

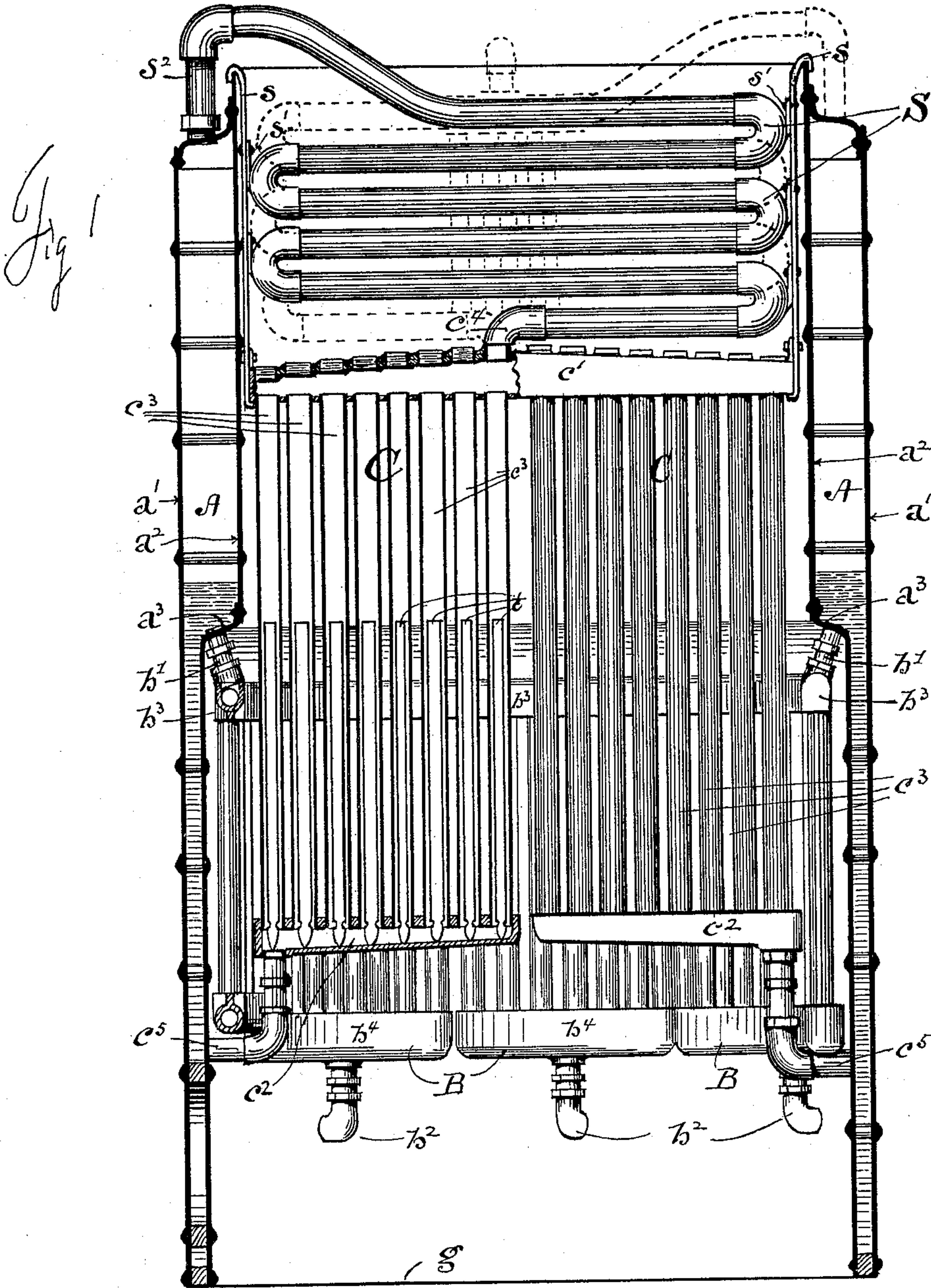
(No Model.)

2 Sheets—Sheet 1.

C. H. FOX.
STEAM GENERATOR.

No. 603,502.

Patented May 3, 1898.



Witnesses:

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Attorney at Law.

Charles H. Fox

Inventor,

by A. M. Reed atty.

(No Model.)

