(No Model.) 2 Sheets—Sheet 1.

J. E. CULVER.

STEAM GENERATOR.

No. 417,385. Patented Dec. 17, 1889.

Fig. 1.

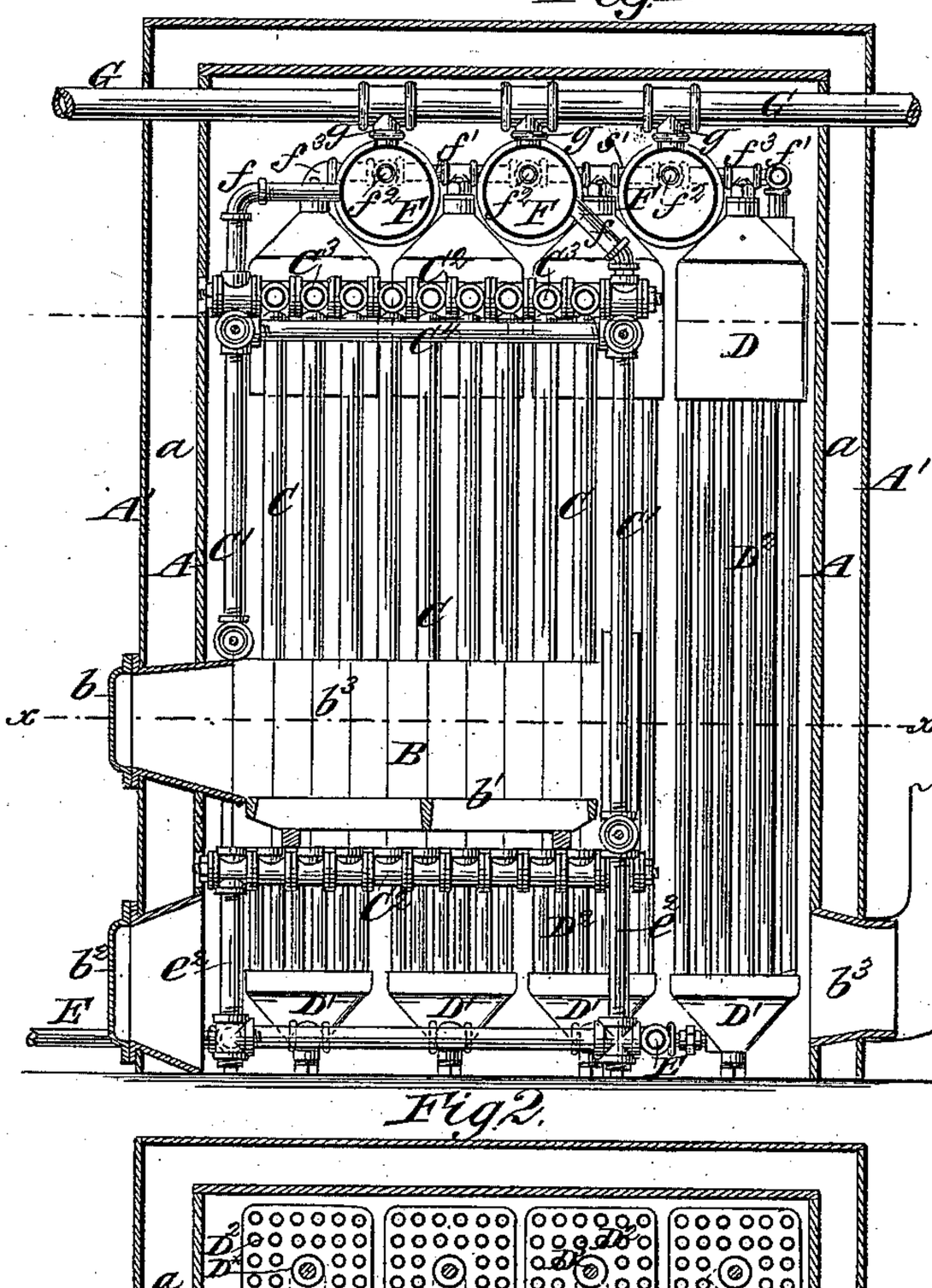

Fig. 3.

