(No Model.) 2 Sheets—Sheet 1.

J. WATERS.

STEAM GENERATOR.

No. 365,889. Patented July 5, 1887.

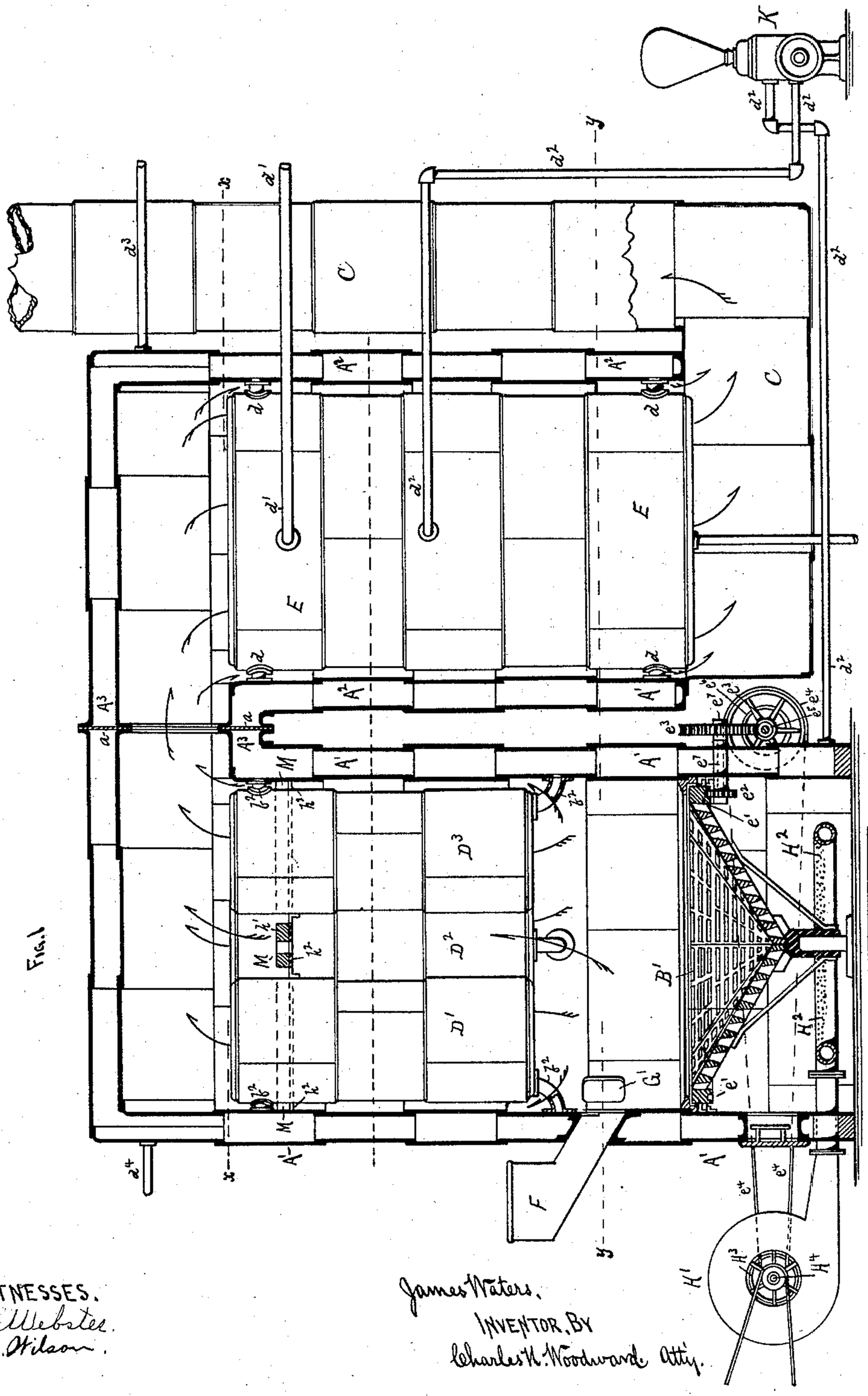

Fig. 1.

WITNESSES.
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INVENTOR. BY
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(No Model.) 2 Sheets—Sheet 2.

