No. 765,070. PATENTED JULY 12, 1904.

C. DOYERE.

STEAM GENERATOR.

APPLICATION FILED JUNE 1, 1900.

NO MODEL. 2 SHEETS—SHEET 1.

FIG. 2.

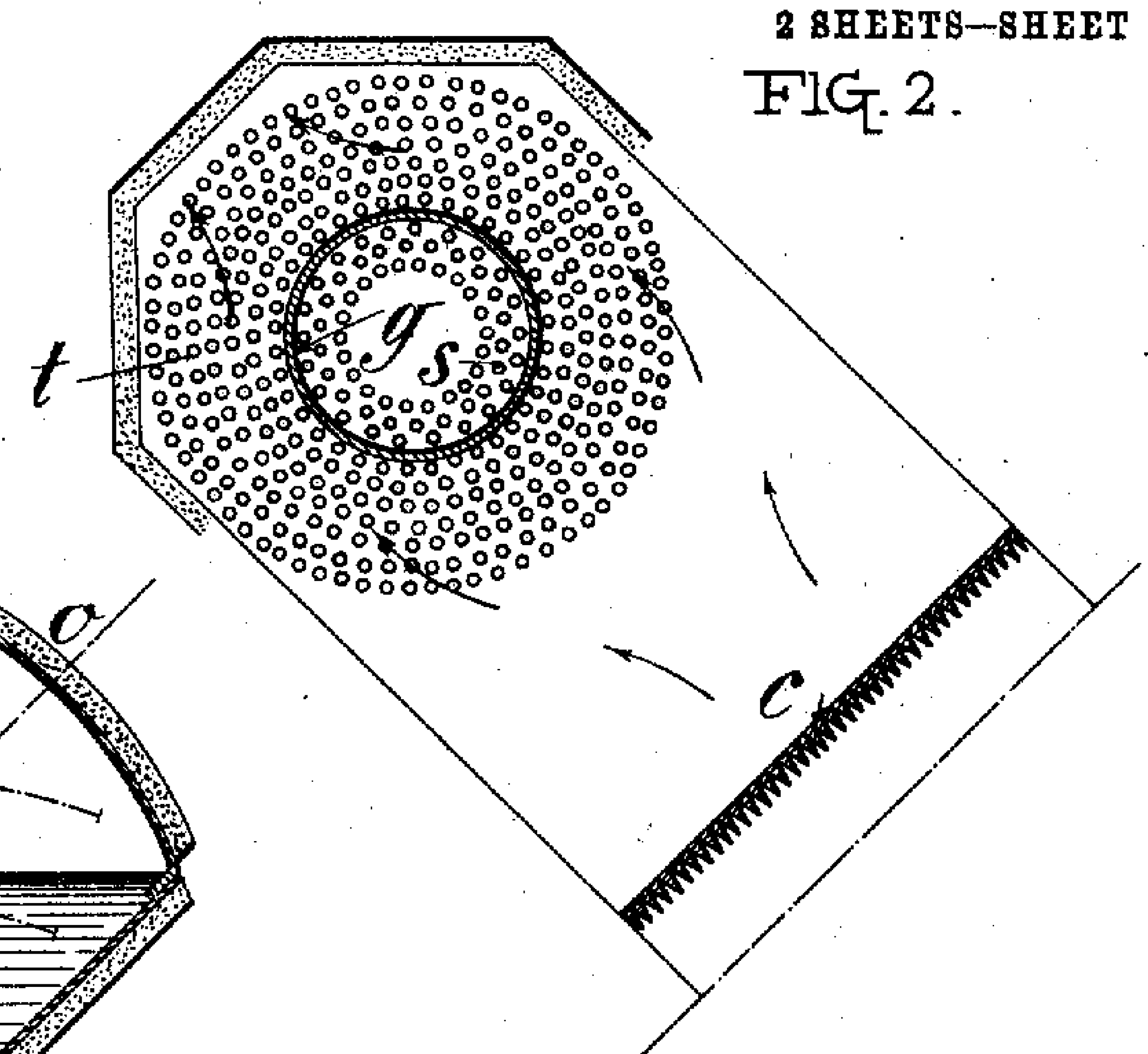


FIG. 1.

