No. 616,532. Patented Dec. 27, 1898.

J. M. A. GÉRARD.

STEAM GENERATOR.

(Application filed Dec. 28, 1897.)

(No Model.) 2 Sheets—Sheet 1.

FIG. 1.

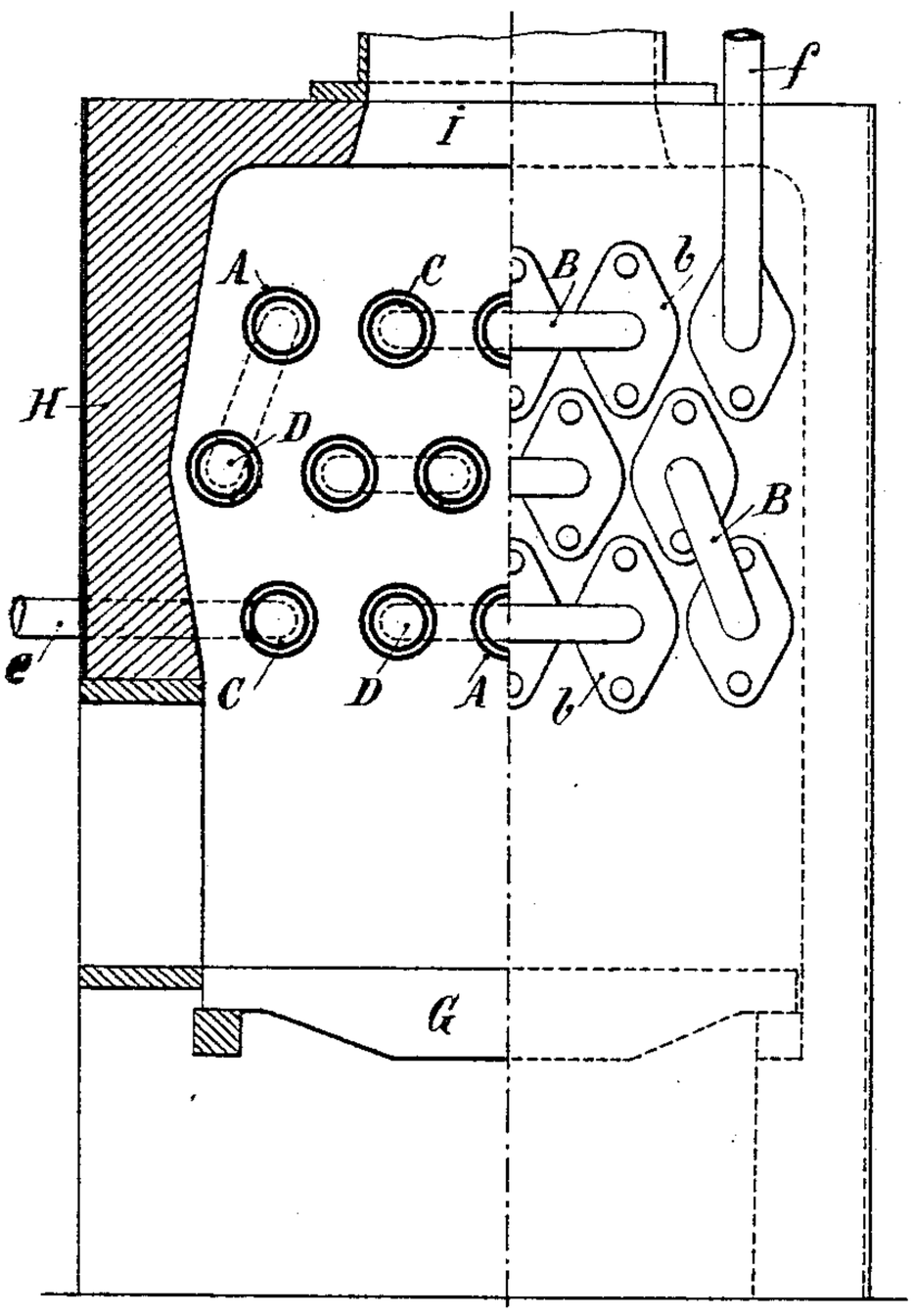


FIG. 4.