Fig. 2.

Fig. 4.

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(No Model.) 2 Sheets—Sheet 2.

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Fig 5

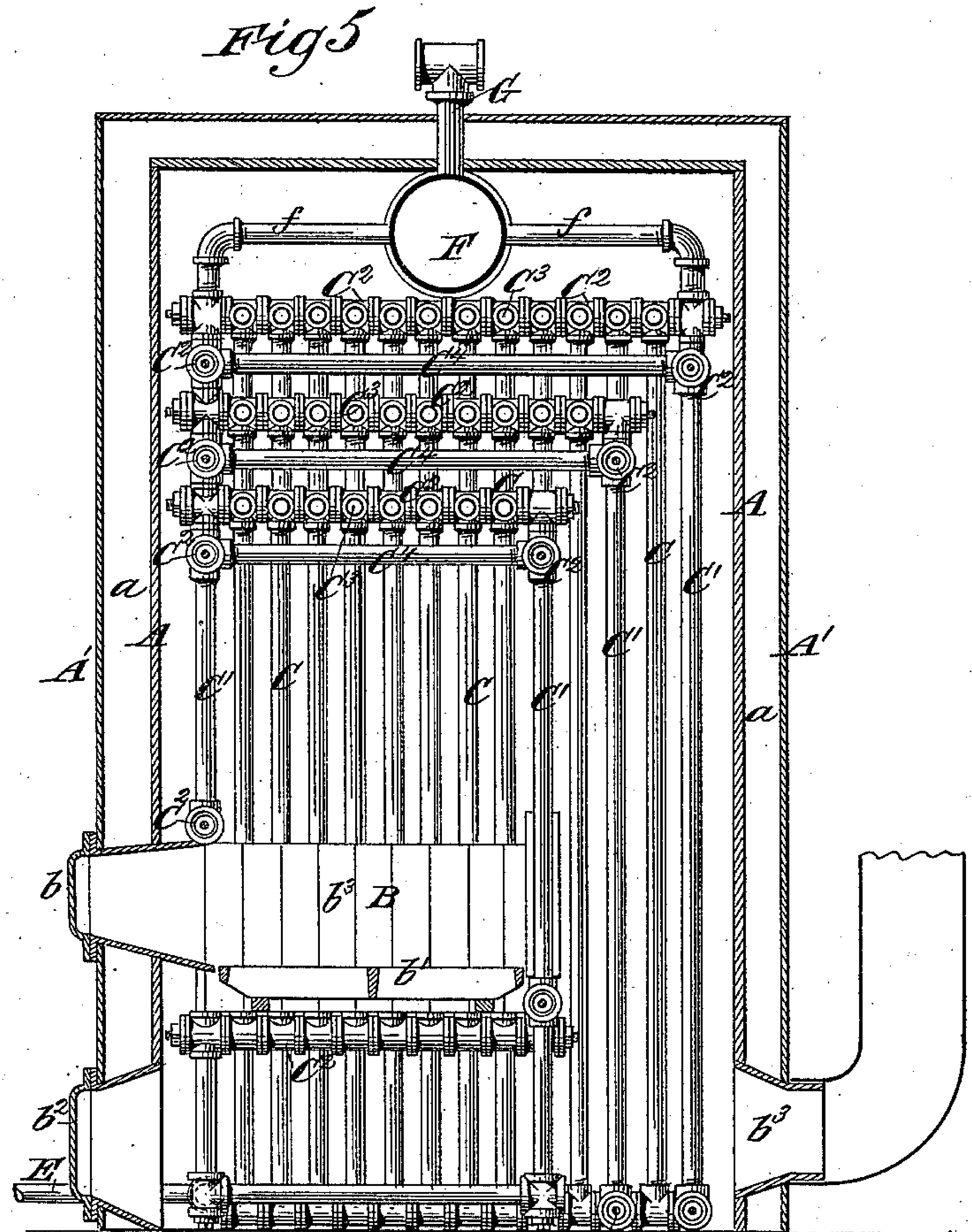


Fig.6.