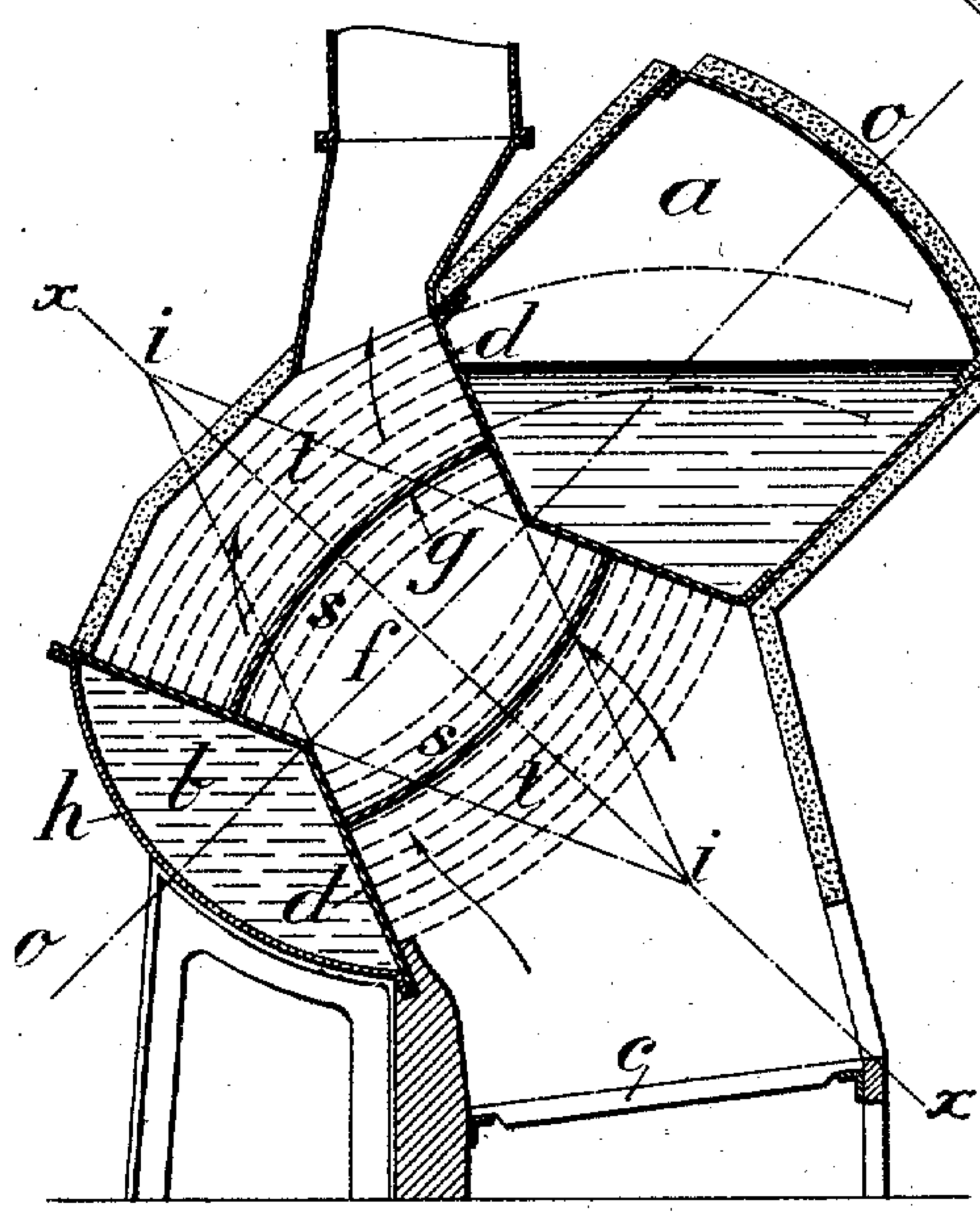