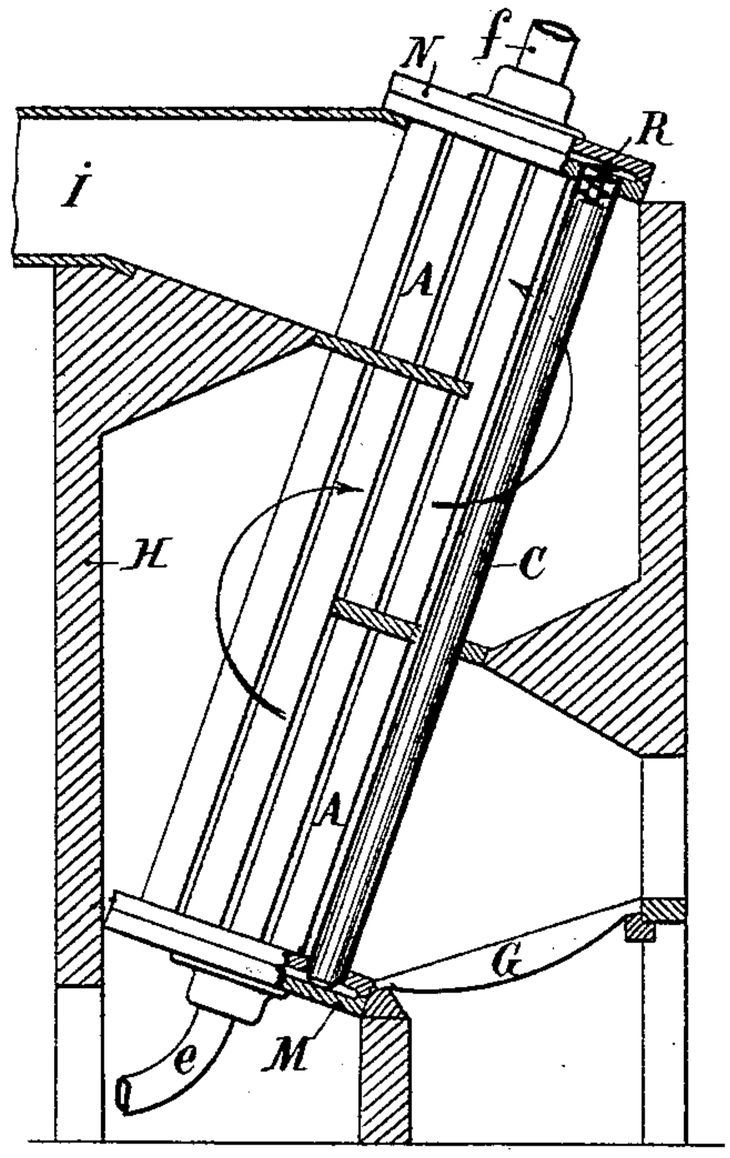


FIG. 2.

