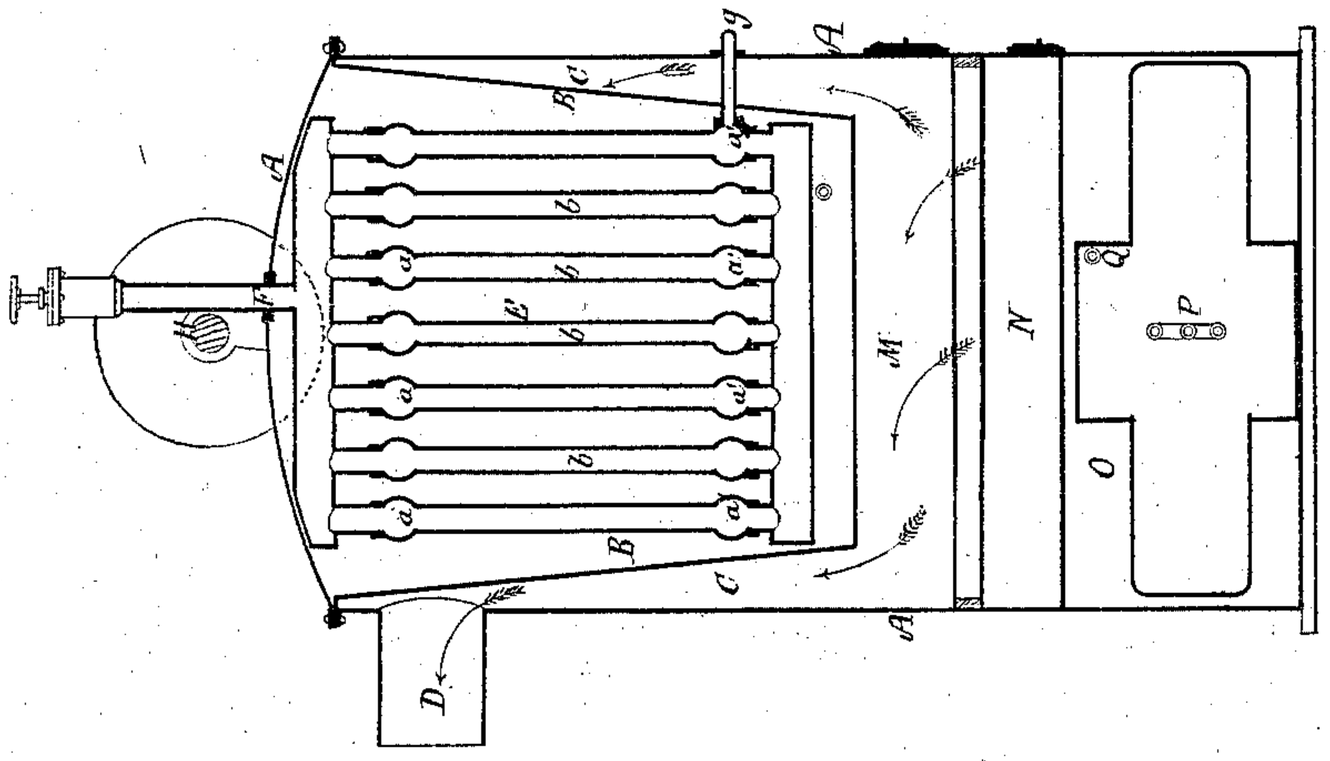
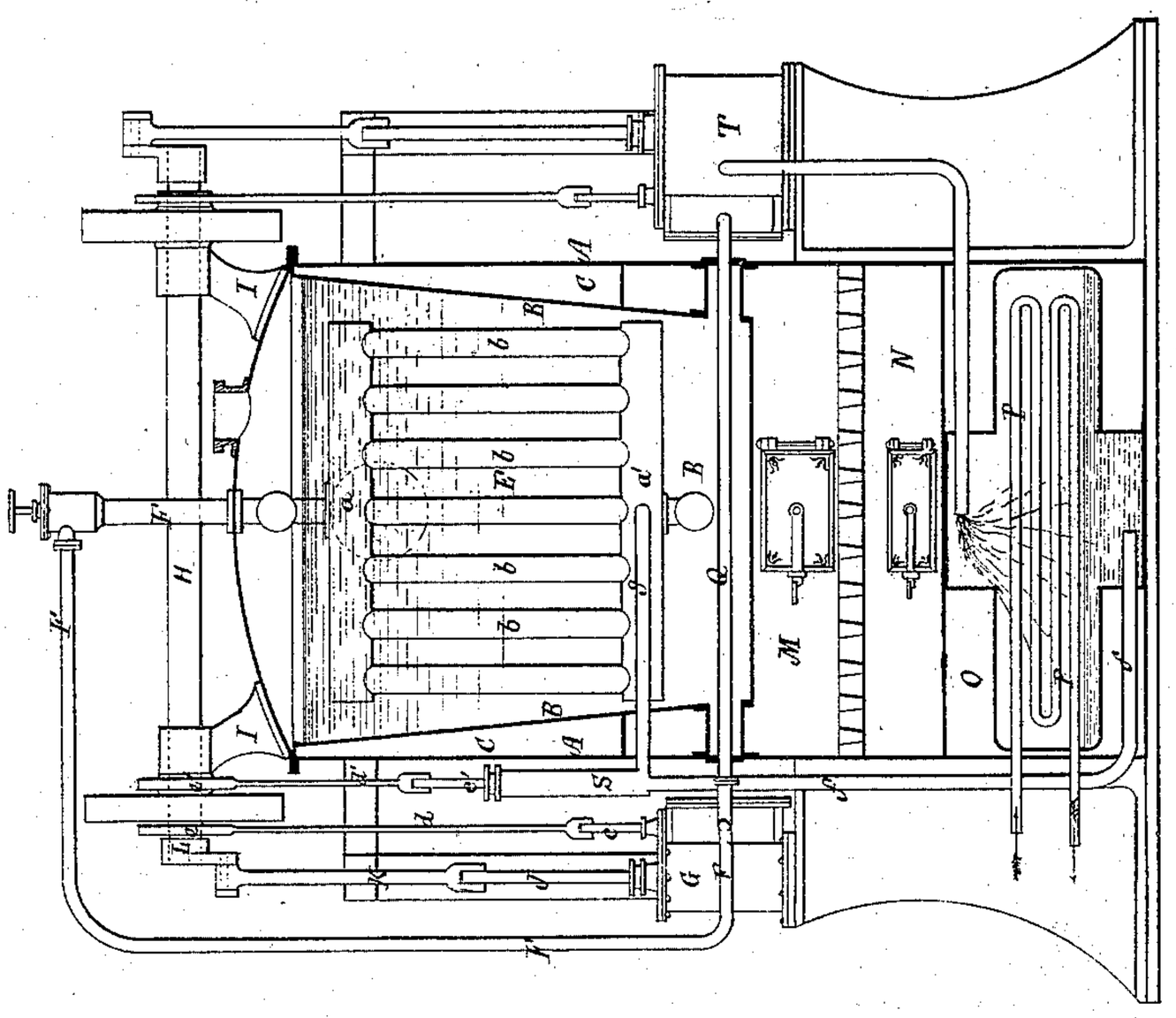