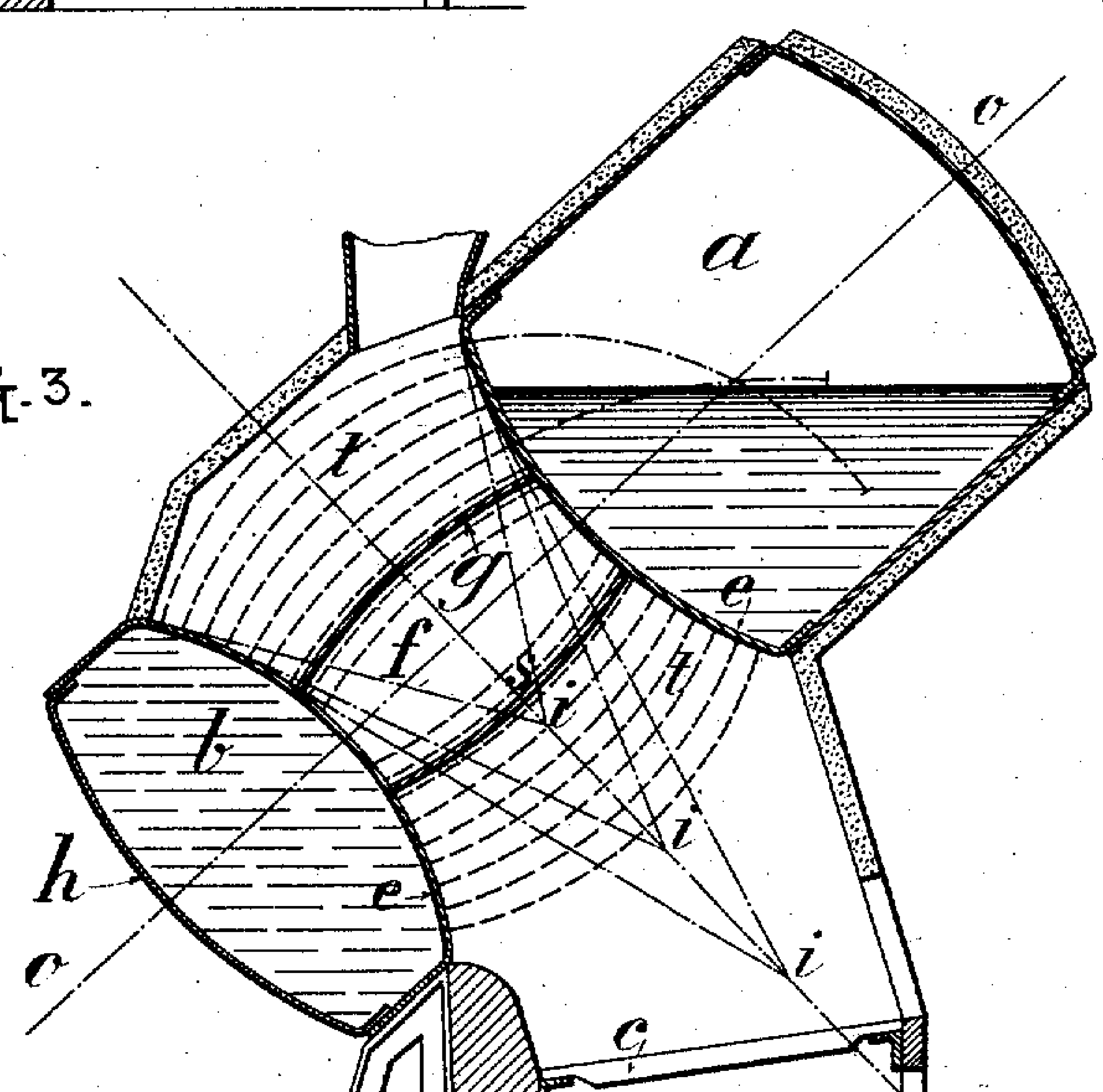