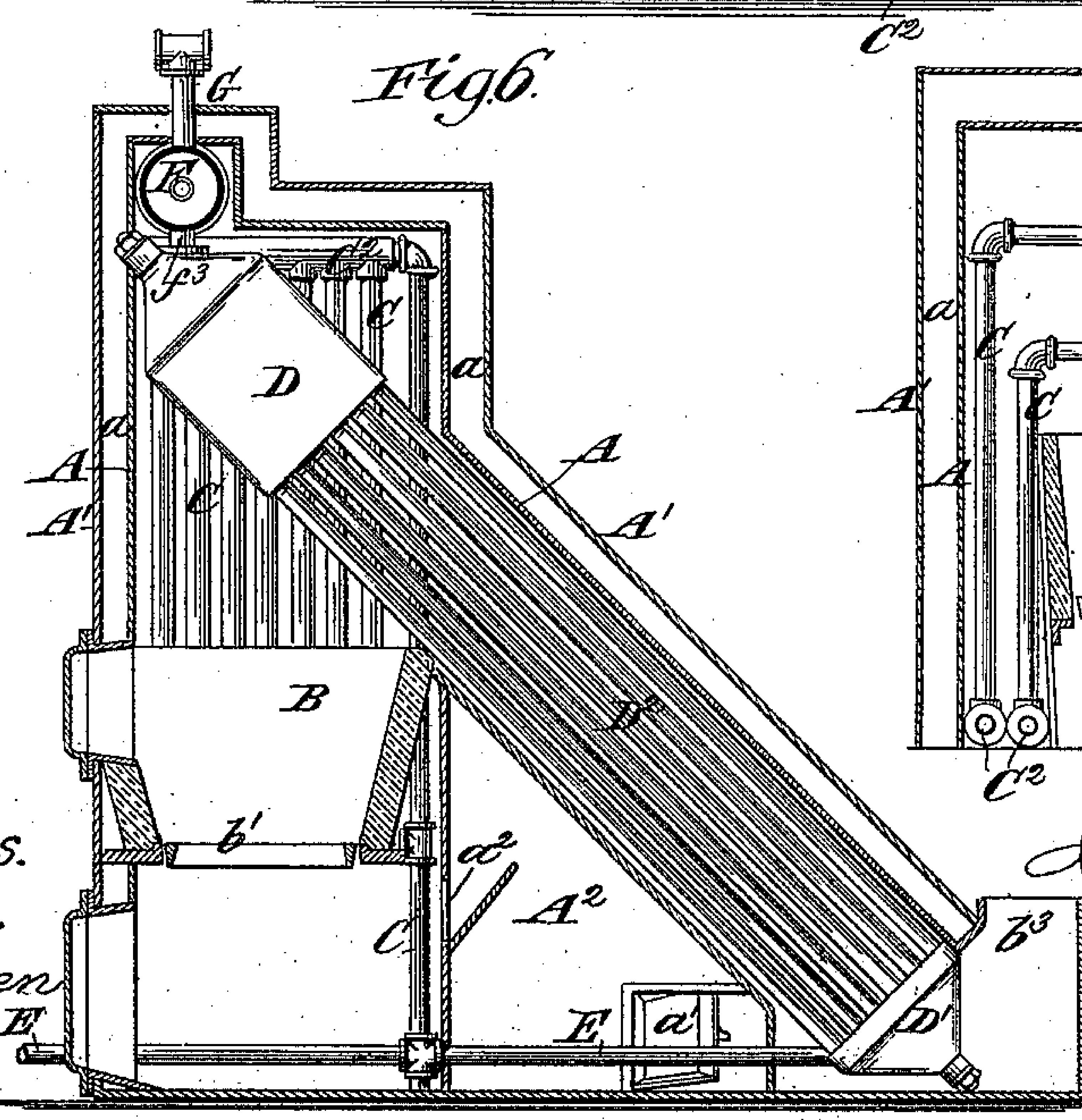