Fig. 2.



Witnesses.
H. C. Saunders
H. E. Boardman.

John H. Mills.
F. Curtis. Atty.

UNITED STATES PATENT OFFICE

JOHN H. MILLS, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN STEAM-GENERATORS.

Specification forming part of Letters Patent No. **138,269**, dated April 29, 1873; application filed October 23, 1872.

To all whom it may concern:

Be it known that I, JOHN H. MILLS, of Boston, Suffolk county, Massachusetts, have invented a novel and useful Steam-Generator, of which the following is a specification:

This invention relates to the generation of steam from a liquid more volatile than water, the object being to obtain a given power from less fuel than practicable where water is the fluid from which the steam is generated, and to secure, as far as possible, absolute safety against liability of excessive steam-pressure in the generator. In order to obtain this result I have devised a steam-generating apparatus, in which the boiler or generator containing the sensitive fluid is heated by means of water or other liquid contained in a holder surrounding said generator, which holder is open or practically open to the atmosphere, so that the water or other liquid-heating medium contained in it can never be raised to a temperature beyond the boiling-point. Thus the sensitive fluid in the generator can never be acted on by a heat greater than that which the surrounding liquid-heating medium possesses at its boiling-point, which heat will vary according as the particular liquid-heating medium has a higher or lower boiling-point. For most purposes I prefer to use water as the heating medium, as its boiling-point, 212°, is sufficient to impart the requisite heat to the sensitive fluid. But in some instances it may be desired to raise the pressure of steam to a higher point than 212° Fahrenheit will produce; and in this case I can either employ a steam-generating liquid of greater volatility than the bisulphide of carbon, (which is the sensitive liquid which I prefer to employ,) or I can use a less volatile liquid than water as a heat-transmitting medium, or one that will require a greater degree of heat than 212° Fahrenheit in order to be vaporized. (Oils, for instance, can be used for this purpose to impart a higher degree of heat to the generator without raising such substances above or even as high as their boiling-points;) and thus as high a pressure of steam as desired may be attained without departure from my invention, the holder for the liquid-heating medium remaining at all times open, or practically so, to prevent the accumulation of any vapor or steam from said medium, which thus remains at all times without pressure, and is not under confinement, no matter how much heat is imparted to it from the furnace.