FIG. 3.



Witnesses:—

W. K. Bonelli

D. G. Winthrop

Inventor:

Charles Doyère

By Wm. E. Boulter

Attorney

No. 765,070. PATENTED JULY 12, 1904.

C. DOYERE.
STEAM GENERATOR.

APPLICATION FILED JUNE 1, 1900.

NO MODEL. 2 SHEETS—SHEET 2.

FIG. 4.

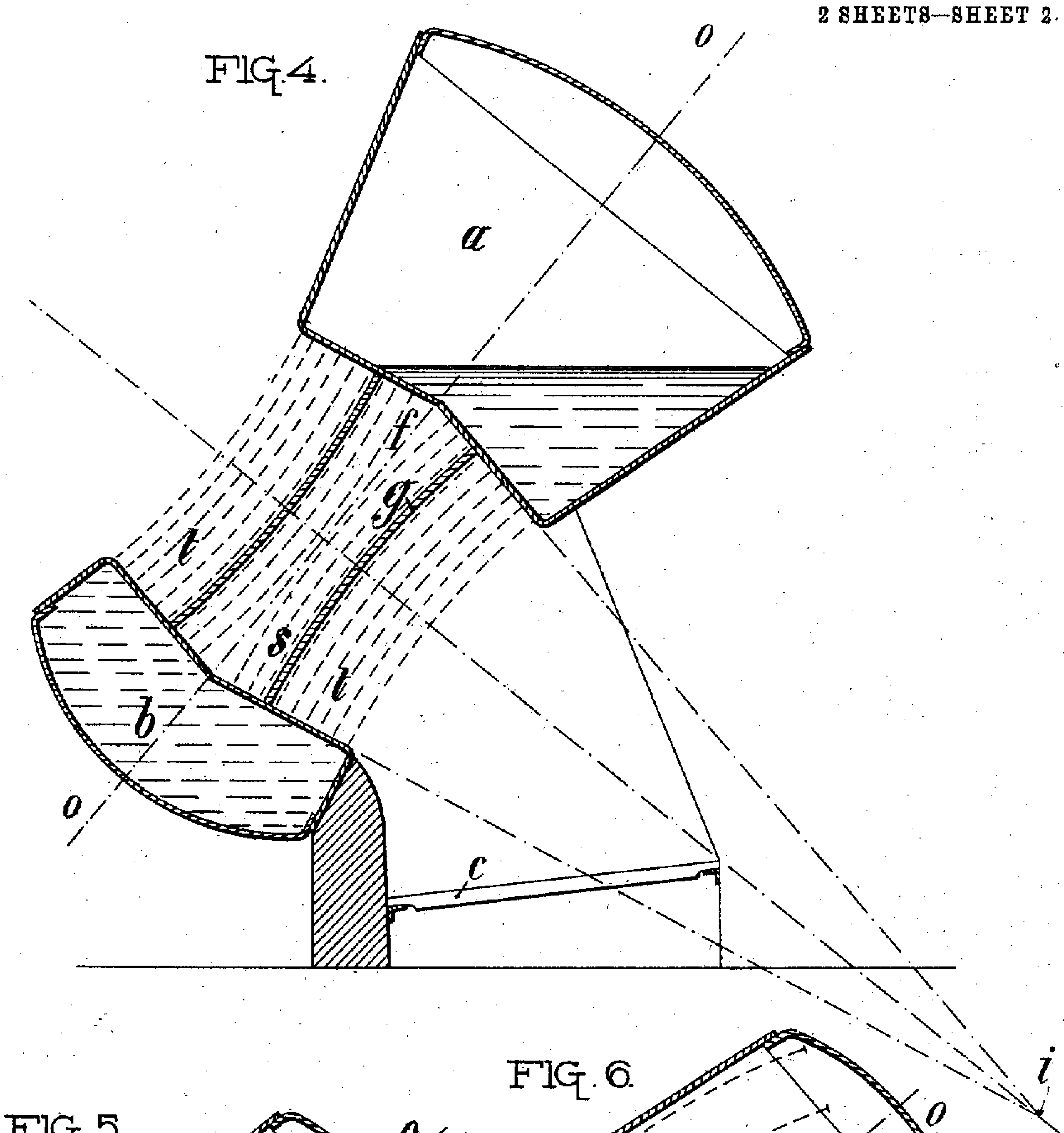


FIG. 5.