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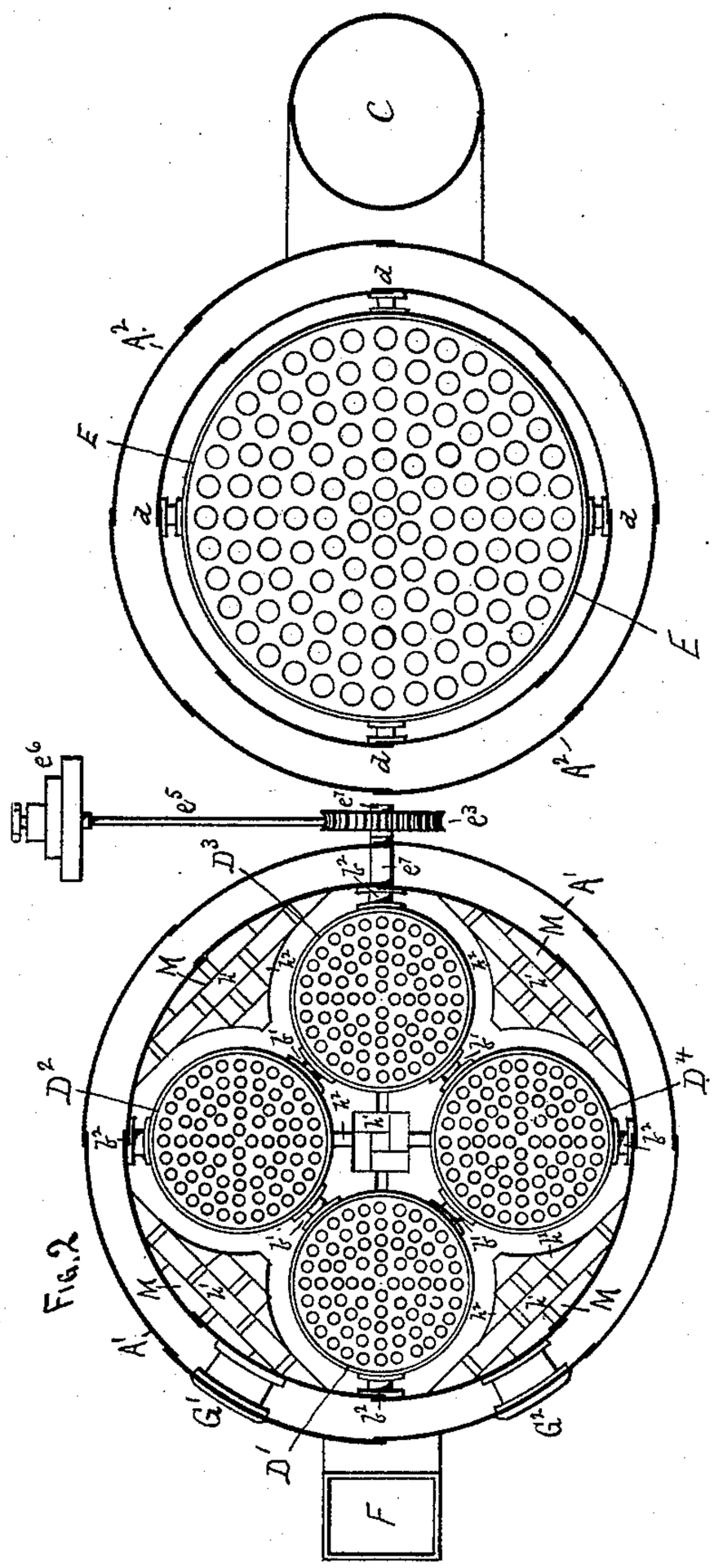