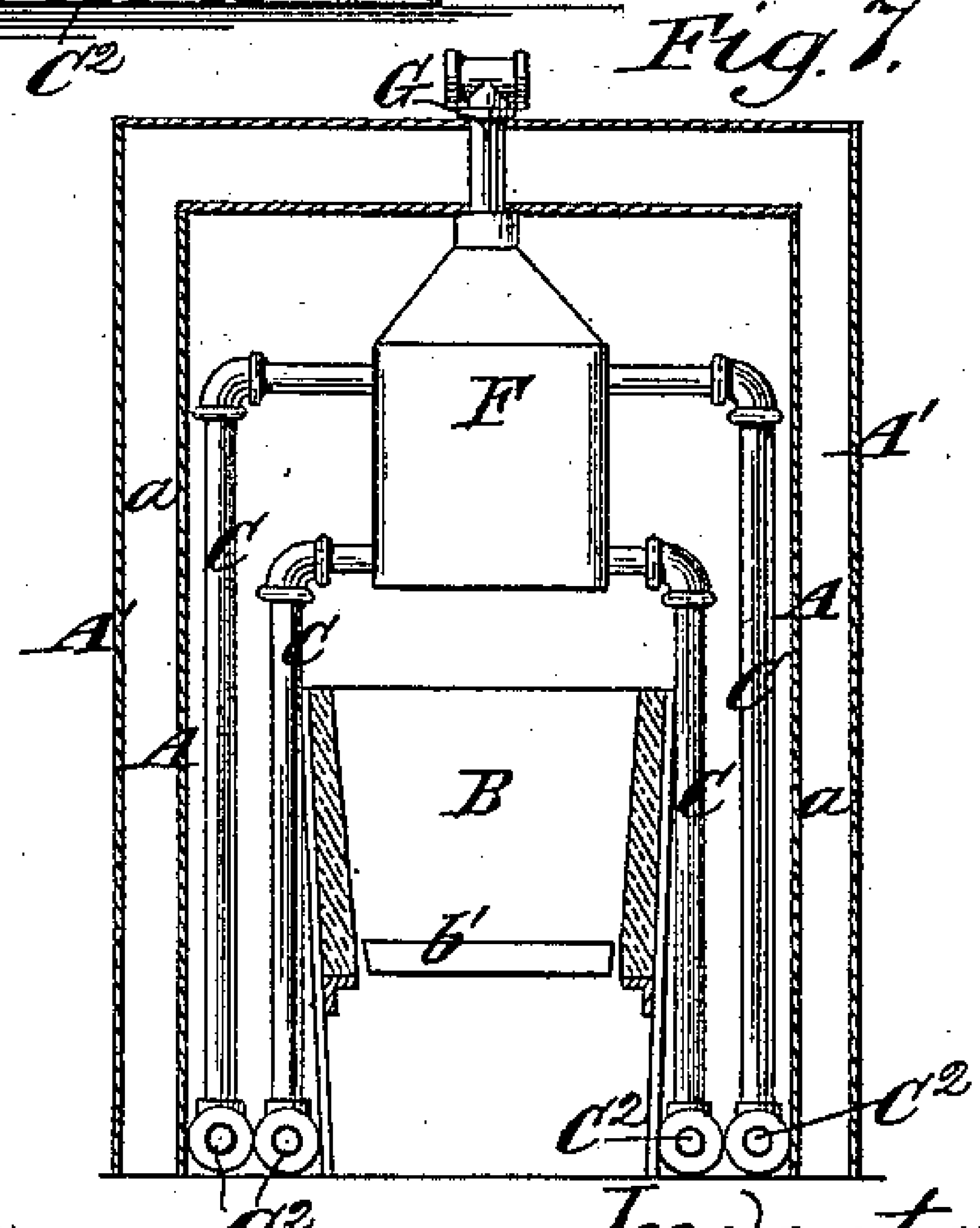