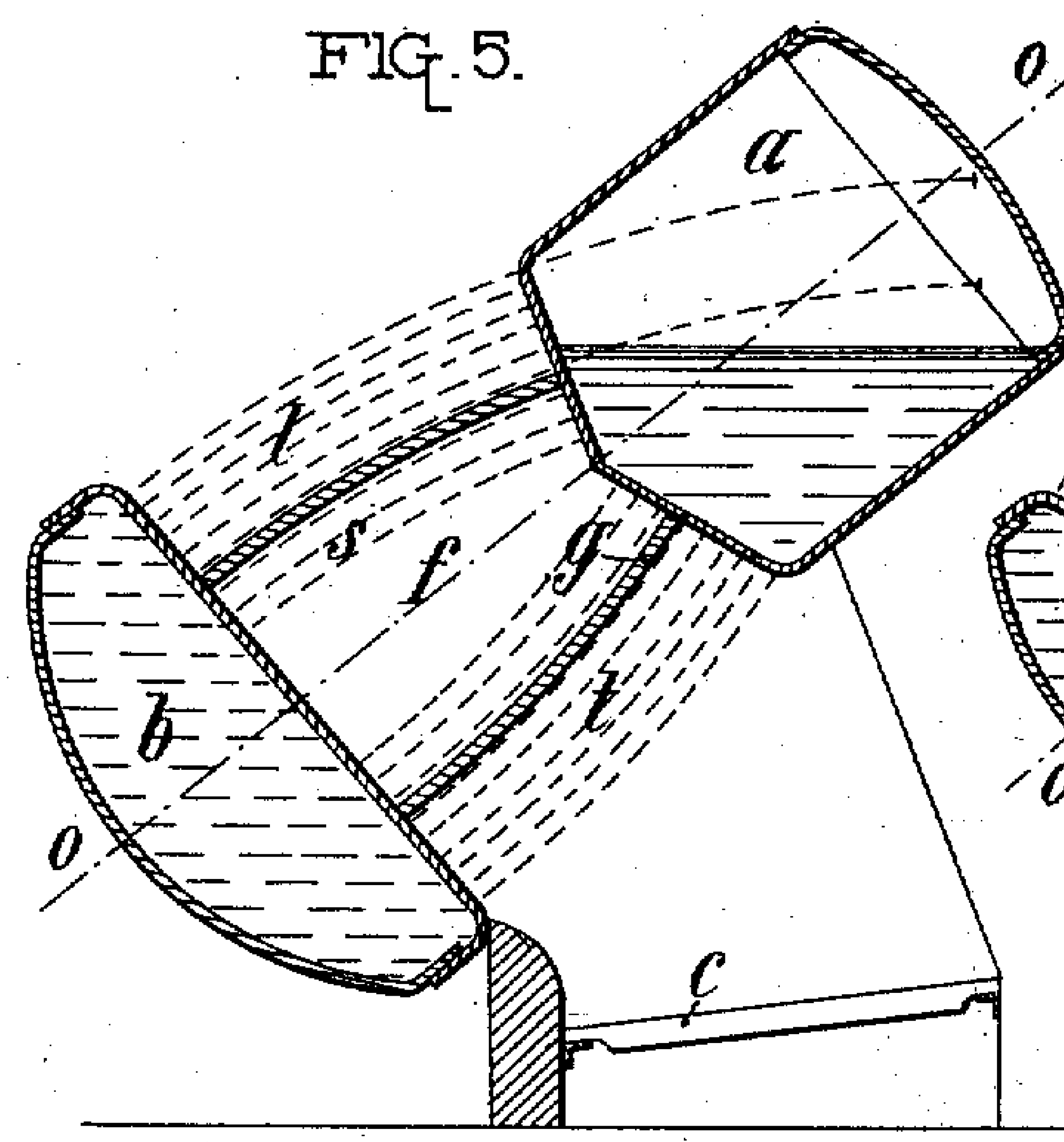