FIG. 2

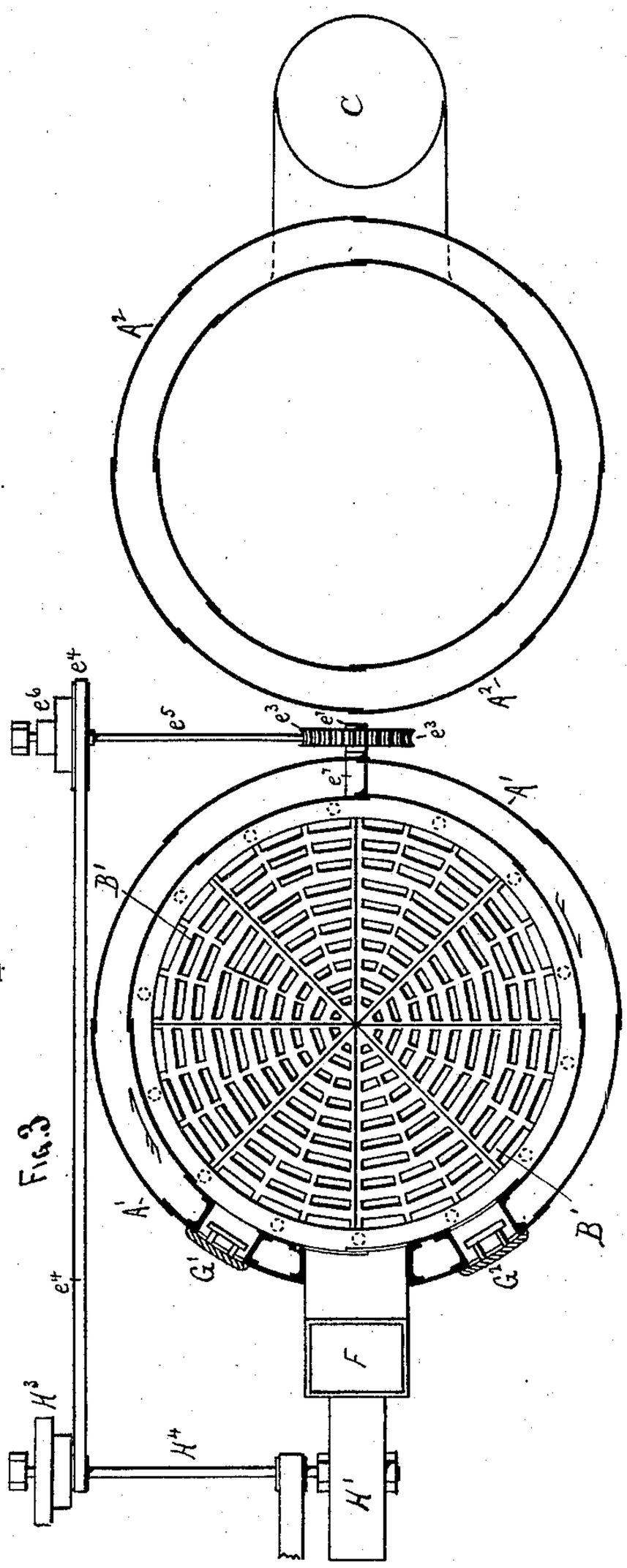

FIG. 3

WITNESSES.
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Charles H. Woodward
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UNITED STATES PATENT OFFICE.

JAMES WATERS, OF MINNEAPOLIS, MINNESOTA.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 365,889, dated July 5, 1887.

Application filed May 5, 1886. Renewed April 15, 1887. Serial No. 234,974. (No model.)

To all whom it may concern:

Be it known that I, JAMES WATERS, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Steam-Generators and Furnaces therefor, of which the following is a specification.

This invention relates to steam-generators and furnaces therefor; and it consists in the construction and arrangement of the parts, as hereinafter shown and described.

In the drawings, Figure 1 is a sectional side elevation of the plant complete. Fig. 2 is a sectional plan view in section on line *x x* of Fig. 1. Fig. 3 is a sectional plan view in section on the line *y y* of Fig. 1.

This form of generator is more particularly applicable to marine uses or upon steam-vessels, but may be used to advantage in many locations on land.

A′ A² represent two "double" shells or outer casings capable of holding water in their lower parts and steam in their upper parts, and connected at their upper parts by a double shell or flue, A³, the latter divided centrally by a diaphragm, *a*, so that steam cannot pass from one shell to the other.

In the lower part of the shell A′ is a concave or inverted-cone-shaped revolving grate, B′, and connected to the lower part of the shell A² is a smoke-exit flue, C. Suspended in the shell A′ above the grate B′ are a series of tubular boilers, D′ D² D³ D⁴, united to each other at their upper and lower parts by connections *b′*, and each united to the shell A′ at or near its upper and lower ends by connections *b²*, all the upper connections *b′ b²* being above the water-line (indicated by the dotted line) and all the lower connections *b′ b²* being below the water-line, so that the circulation of the water is insured and the heat equalized upon all the different parts.