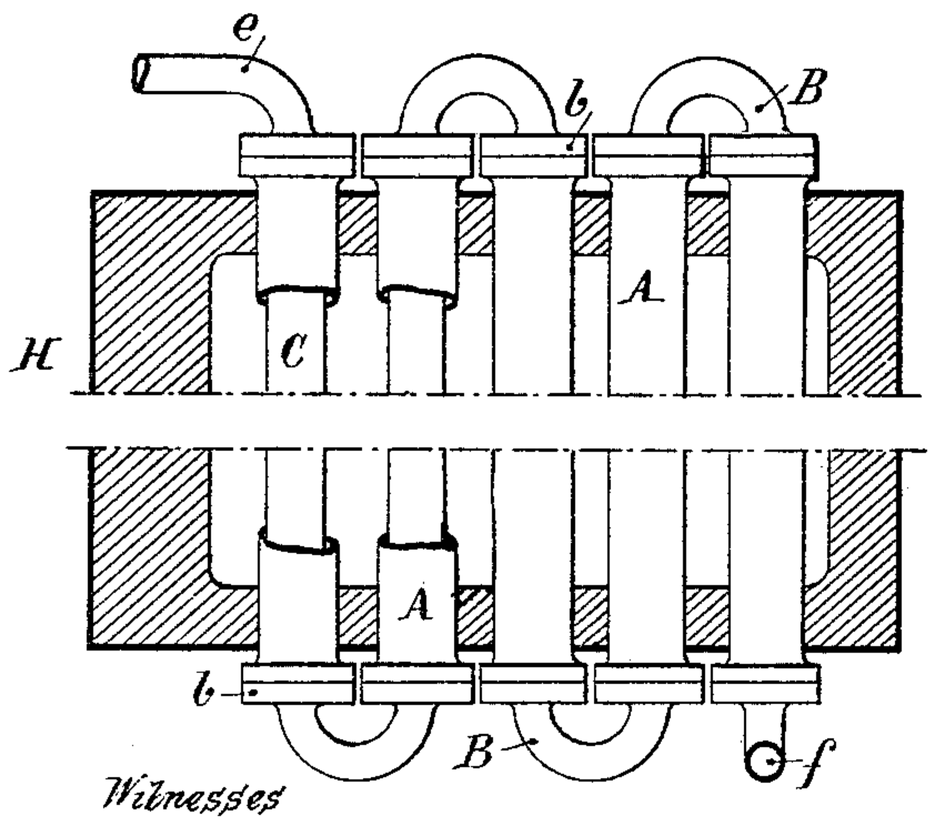
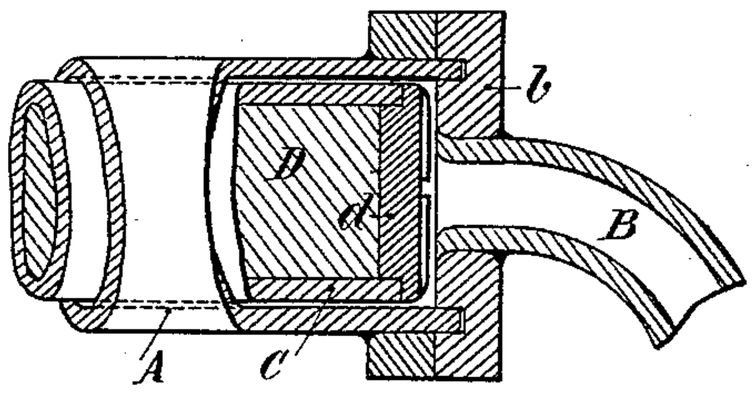


FIG. 3.



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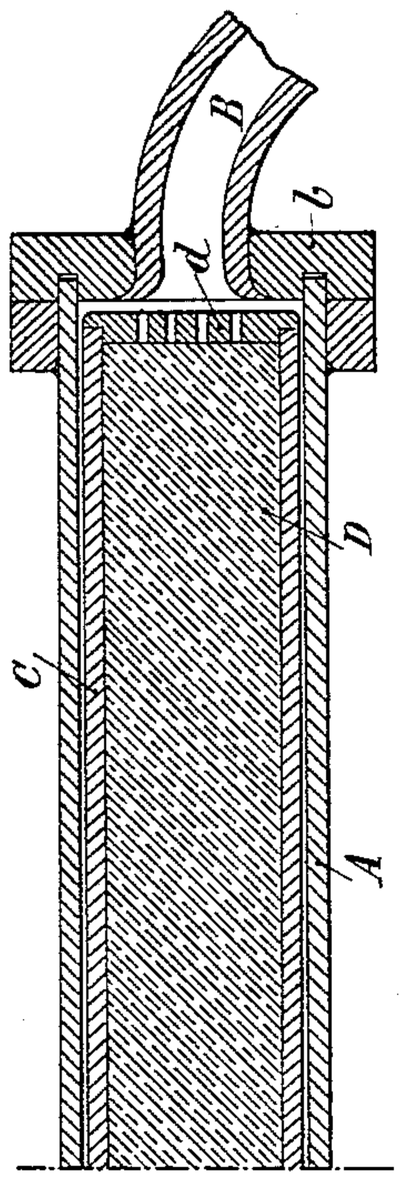
(No Model.) 2 Sheets—Sheet 2.