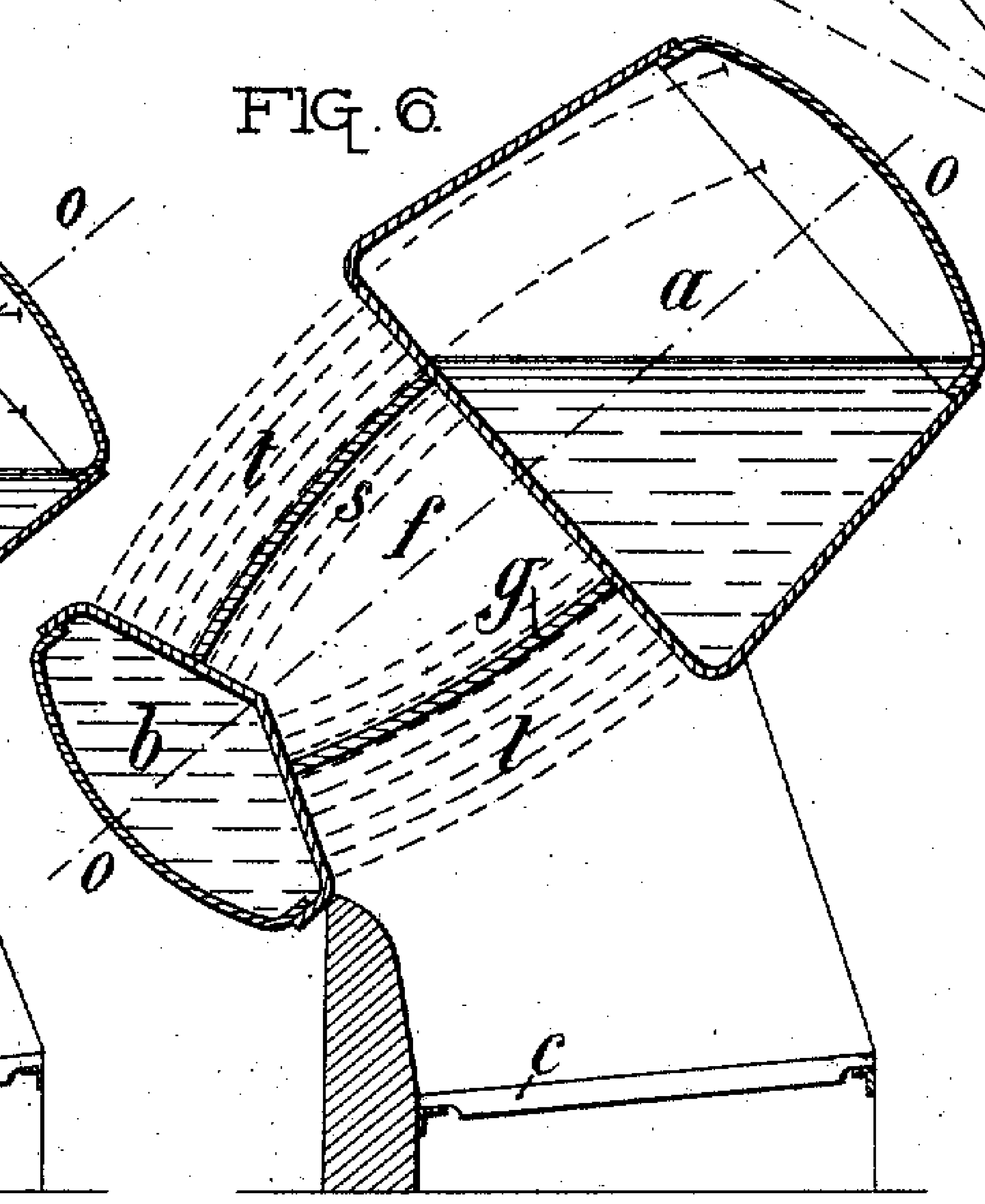