2 Sheets—Sheet 2.

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Fig-2-

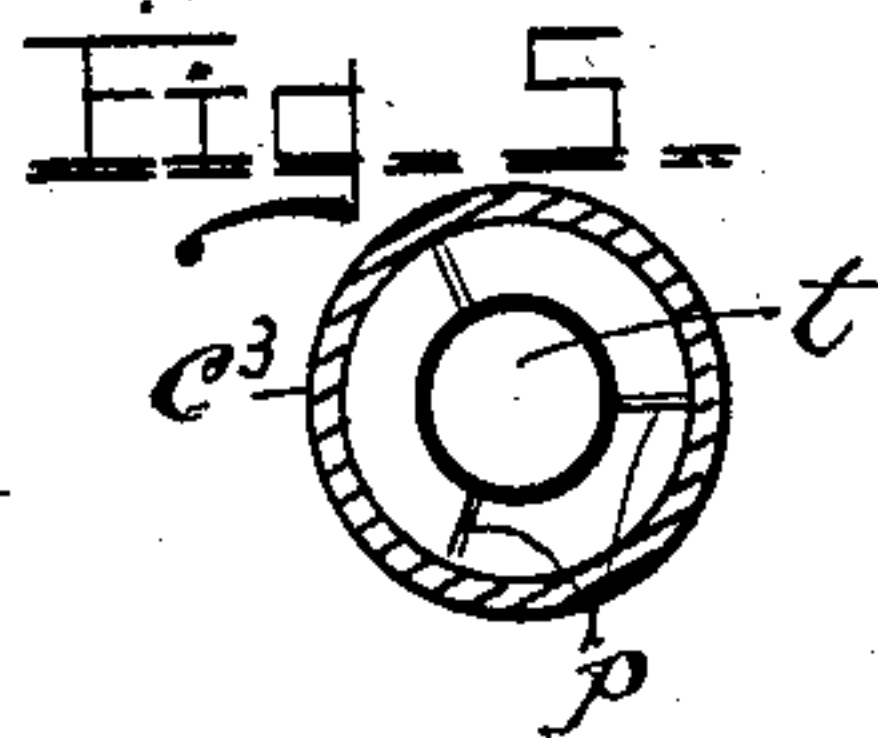
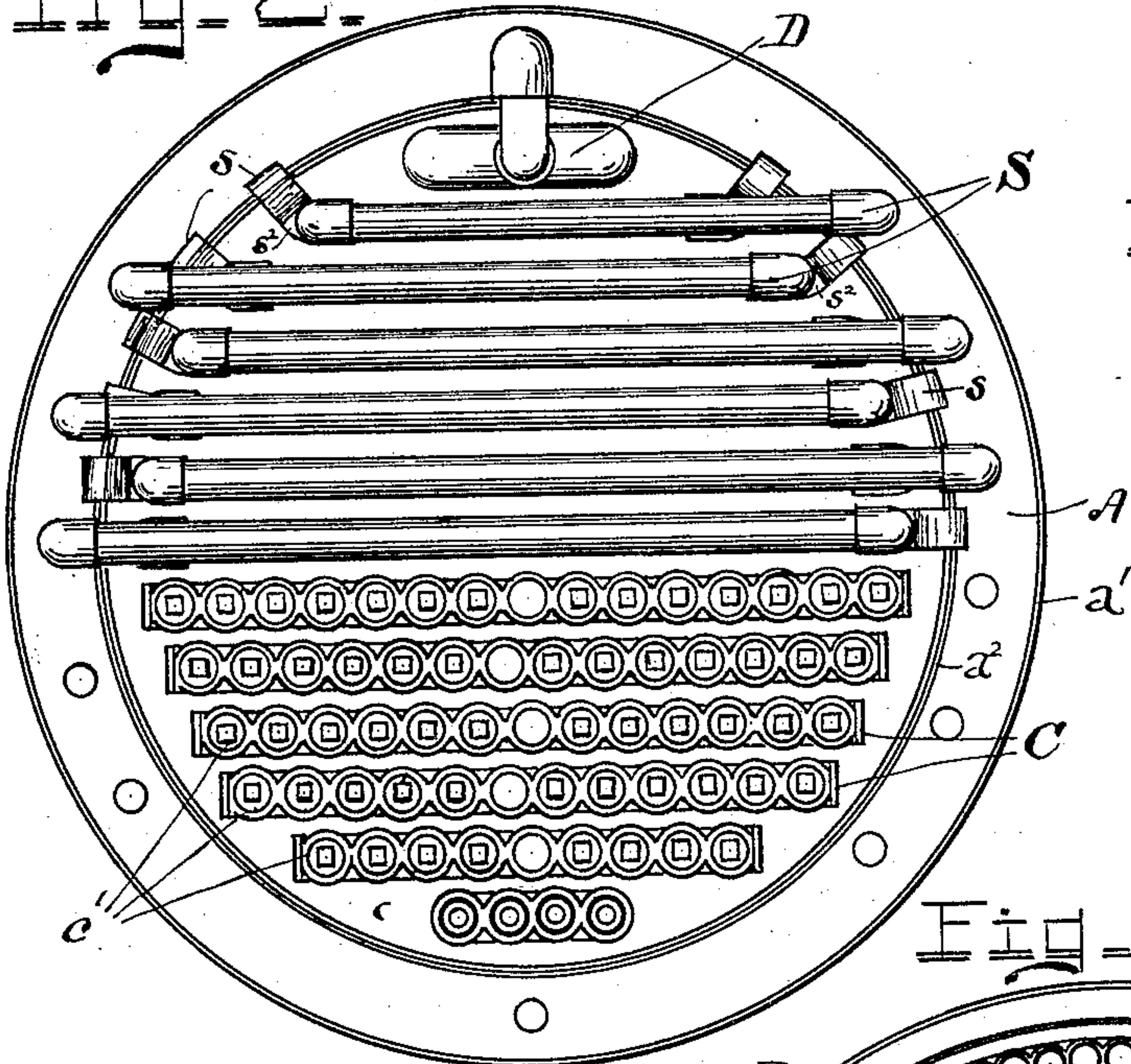