FIG. 3a.



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UNITED STATES PATENT OFFICE.

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STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 616,532, dated December 27, 1898.

Application filed December 28, 1897. Serial No. 663,885. (No model.)

To all whom it may concern:

Be it known that I, JEAN MARIE ANATOLE GÉRARD, engineer, of 16 Rue des Grandes Carrières, Paris, in the Republic of France, have invented an Improvement in Steam-Generators, (for which I have obtained a patent in France, No. 256,375, dated the 13th of May, 1896; in Belgium, No. 124,677, dated the 21st of November, 1896; in England, No. 27,556, dated the 3d of December, 1896, and in Germany, No. 93,993, dated the 10th of December, 1896,) of which the following is a specification.

The invention relates to that type of steam-generator in which the volume of water provided by each stroke of the feed-pump is instantly transformed into steam by its passage in a fine stream or sheet over surfaces of metal heated to a high temperature. Its object is to provide means of obtaining a generator of this kind the weight of which is inconsiderable and which nevertheless has a sufficient amount of heat stored to allow the generator to produce when necessary a greater quantity of steam than that produced in a normal manner by the action of fire.

It consists, first, in utilizing for the storing or accumulating of the heat certain materials not having a high density and having a sufficiently high capacity of heat, and, secondly, in a special arrangement of generator which allows the use of these substances for this purpose.

Instead of increasing the reserve of heat in the generator by augmenting the quantity of metal used in its construction—that is to say, by the employment of materials whose density is about eight, while their capacity of retaining heat is about 0.11—I employ materials which are not decomposed by heat whose density is only about two, while their heat-retaining capacity reaches double or treble that of metals.

Among materials the density of which is about twice that of water, I might employ the following, the caloric-retaining capacity of each of which is shown: wood-carbon, 0.24; animal black, 0.26; magnesia, 0.24; alumina, 0.29; silica, 0.31; plaster, 0.33. These materials may be employed alone, or their action may be greatly increased by filling the interstices between the particles of these finely-powdered materials with water the density of which is equal to one and the heat capacity is also one. I will describe the arrangement of generator by which I employ these materials for the object mentioned above.

Figure 1 is an elevation, with part vertical section, of the generator; Fig. 2, a plan, partly in section, of the generator; Fig. 3, a sectional detail showing construction of extremity of a tube. Fig. 3ª shows a section of the steam-tube, with inner vessel provided with perforated plug *d;* Fig. 4, a vertical section showing another arrangement of the generator.

Referring to Figs. 1, 2, and 3, the generator is composed of a number of straight tubes A, of iron or copper or aluminium, and each of these tubes is connected to the next by means of a bent or curved tube B and flanges *b*, so that the whole represents a kind of coil made up of straight elements, into which the water is introduced by a feed-pipe *a* and escapes as steam by an outlet-pipe *f*. Each one of the straight tubes A contains a core of the same length and having diameter almost as large as the interior of these tubes. This core consists of a metal tube or sleeve C, filled with one of the materials D above mentioned—such as plaster, carbon, &c.—and both ends of which are closed by means of metallic plugs or caps *d*, Fig. 3. These cores constitute the caloric-accumulator of the generator, and the heat that they accumulate or store during the intervals of time between each stroke of the feed-pump forms a reserve which can be utilized when a momentary excess of work by the motor absorbs a greater quantity of steam than the generator normally provides.