FIG. 6.



Witnesses:

Inventor:
Charles Doyère
By Wm. E. Boulter
Attorney

No. 765,070. Patented July 12, 1904.

UNITED STATES PATENT OFFICE.

CHARLES DOYERE, OF FOO-CHOW, CHINA.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 765,070, dated July 12, 1904.

Application filed June 1, 1900. Serial No. 18,750. (No model.)

To all whom it may concern:

Be it known that I, CHARLES DOYERE, a citizen of the Republic of France, residing at Foo-Chow, China, have invented certain new and useful Improvements in or Relating to Steam-Generators, (for which I have made application for Letters Patent in Great Britain under No. 2,686, dated February 10, 1900; France, No. 294,966, dated December 5, 1899; Belgium, No. 116,559, dated February 7, 1900, and Germany, No. 42,888, dated February 10, 1900,) of which the following is a specification.

The present invention relates to steam-generators and comprises an upper reservoir and a lower reservoir communicating with each other by curved steam-tubes and water-tubes, both held in place by simple swaging or expanding without any necessity for securing by means of screw-threads or the like.

The principle on which the invention is based is as follows: The whole of the bundle of tubes and the area of the upper and lower reservoir occupied by the ends of the tube constitute a system of revolution around a common axis, the latter forming with a general plan of the boiler and the plane of the furnace an arbitary angle. According to the curve of the tubes the form adopted for the meridian of the tube area both on the upper and the lower reservoirs and according to the inclination of the axis of revolution of the series of tubes the principle described above when carried into effect gives rise to a number of boiler types, which will be described, reference being had to the accompanying drawings.

Figures 1, 3, 4, 5, and 6 represent vertical sectional views of different arrangements of a type of boiler of which the axis of revolution of the tubes is inclined. Fig. 2 is a sectional view on line *x x* of Fig. 1.

The type of boiler represented by Figs. 1 to 6 is characterized by the following fundamental features:

First. The area on the reservoirs *a* and *b* occupied by the tubes *t* forms two revolution-surfaces, with an inclined axis *o o* contained in a vertical plane to the axis of the grate *c*, the meridians of these revolution-surfaces consisting of either two converging lines when the area occupied by the tubes consists of two cones *d* with the apices opposite to each other, Fig. 1, or two curves with their convexity opposite to each other, as when two convex-tube areas *e*, Fig. 3, are employed.

Second. The tubes *t* are circularly arched or curved and extend perpendicularly from the surface of the reservoirs *a* and *b*, an arrangement which allows of the tubes being inserted or removed separately through one or the other of its connections by drawing them, as it were, out of the sheath formed by the neighboring tubes around it. According to the type represented in Fig. 1 all the tubes being in the same meridian plane have a common center as regards their curves, the center being indicated by the point *i* where the two generatrices or prolongations of the cone sides *d* of the reservoirs meet. In the type represented in Fig. 3 the center of each tube in the meridian plane is the point where the tangents of the said meridians of the reservoirs meet, the tangent being drawn at the point of connection of the tube.

Third. The tubes of the inner rows are arranged at a certain distance from the apices of the two cones or cups forming the tube areas in such a manner as to form round the axis *o o* and in the center of the ovoid formed by the bundle of steam-generating tubes an ovoidal empty space *f*, which is isolated from the steam-tubes by a screen or partition *g*. In the interior of this space is arranged a small series of curved tubes *s*, connecting the two reservoirs *a* and *b*, which tubes *s*, being outside the direct action of the flame and hot gases, are intended to serve as water-circulating tubes.

Fourth. The angle of the cones *d*, or the amount of curvature of the two cups or curved surfaces *e*, forming the tube area, the inclination of the axis of revolution *o o*, the distance of the innermost row of tubes *t* from the axis *o o*, the relative position of the two reservoirs *a* and *b* are all variable items, which may be modified to suit each particular case in order to modify as desired the medium inclination of the tubes, the extent of the heating-surface of the tubular system, the grate-surface, and the various conditions on which

depend the length, width, or height of the boiler.