Fig-3-

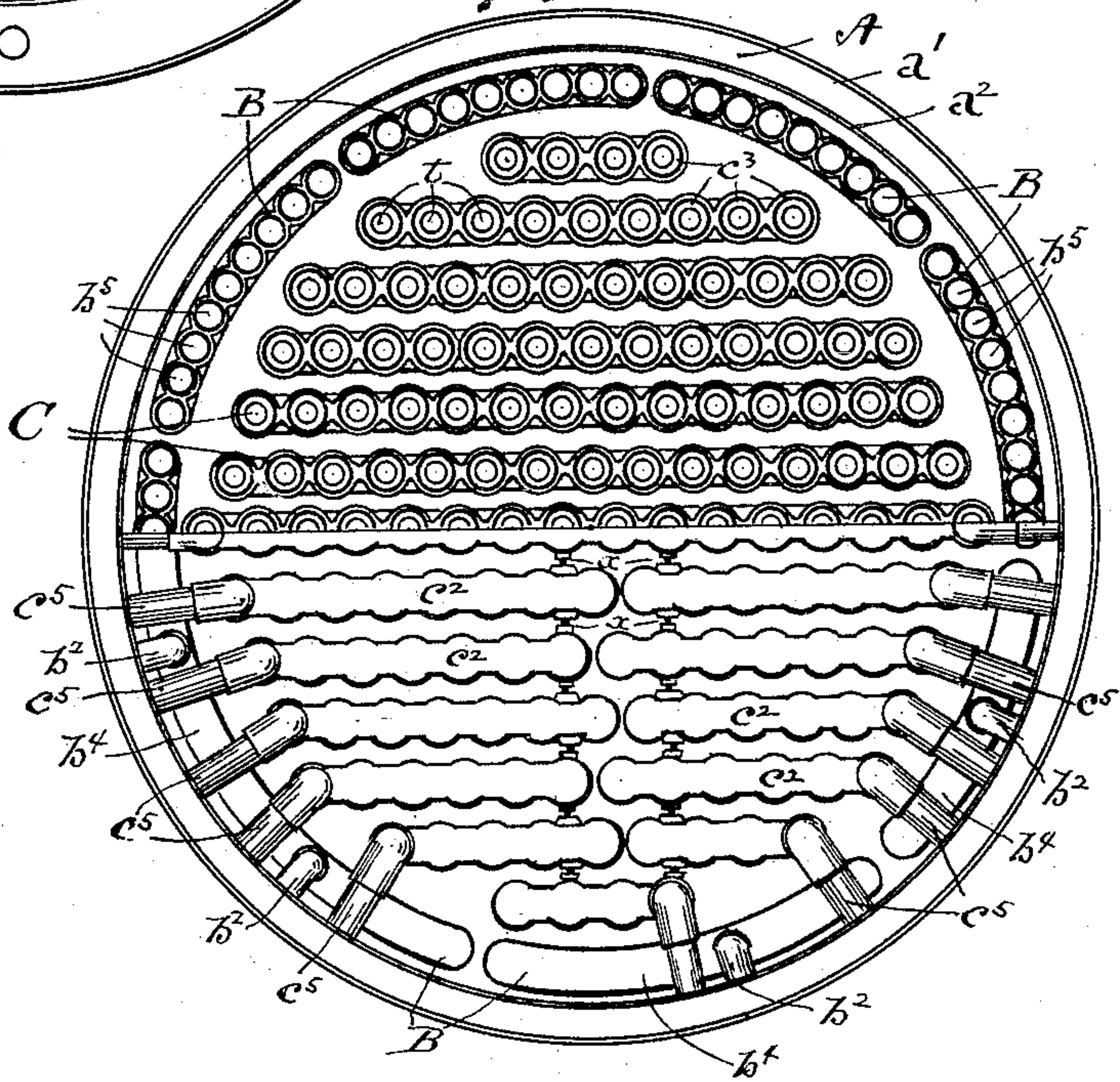
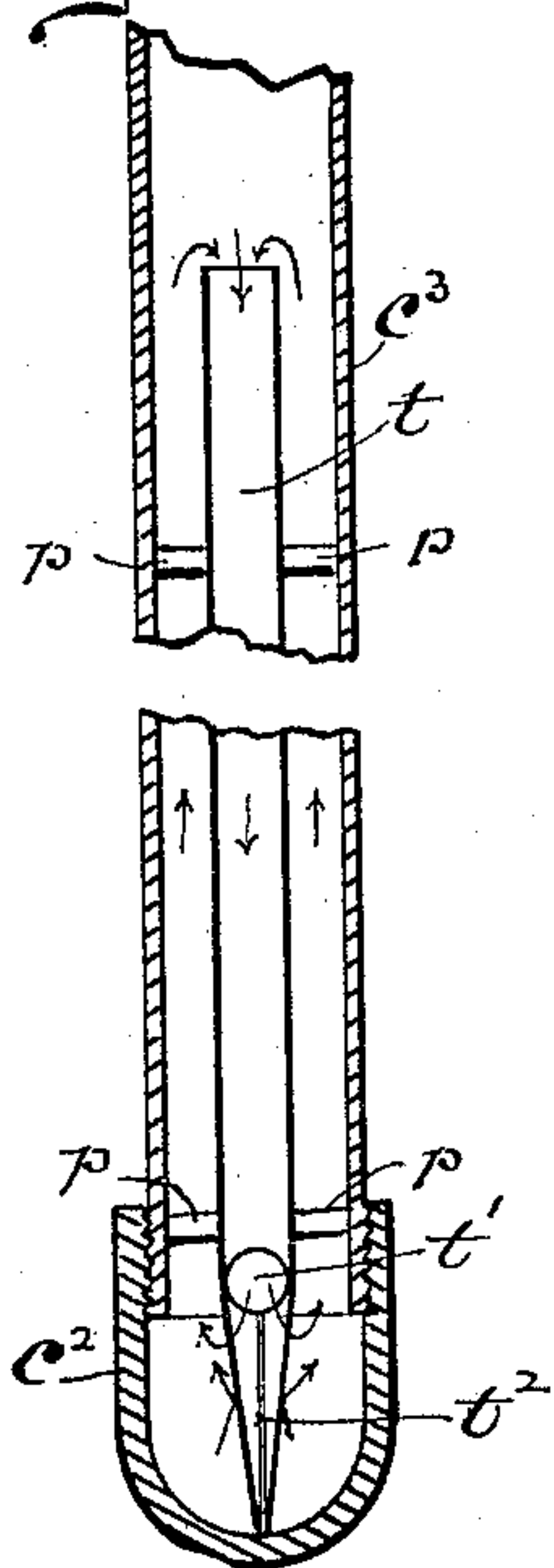


Fig-4-



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UNITED STATES PATENT OFFICE.

CHARLES H. FOX, OF CINCINNATI, OHIO.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 603,502, dated May 3, 1898.

Application filed November 30, 1896. Serial No. 613,910. (No model.)

To all whom it may concern:

Be it known that I, CHARLES H. FOX, a citizen of the United States, residing at Cincinnati, Ohio, have invented new and useful Improvements in Steam-Generators, of which the following is a specification.

My invention is an improvement in steam-boilers of the water-tube type, its object being to combine in one structure advantages heretofore existing independently, and also to embody other advantages shown by experience to be desirable, so as to produce a steam-generator of the highest efficiency and economy both in construction and steam production.