Suspended in the shell A² is a tubular "heater" or boiler, E, united at or near its upper and lower ends by connections *d* to the shell A², so that the free communication of the water between the boiler and outside shell or water-case is insured. By this arrangement the products of combustion pass upward from the grate B′, through and around the boilers D′ D² D³ D⁴, thence over and down through and around the boiler and heater E, and thence upward, and exits finally through the smoke-stack C.

Under some circumstances the shells A′ A² and tubular connections A³ might be made with single walls, or without the water and steam spaces, and the steam generated entirely in the tubular generators; but the construction shown will generally be employed.

As before stated, the grate B′ is a revolving one, and this revolution may be accomplished in any suitable manner; but for the purpose of illustration I have shown the outer rim of the grate on the under side with a circular gear-rack, *e′*, in which a pinion, *e²*, journaled on a shaft, *e³*, passing through the shell A′, is adapted to engage to revolve the grate.

The grate is very much larger in diameter than is usual in generators, and is made "concave" or in an inverted conical shape, so that the fuel will run down toward the center and cover all parts of the grate, and not remain principally at the outer edges, as it would if the grate were horizontal or "convex."

The boilers D′ D² D³ D⁴ being each the size of an ordinary boiler, the shell A′ and grate B′ will be proportionately larger than in ordinary generators, and the fuel, to be effective upon all the boilers, must be manipulated differently from the ordinary methods.

The fuel will be fed to the combustion-chamber through a hopper, F, and falls upon one side of the revolving grate, the latter, by its constant revolution and concave form, causing the fuel to be distributed in a substantially uniform layer over the whole surface of the grate, so that each of the boilers D′ D² D³ D⁴ receives its proper share of the heat and the effects of the combustion.

A door, G′, on one side of the hopper F, enables the operator to observe the operation of the combustion and spread the fuel more evenly upon the grate, if it is required, just after passing the hopper, and another door, G², on the other side of the hopper F, enables the operator to relieve the fuel from clinkers and ashes just before it passes the hopper.

The grate being so large, it would be very inconvenient to properly supply all parts of it equally with the fuel or reach all parts with

pokers; but when arranged to be revolved, as shown, the fuel is supplied to all parts of the grate uniformly, and all parts can be reached through the doors G' G² with pokers, &c.

A fan, H', adapted to be driven by any motive power, but preferably by a separate "donkey-engine" or other similar suitable means, is shown arranged to supply an air-blast to the combustion-chamber through a perforated pipe, H², in the ash-pit beneath the grate B', and a pulley, H³, on the shaft H⁴ of the fan is shown connected by a belt, e^4, to the worm-gearing e^3, by which the pinion e^2 is operated, whereby the speed of the fan and grate will be made to coincide, so that the power which operates the blast and the feeding of the fuel to the grate will be utilized to govern the generation of the steam.

The inclination and form of the feed-hopper F will be so proportioned to the grate and combustion-chamber that the coal will flow from it upon the grate only while the grate is revolving, and the faster the grate is revolved the faster the fuel will be drawn from the feed-hopper, and vice versa. Thus it will be seen that the faster the grate is revolved the faster and greater in quantity will be the flow of the fuel, and the consequent increase of combustion will cause an increased generation of the steam, and if the same motive power which operates the fan or other means for producing the artificial draft be connected to the mechanism which revolves the grate it will be apparent that the generation of the steam can be made to correspond to the requirements of the motive power which the steam is utilized to operate by changing the speed of the motor which operates the grate and fan.

The fan-shaft H⁴ and the shaft e^5, to which the grate-operating mechanism is attached, are shown supplied with cone-pulleys e^6 H⁵, so that the relative speeds of the fan and grate may be altered as required.

Any other suitable means than the fan H' may be used to secure the requisite supply of air to the grate, and any other suitable means than that shown may be employed to revolve the grate, so long as they are arranged to be connected and work together.

The tubular generator E is mentioned as being a "generator" or "heater," and by reason of the functions which it performs it is both of these at the same time.

d' represents the exhaust-pipe from the engine or engines driven by this generator as a whole, and which is conducted into the combined generator and heater E above the water-line. It may be conducted into the shell A² above the water-line, if preferred, instead of into the heater E direct.

d^2 is a pipe leading through a pump, K, from the generator E, just below the top of its water-line, to the shell A' near its bottom, whereby the main generator A' D' D² D³ D⁴ is supplied with its feed-water from the generator E, the latter thus serving as a feed-water heater to the main generator, and also as a generator to supply steam through a pipe, d^3, to a secondary engine, or, in connection with the steam-pipe d^4 from the main generator, to supply steam to a system of "compound" engines.