Fig. 7.



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UNITED STATES PATENT OFFICE.

JOSEPH E. CULVER, OF JERSEY CITY, NEW JERSEY.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 417,385, dated December 17, 1889.

Application filed October 11, 1887. Serial No. 251,986. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH E. CULVER, of Jersey City, in the county of Hudson and State of New Jersey, have invented a new and useful Improvement in Steam-Generators, of which the following is a specification.

My invention relates particularly to what I term a "thermostatic steam-generator," in which there is no circulation of water, but in which the water is subjected to the most heat from the products of combustion near its surface, and in which the products of combustion, after imparting their greatest heat to the water near its surface, pass downward to the lower portion of the generator, thereby, as they decrease in temperature, being brought to act upon water which is of gradually-decreasing temperature. Among the most prominent advantages of a generator of this character it may be mentioned that the products of combustion do not escape from the generator until they have reached a very low temperature—say 110° Fahrenheit—in contradistinction to an ordinary steam-generator, from which the products of combustion escape ordinarily at a temperature of several hundred degrees.

My invention also relates to generators which may be termed "sectional," in that they are mainly or entirely made up or composed of sections each substantially complete in itself and requiring only to be properly connected with other parts to render them operative sections of the generator.

The invention consists in novel features of construction and combinations of parts, which are hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a vertical section of a generator embodying all the features of my invention. Fig. 2 is a transverse section upon the plane indicated by the dotted line *x x*, Fig. 1. Fig. 3 is a vertical section, upon a larger scale, of one of the multitubular sections, the intermediate portions of the tubes being broken away to reduce the height. Fig. 4 is a sectional view, also upon a larger scale, illustrating the construction of the sectional manifolds or sectional branch T's, from which extend the series of tubes surrounding the fire-box or furnace; and Figs. 5, 6, and 7 are vertical sections representing generators of slightly-modified forms, but all of them embodying features of my invention.

Similar letters of reference designate corresponding parts in all the figures.

Referring first to the construction shown in Figs. 1 to 4, inclusive, A designates the casing which incloses all the operative parts of the generator, and which, as here shown, has an outer jacket A′, forming an air-space *a* between them; or, if desired, the space *a* might be filled with asbestus or other non-conducting material.

B designates the furnace or fire-box, which has a suitable feeding-opening closed by a fire-door *b*, and in the bottom of the fire-box is the grate *b′*.

b^2 designates the ash-pit door, and b^3 designates the escape-opening for the spent products of combustion from within the casing A to the smoke-pipe or chimney A^2.

The furnace or fire-box B is surrounded, as here represented, on all four sides by series of tubes C C′. At opposite sides of the furnace are series of tubes C, which extend both above and slightly below it, and at the front and back of the furnace are series of tubes C′. The tubes in each line or row are connected at their lower end with sectional manifolds C^2 and at their upper end with like manifolds C^2. These manifolds or branch T's are all of similar construction and may advantageously be of the construction shown in Fig. 4. As there represented, the manifold C^2 is made up of sections *c*, with which the tubes are severally connected, each tube being screwed into a single section and the several sections being connected by interfitting joints, one section being rabbeted into another, as shown at *c′*. A packing of a fire-proof mineral or of other material may be introduced between adjacent sections in order to produce tight joints. To hold the several sections *c* together, a bolt or screw-threaded rod c^2 may be employed. In this way a number of tubes forming a row or series of any length adapted to the size of the generator may be joined together in a water-tight or steam-tight manner. It will be understood that at each end of the sectiona- manifold there may be employed a cap or washer c^3, closing the end section and form-

ing a bearing for the nut applied to the bolt c^2. Not only is the furnace or fire-box thus surrounded by series or rows of tubes, but the series or rows which are on opposite sides of the fire-box are connected by cross-tubes C^3 C^4, which extend from the manifolds C^2 at the top of the tubes. The two series of tubes C, which are at the sides of the fire-box, are connected by horizontal tubes C^3, which extend between and connect their upper sectional manifolds C^2, and a series of tubes which are at the front and back of the fire-box are connected by horizontal tubes C^4, which extend between their upper sectional manifolds.