Of the various volatile fluids which are available for my purpose I prefer to employ bisulphide of carbon, as imparting good results at comparatively low cost, this liquid rendering steam of a pressure of about sixty-five pounds to the square inch from 212° heat.

In the drawing accompanying this specification I have represented, in Figure 1, a horizontal section, and in Figs. 2 and 3, vertical sections, of one form of a steam-generator and engine and their adjuncts, in which the principle of my invention may be carried out, and I have adopted, in this instance, a double-cylinder engine—that is to say, one containing two cylinders, a primary one in which direct steam is employed, and a second of larger diameter, in which the exhaust steam from the first operates, this duality of cylinders, however, being in nowise essential to the development of the principle of my invention, but being embodied herein as exhibiting to perhaps better advantage the merits of such principle.

In the drawing accompanying this specification, and illustrating my invention in one practical form of embodiment, A represents an upright cylindrical shell or structure, which incloses within it the greater portion of the entire steam-generating apparatus. Within the upper part of this shell A I dispose a water receiving and heating tank, B, of somewhat less diameter, in order to obtain a heat and smoke distributing chamber, C, from the upper part of which a smoke-discharge flue, D, conducts the smoke, gases, and waste products of combustion from the furnace below.

As above stated, the tank B should be open or practically so to the atmosphere, to permit the discharge of any vapor or steam generated from the heat-transmitting liquid by the heat from the furnace, so that the heat imparted to the generator may in no event exceed that of the liquid at its boiling-point. For this purpose the filling-orifice of the tank may be open, as shown.

Within the water-heater C I dispose the generator E, which may be of any suitable form, as I am not limited in this respect, the

generator, as herein shown, consisting of a series of upper and lower horizontal pipes, *a a a' a'*, &c., connected by vertical ranges *b b b*, &c., open communication being established between them, and the entire cluster being submerged, partially or entirely, in the water contained in the tank B. The steam-delivery pipe leading to the cylinder of the engine is shown at F as erected upon and communicating with the interior of one of the upper pipes, *a*, thence rising through the dome of the structure A, and passing to the steam-chest of the engine-cylinder, which is represented in this instance at G as a vertical one, and situated at one side of the structure A. The driving-shaft of the engine, which is horizontal herein, is shown in the drawing at H as revolving in bearings I I, erected upon the dome of the shell A, the piston-rod of the cylinder G being shown at J, the connecting-rod of the same at K, and its crank at L, the valve-rod at *c*, and its pitman at *d*, and eccentric at *e*, such parts being arranged after the ordinary method of vertical steam-engines. The furnace of the apparatus is shown at M, as of any proper construction, and disposed below the water-heating tank B, and within and spanning the area of the structure A, the ash-pit, shown at N, being disposed below the furnace in the usual manner.

As the engine herein illustrated is a condensing-engine to prevent waste of the material within the generator, which material I prefer at present should be bisulphide of carbon, a suitable condenser must be provided; and to this end I dispose in a close chamber or drum, O, which is situated below the ash-pit, a cluster or coil of pipe, P, the chamber being to receive the exhaust steam from the engine-cylinder, and the pipe to receive a current or blast of cold air from a blowing-engine to immediately condense the steam surrounding it. The exhaust-pipe is shown in the drawing at Q as leading from the cylinder G, and passing horizontally through the lower part of the water-tank B; thence into and discharging within the condenser, as shown in Fig. 2. The water feed-pipe returns the condense-water from the condensing-tank O to the generator, the water being elevated from such tank by a suitable force-pump, which is exhibited in the accompanying drawing at S, its suction-pipe for taking the condense-water being shown at *f*, and its discharge-pipe, which ejects it into the generator, being shown at *g*, the latter leading from the pump to and discharging into one of the lower pipes *a'* of the generator. The valve-rod of the pump S is shown at *c'*, its pitman at *d'*, and its eccentric at *e'*, the latter being mounted upon the driving-shaft H, before alluded to.

The operation of this engine, being on the principle of any condensing-engine, will be readily understood: The vapor or steam from the volatile and sensitive fluid within the generator B passes through pipe F into the cylinder G, and having performed its office therein exhausts through pipe Q into the condenser O, from whence it is raised by the pump S, and injected into the generator B to be reconverted into steam by the heat of the water surrounding such generator.