When it is desired to still further increase the reserve of heat contained in the cores or auxiliary vaporizers in the tubes A of the generator, this can be done in the following way: The tubes or sleeves C forming the cores or vaporizers are filled with coke or other material in a powdered or granular condition, and the plugs or caps *d* of these tubes are perforated, so that the water introduced into the generator may penetrate therethrough. It will be understood that this water will remain suspended among the particles of the substance employed, while the water con-

stantly supplied by the feed-pump will find a more easy passage into the free spaces between the cores C and the tubes A, which inclose them, and it will circulate in a regular manner in these spaces until it evaporates; but when the steam thus produced becomes momentarily insufficient to feed the motor the water contained in the vaporizing-cores, which is at a high temperature, then evaporates, utilizing the heat which has been already stored when acting normally. Admitting that the quantity of water thus lodged in the interstices of the grains or inert material be equal to the half of the weight of the holder, it will be seen that the average caloric capacity of the materials of which it is made up, which can be valued at $\frac{0.20+1}{2}=0.60$, is nearly six times greater than that of a metal which can be valued at 0.11, as explained above.

Referring to Figs. 1 and 2, the serpentine form of generator is placed in a furnace H, provided with fire-bars G, with a flue or opening I communicating with a chimney; but any convenient arrangement of heating apparatus may be employed.

In order to prevent the deposit of calcareous matter between the tubes A of the generator and the vaporizing-cores, the latter can be made to move longitudinally and automatically in the following way, (represented in Fig. 4 of the drawings, it being also seen from this figure that the cores are made slightly shorter than the tubes A, which contain them, and are pressed against the bottom of the tubes A by a spring R at the end opposite to that from which the water enters:) At each stroke of the pump these cores are forced to move a certain distance forward and compress their springs R, when the water passing into the annular space separating the two tubes A and C is evaporated, and at that moment the pressure is equal on the two ends of the cores and the spring R again becomes preponderant and pushes the core C back into its place until a fresh pulsation of the pump reproduces the action. In order to facilitate these movements of the cores or auxiliary vaporizers, the tubes of the generator may be fitted between two plates M and N, Fig. 4, receiving the inlet-pipe *e* and outlet-pipe *f*, and in this case the generator is placed in an inclined position, so as to facilitate the action of the springs R.

It will be understood, finally, that the invention is not limited to the arrangement of generator described above for the use as heat-accumulators of the materials above indicated on account of the advantages they may present because of their low density, which is only about two, while their caloric capacity is much higher than that of metals, so that by using them the maximum of power and the minimum of weight are obtained.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is—

1. In a tubular steam-generator, the combination with each of the tubes of a second smaller tube placed in the interior thereof, so as to admit only of a narrow annular passage for the liquid to be heated; the said inner tube being closed at its ends and filled with substances having a high specific heat substantially as described.

2. In a tubular steam-generator the combination with each of the tubes of a second smaller tube placed in the interior thereof, so as only to allow to the liquid to be heated, a narrow and circular passage; this inner tube being closed at both ends by perforated plugs, and filled with insoluble porous materials having a high specific heat, substantially as described.

3. A steam-generator composed of parallel tubes connected together, each tube inclosing a narrower inner tube, which allows the liquid only a narrow annular passage, each inner tube being filled with materials having a high specific heat, and being closed at both ends by a plug.

4. In a multitubular steam-generator, the combination of an outer tube inclosing a cylindrical inner vessel shorter than the tube and filled with materials having a high specific heat, and a spring adapted to be pressed upon one of the ends of the said inclosed vessel and interposed between the said vessel and the entrance of the water into the outer tube.

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

JEAN MARIE ANATOLE GÉRARD.

Witnesses:
LOUIS TALLFER,
JACQUES CONDOMY.