The fire-box or furnace B is completed by fire-brick, cast-iron, or other fire-proof sections b^3 of peculiar shape, as represented in Fig. 2, which are made to fit the adjacent tubes C or C′, between which they are placed, and to join with each other, so as to form a substantially-tight wall.

In addition to the parts above described I have represented as forming parts of the generator a number of multitubular sections, each of which constitutes a substantially complete structure in itself capable of proper operation when connected with the other parts of the generator. One of these sections is represented in detail in Fig. 3. It is composed of an upper chamber D, a lower chamber D′, and tubes D^2 connecting them. These chambers may be made of cast metal, and the tubes may be connected with them by any suitable joints. As here represented, the tubes D^2 are screwed into the upper chambers D, as shown at d, and their opposite ends slipped into recesses or cavities formed in the wall of the opposite chamber D′, as indicated at d'. For securing the chambers D D′ at proper distance apart and binding them upon the ends of the tubes I employ a bolt or screw-threaded rod D^3, which passes through these chambers and is provided at one or each end with a nut d^2 for tightening it. In order to shield the bolt or rod D^3 and prevent it from being subjected to an excessive temperature, which would produce its considerable extension, I have shown it as arranged within a larger tube D*, which is central within the remaining tubes D^2, and which serve to protect the bolt D^3 from the products of combustion. The feed-water is supplied to the above-described parts of the generator through feed-pipes E, of which two are represented in Fig. 2 as extending around the fire-box or furnace and forming a complete channel. This feed pipe or channel E is provided with branches e, which communicate with the distributers C^2 at the lower ends of the pipes C C′, and with other branches e', which communicate with the lower chambers D′ of the several multitubular sections. The branches e do not communicate directly with the manifolds C^2, but connect with upright pipes c^2, which serve both to supply the manifolds and as legs or columns for supporting the furnace and its contents, and the weights of the tubes superposed above the manifolds.

In order to receive the steam which is generated from the several parts of the apparatus, I employ one or more steam-drums with which such parts are connected. In the present example of my invention three such drums F are represented, two of which are connected by branches f with the manifolds C^2, which are at the upper ends of the series of tubes C, as best shown in Fig. 1. I also employ a pipe f', which extends throughout the series of multitubular sections and is connected by branches f^2 with the drums F and by branches f^3 with the upper chambers D of the several multitubular sections.

It will be seen that the generator is composed largely of duplicate parts, which can either be purchased in the open market or constructed at small expense, and hence provision is afforded for the convenient repair and enlargement of the generator as occasion may require. The steam may be taken from the generator through a pipe G, which is connected by branches g with the several drums F.

It will be observed from Fig. 1 that all the parts which I have above described as forming the water and steam spaces of the generator are arranged within the casing A, which has its outlet b^3 at the lower portion. Consequently all such parts are subjected to the contact of the heated products of combustion which rise from the fire-box or furnace, and they, after acting upon the steam-containing bodies or portions and the water-containing portion at the water-level, gradually descend, owing to their decreasing temperature, and come in contact successively with portions of the generator which contain water of gradually-decreasing temperature, until finally they arrive at the smoke-outlet b^3, from whence they escape at a very low temperature as compared with other steam-generators of the classes now generally in use.

In the example of my invention shown in Fig. 5 I dispense with the several multitubular sections shown in the preceding example, and the water and steam spaces of the generator are composed entirely of series of tubes which surround the fire-box or furnace and which extend between manifolds C^2, which are in turn connected with a steam-drum F, from which a steam-pipe G leads. As shown in Fig. 5, there are three parallel series of tubes C′ at the back of the fire-box, which at their top are connected with manifolds C^2, and these manifolds are connected by three series of horizontal tubes C^4 with corresponding manifolds at the front of the generator. At opposite sides of the generator there are three series of tubes C, which are connected with manifolds C^2, and these manifolds on opposite sides of the fire-box are connected by three series of horizontal tubes C^3. These manifolds and the series of horizontal tubes which connect them are arranged cob-house fashion in the upper part of the gen-