Fifth. The lower reservoir *b* is closed by a cover or surface *h* of any form. According to Fig. 1 this surface is a simple spherical cup. According to Fig. 3 it is developed into a cylindrical part, which allows the volume of water to be increased, but which facilitates also the adjustment or the extraction of other tubes and the fixing of the tubes without removing the cover by means of an examination-hole and the like. Any other form may be adopted—for instance, a cover concave on the outside, so as to diminish the quantity of water, and so on.

Sixth. The same remarks will apply to the upper reservoir *a*, the form of which beyond the area occupied by the tubes is evidently independent of the arrangement of the principle which constitutes the invention. A reservoir of any form united with the tube area by means of a forged or cast connection may be used, so as to vary at will the volume of water, the volume of steam, and the free surface above the water-level. According to Figs. 1 and 3 the reservoir *a* is supposed to be a circular straight-sided cylinder directly connected with the base of the cone or the cup forming the tube area. The diameter of this cylinder is arranged with regard to the length and curvature of the tubes in such a manner that they may be passed in and out through the holes of the plates in the interior of this reservoir, as indicated by the dotted lines, thereby facilitating by providing a manhole at a suitable point the repair or replacement of a tube; but this arrangement is not obligatory and may be replaced in certain cases by an arrangement which permits the exchange of tubes to be effected from the back by opening the lower reservoir.

Seventh. A modification rather different as regards form, but still belonging to the same kind of construction, is the type represented by Fig. 4, in which the reservoirs *a* and *b* are of any kind of form with conical or concave cups and in which the tubes *t* present a convex form toward the axis *o o*.

Eighth. An intermediate type between the last and the preceding is that in which one of the tube areas is a flat surface and perpendicular to the central axis, around which the tubes are arranged—*i. e.*, a cone with an angle of one hundred and eighty degrees. This gives the two arrangements schematically represented in Fig. 5 or Fig. 6, according as to whether the upper or the lower reservoir is flat, and the closing of such a reservoir with plane-tube area being arbitrary this type may be used as a steam-generator with an upper or lower water-plate.

In the type of generator described above it will be evident that the dimensions of the various elements, as well as the accessory arrangements, may be varied, and of course strengthening devices—such as ties, cross-bars, and the like—as well as manholes and inspection-places for examining, cleaning, dismounting, and other purposes in connection with the type employed, will be provided where necessary. Further, the tubes, which may be curved or sinuous, need not be closely or symmetrically arranged; but spaces may be left between them, or some may be omitted, either for the purpose of increasing the space above the grate or for facilitating the draft or for any other purpose. Finally, in some cases the water-tubes *s* may be omitted or they may be prolonged into the interior of the reservoirs by continuations or pipes passing into the farther parts of the reservoirs.

I claim—

1. A steam-generator comprising upper and lower reservoirs, a series of curved heating-tubes joining the said reservoirs at approximately right angles to the same, water-circulating tubes having a curvature corresponding to that of the heating-tubes and joining the upper and lower reservoirs at approximately right angles to the same, and a seating arranged between said heating-tubes and water-circulating tubes, as described, said heating and circulating tubes and surfaces in which said tubes are fixed constituting a system of revolution around a line which forms the common oblique central axis of the system constituted by the tubes and reservoirs.

2. A steam-generator comprising upper and lower reservoirs, a series of curved heating-tubes joining the said reservoirs at approximately right angles to the same, said tubes being arranged concentrically around an oblique line forming an oblique central axis of both reservoirs and leaving a space immediately surrounding the said central axis, water-circulating tubes arranged within the space around the central axis and joining the upper and lower reservoirs at right angles to the same, the curvature of said water-circulating tubes corresponding to that of the heating-tubes, the said heating and circulating tubes and surfaces in which said tubes are fixed constituting a system of revolution around a line which forms the common oblique central axis of the system constituted by said tubes and reservoirs.

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

CH. DOYERE.

Witnesses:
A. AUBIN,
A. DOIRE.