The pressure of steam in the parts A' D' D² D³ D⁴ of the generator will be greater than in the parts A² E when used to operate compound engines; hence the necessity for the diaphragm a to keep them separated.

I have shown four of the generators D' D² D³ D⁴ in the shell A'; but it is evident that a greater or lesser number may be used, as desired, the only changes necessary to increase or decrease the number being to increase or decrease the diameter of shells A' A² and grate B', and also to increase or decrease the capacity of the combined heater and generator E to conform therewith.

Retarding-plates M may be inserted into the spaces between the generators D' D² D³ D⁴ and the shell A', to retard the products of combustion and cause a proper proportion to pass through the flues in the generators. These retarding-plates may be constructed in any suitable manner, but will generally be formed of fire-brick h', supported upon iron brackets h^2, and left somewhat open, so that a small quantity of smoke and other products of combustion may pass through them, but close enough together to retard the greater mass and cause it to pass around and through the generators.

I claim many advantages by this construction of the boilers. The arrangement of the shells A' A² enables me to utilize the spaces between their walls for holding a supply of water and steam in addition to that in the main generators D' D² D³ D⁴ and the combined generator and heater E, and also enabling me to superheat the steam in that part of the shells above the tubular generators.

The arrangement of the tubular generators D' D² D³ D⁴ is an important feature of my invention, as a very extensive heating-surface is thereby obtained and a very large amount of steam generated in a generator occupying a comparatively small space.

An extensive "plant" of boilers is thereby obtained, with one combustion-chamber common to all, and that requires but very little more space for its "fire-hole" than a single boiler or nest of boilers. This latter advantage is a very important one, especially on steam-vessels and in other places where space is valuable, or where it is absolutely necessary to confine the generators within certain prescribed limits. By this construction the "firing" is all done on one side of the generator, as in an ordinary boiler, whereas in a boiler-plant of the same capacity constructed in the ordinary manner each boiler would require its own separate fuel-door and space in front for the fireman. By this construction, on the other hand, it will be readily seen that I only require a small space on one side of the gen-

erator for the fireman to work in, and this space need be only a very little, if any, larger than for a single generator.

Having thus described my invention, what I claim as new is—

1. A combustion-chamber and a series of steam-generators suspended within the same, in combination with a single constantly-rotating grate arranged at the lower part of said chamber beneath all of said generators, and a single feed-opening for supplying fuel to said grate, substantially as set forth.

2. A hollow water-holding shell and a series of steam-generators suspended within the same, in combination with a constantly-rotating grate mounted within said shell and beneath all of said steam-generators, substantially as set forth.

3. A shell, A′, with a combustion-chamber provided with a constantly-rotating grate in its lower part, and having a series of connected tubular generators suspended therein above said grate, said combustion-chamber adapted to be supplied with fuel through a single feed-opening in said shell, means for supplying an artificial air-draft to said combustion-chamber, and means for connecting the motive power which rotates said grate with the mechanism which operates said artificial air-draft, substantially as set forth, whereby the movement of the grate and the supply of air to said combustion-chamber correspond to regulate the generation of steam in said generators.

4. The hollow shells A′ A^2, capable of holding water and steam between their walls, and with their interiors connected at their upper ends by tubular chamber A^3, having diaphragm *a*, for separating the steam-chambers of said shells, grate B′ in the lower part of said shell A′, tubular generators D′ D^2 D^3 D^4, suspended in said shell A′ above said grate, and connected to each other and to said shell A′, tubular heater and generator E, suspended in said shell A^2 and connected thereto, and exit-flue C, leading from said shell A^2, substantially as set forth.

5. A hollow water-holding steam-generating shell and a series of steam-generators suspended within the same, said generators communicating with said shell, and said shell being extended up beyond the tops of said generators, whereby a superheating-chamber is formed, in combination with a grate located within said shell and beneath said generators, substantially as set forth.

6. In a furnace for steam-boilers, a grate adapted to be revolved, means for producing an artificial air-draft to the fuel on said grate, and means for connecting the mechanism which produces said artificial air-draft with the mechanism which revolves said grate, whereby they correspond in action to regulate the generation of the steam, substantially as set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

JAMES WATERS.

Witnesses:

C. N. WOODWARD,

L. R. ROBERTSON.