erator, the manifolds being connected with each other, so that water or steam may pass from one to the other of them, the uppermost manifolds being connected by branches *f* with the steam-drum F. Of course the series of tubes which surround and are above the fire-box might be multiplied almost indefinitely, and the entire water and steam spaces of the generator are inclosed by a casing A, as before described. From the bottom of this casing leads the escape-opening b^3 for the products of combustion, and the casing is surrounded by an outer jacket A′, forming a space *a* for air or for a non-conducting material. The several series of upright tubes C C′ extend from manifolds C^2, with and by which they are connected, and are supplied with water through one or more feed-pipes E.

In the example of my invention shown in Fig. 6 the fire-box or furnace D has upright tubes C at the sides only, and the manifolds C^2, which are at the top of these tubes, are connected with the steam-drum F, from which leads the steam-pipe G. In an inclined position at the back of the generator are multitubular sections, each composed of chambers D D′ and tubes D^2 connecting them, as before described, and each connected at its upper end by a branch f^3 with the steam-drum F. Each of these multitubular sections has a feed-connection E leading to its lower chamber D′, and such feed-connection E also supplies feed-water to the lower ends of the tubes C. In this example of my invention, also, all parts of the generator which form the water and steam spaces are contained within the suitably-shaped casing A, which has a surrounding casing or jacket A′, separated therefrom by an air-space *a*. From the lower portion of the casing A leads the smoke-escape b^3. In this example of my invention the outer casing is so constructed as to form an inclosed space A^2, to which air may enter through the opening *a*′, and from which the air may pass after being heated in the space A^2, and through an opening a^2 to the ash-pit, from which it may pass upward through the grate *b*′ and promote combustion of the fuel thereon.

In Fig. 7 I have shown one of the simplest examples of my invention, in which all the steam and water spaces of the generator are surrounded by the casing A and by the outer jacket A′, forming the air-space *a*. In this case the fire-box or furnace B, which contains the grate *b*′, is surrounded on two or more sides by series of tubes C, which extend from manifolds C^2 and connect with a receiver or steam-dome F, from which leads the steam-pipe G.

In each and all of the examples of my invention hereinbefore described and shown an air-tight inclosure separates the ash-pit from the rest of the space within the casing A, permitting no communication between the ash-pit and the combustion-chamber or smoke-way other than by way of and through the grate and fire-pot.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a steam-generator, the combination of series of upright pipes connected at the bottom to provide for a uniform supply of water and surrounding the furnace and two series of cross-tubes at a distance above the furnace and at different levels, one of said series of cross-tubes connecting the tubes which are on opposite sides of the furnace and the other series of cross-tubes connecting the upright tubes which are at the front and rear of the furnace, substantially as herein described.

2. The combination, with a steam-generator furnace and series of tubes surrounding or partly surrounding the furnace, of multitubular sections, each complete in itself and composed of upper and lower chambers and tubes connecting them, feed-pipes for supplying water to the lower portions of the tubes which surround the furnace and to the lower chambers of the sections, and a steam drum or collector, with which are connected the upper ends of the tubes which surround the furnace and the upper chambers of said sections, substantially as herein described.

3. The combination, with a steam-generator furnace, of a number of water-tubes, a number of steam-tubes, both said water and steam tubes being arranged directly over the furnace, a number of multitubular boiler-sections arranged about the sides and outside said furnace, and a steam drum or collector for steam from said steam-tubes located over said tubes, substantially as specified.

4. The combination, with a steam-generator furnace, of water-spaces surrounding the furnace and feed-connections with the lower part of the said water-spaces, one or more steam-collectors connected with the upper parts or steam-spaces of said water-spaces and receiving steam from them, and a casing inclosing all said parts, including the one or more steam-collectors, and having the smoke-escape at its lower part, substantially as herein described.

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FREDK. HAYNES.