As I have hereinbefore stated, the principle of my invention appears to good advantage when applied to the double-cylinder engine; therefore I have adopted, in the present instance, a second cylinder, which is shown in the accompanying drawing at T, as a vertical one, and disposed alongside of the structure A in manner similar to the disposition of the primary cylinder G, but upon the opposite side of such structure, the exhaust steam from the primary cylinder entering the auxiliary cylinder T and actuating its piston, and thence exhausting into the condensing-chamber O, as shown in Fig. 2. As above stated, the exhaust-pipe from the first cylinder leads through the water-tank on its way to the second cylinder. The object of this is to reheat the exhaust steam, at the same time preventing it from being subjected to greater heat than that to which the sensitive fluid in the first instance is subjected.

Among many advantages attaching to this apparatus the following are prominent: First, as the vapor of the volatile material at sixty-five pounds, from which I generate steam, contains only about one-fourth as many units of heat or mechanical equivalents as steam from water at the same pressure, and as I utilize a large portion of this heat in the cylinder of the engine, I have only to abstract the small remaining portion to secure the desired vacuum; and especially if the double-cylinder engine, before named, be employed the power obtained from the auxiliary and larger cylinder and piston would equal if not exceed that derived from the direct pressure on the primary and smaller piston, for the reason that the small amount of heat and air to remove from the condenser enables me to obtain a vacuum more nearly perfect than could otherwise be effected. Second, in the event of adopting the double-cylinder engine, I propose, as herein stated, to place the two cylinders and their mechanism upon opposite sides of the generator, and conducting the exhaust-pipe from the first cylinder through the water or other agent which heats the steam-generating liquid, by which means I simplify the construction and reduce the cost of the engine, and entirely obviate liability to over pressure of steam between the cylinders, owing to the uniformity of temperature of the heating fluid or agent, which never exceeds the boiling-point, for the reason that it may be open to the atmosphere, if desirable. Third, an important advantage of this system of generating steam, compared with the use of water as a steam-generating fluid, consists in the fact that neither the inside or outside surface of the generator-tubes ever becomes foul or deteriorated, for the reason that the salts and lime precipitated from water are not present in the volatile fluid to injure

the interior of the tube, and soot cannot get access to the exterior of the same, for the reason that they are submerged or surrounded by water, and not exposed at all to the direct action of fire, smoke, or gases. Fourth, owing to the low degree of heat required, and the immunity of the generator pipes or flues from the action of the same, not only these pipes but the entire furnace is exempt from the rapid destruction now common to such apparatus from the excessive heat of the fires. Fifth, from what has been said it will be evident that I have in my system obtained perfect safety from explosion, since the water or other heating medium, being open to the atmosphere, can never derive a temperature above the boiling-point from any degree of heat in the fire, while, as a still further economy and advantage, I reduce the loss of heat by radiation to a great extent, as the temperature of the entire apparatus is very materially less than when vaporizing water, while if the fluid in the vaporizing-generator should, by accident or neglect, be allowed to entirely evaporate no injury would result, as the temperature of the heating medium would not be sufficient to injure such generator. This engine, as compared with steam, possesses many minor advantages, and in marine service will be found valuable, for the reason that as a very small amount of fresh water is requisite no large tanks or condensing apparatus are necessary, and their space may be used for freight; also, the space now occupied by fuel and by steam boilers and engines may be considerably reduced and utilized. For locomotive-engine use the watering-stations and the delays thereat may be avoided, and the stoppages for fuel less frequent. Owing to the rotative condensing and circulating principle of the vaporizing fluid involved in this engine, little waste of such fluid results, as the small amount of vapor which would result by reason of bad joints, &c., in a well-made apparatus would be so small a percentage as not to be of practical account.

Claims.

I claim—

1. In a system of generating steam from a sensitive fluid, as described, in which two differential cylinders are employed for purposes stated, the method, substantially as herein shown, of reheating the exhaust steam in transit from the primary to the auxiliary cylinder by passing the exhaust-pipe through the tank containing the water or other liquid heating medium, substantially in the manner set forth.

2. The combination of the generator E for containing the sensitive fluid, the surrounding water tank or jacket B, the condensing-pipe Q, and the primary and auxiliary cylinders G and T, said parts being arranged for joint operation, substantially as shown and described.

3. In combination with the sensitive-fluid steam-generator and the surrounding water tank or receptacle, the heating-chamber C and the furnace communicating with said chamber, under the arrangement and for operation as shown and described.

Witnesses: JOHN H. MILLS.

FRED. CURTIS.

W. E. BOARDMAN.