In order to explain clearly the object in view in my present invention, it is necessary to refer briefly to some existing types. In a preferred and largely-used type, differing as among the individual species only in the form and disposition of the tubes, the steam-making "units" or groups of tubes are attached to a shell constituting a water-jacketed fire-box, the top of which is a crown-sheet perforated for the admission of the water-tubes and for an upper set of tubes passing through the steam-space of the boiler above the fire-box and out through a corresponding sheet forming the top end of the boiler. In practice a serious defect is found to inhere in this constructive type by reason of the unequal expansion of the several parts of the boiler, producing troublesome leaks at the tube-joints and destructive deterioration of the tubes at the water-line. Repairs and renewal of tubes, which are frequently necessary in this type, are unduly expansive and troublesome, owing to the inaccessibility of the fire-box crown-sheet and the usually intricate arrangement of the rest of the water-tubes within the fire-box, which makes their removal a matter of difficulty, besides rendering the boiler useless for long periods. A second type, the outgrowth of a recognition of these difficulties, known as the "coil" or "sectional" tube generator, consists of a shell (sometimes water-jacketed) inclosing a system of tube-sections through which the water circulates and around which the incandescent gases of combustion play. In this type the difficulty is largely one of arrange-

ment and construction of the tube-sections, which are generally such as to impede or prevent the natural circulation of the water under heat. One of the approved species of this type embodies an annular cylindrical water and steam jacket of two cylindrical shells, the central inclosure of which is a continuously-open fire-box, the upper part being occupied by nests or "sections" of water-tubes. While this type of boiler possesses the advantage of dispensing with a crown-sheet and maintaining the tubes in a position and relation facilitating repairs, &c., yet it is open to the serious disadvantage of a lack of natural circulation and of dependence upon a circulating-pump, taking its supply from the annular water-space and injecting it into the tubes, with all the inconvenience and danger attending this method of maintaining proper operative conditions. These two types in various modified forms of construction are generally employed in steam fire-engines and other practice where quick steaming and large relative capacity are required, and my invention is indented, primarily, to secure the advantages and overcome the defects of both types.

To this end my invention consists in a steam-generator embodying a water-jacketed casing having an enlarged steam-space inclosing a fire-box and combustion-chamber occupied by a system of tube-sections or "manifolds" constructed, arranged, and attached, as hereinafter set forth, with or without a system of superheating-tubes constituting the upper connection of the tube-sections with the boiler.

It consists also in the construction and arrangement of the tube-sections and their connections with the water and steam spaces of the boiler in such manner as to constitute each an independent "steam-generating unit," in which the circulation of water is complete and the separation of steam from the entrained water is facilitated.

Further details of invention will be indicated in the description and claims.

Mechanism embodying my invention is illustrated in the accompanying drawings, in which—

Figure 1 is a vertical axial cross-section of a

steam-generator complete built according to my invention, showing one half of a steam-generating unit in section, illustrating the circulating function. Fig. 2 is a top plan view with some of the superheating-coils removed to exhibit the manifold-sections. Fig. 3 is a bottom plan view with half the manifolds shown in cross-section. Figs. 4 and 5 are vertical and horizontal cross-sections, respectively, of one of the manifold-tubes, showing details of construction.

Referring now to the drawings, A designates the outer water jacket or casing of a vertical steam-generator, consisting of an outer cylindrical shell a' , of uniform diameter, and an inner shell a^2 , of relatively large diameter at the lower part and smaller diameter above, with an intervening annular shoulder a^3 , approximately horizontal. The outer and inner shells are united at top and bottom in any convenient manner and inclose between them an annular space relatively large above and small below, constituting the water-jacket of the fire-box and the ultimate steam-space of the boiler.

Within the inclosure formed by the jacket A, in the enlargement above the grate-line g and below the annular shoulder a^3 , are placed a series of manifolds B in approximate juxtaposition in concentric series, as shown in Figs. 1 and 3, with upper connections b' entering the boiler through the shoulder a^3 , and lower connections b^2 entering the lower part of the water-leg. The manifolds B consist of upper and lower headers b^3 b^4 , substantially alike and, as shown in Figs. 1 and 3, connected by parallel tubes b^5 in the usual manner, the upper headers being connected with the water-jacket A by a nipple-joint entering the shoulder a^3 of the casing below the normal water-level and the lower header by a similar joint with the shell a^2 of the water-leg. These manifolds present no unusual construction, this feature of my invention consisting in their arrangement, in combination with the peculiarly-enlarged fire-box, the water-jacket and the generating units now to be described.

The central space within the circle of manifolds B and extending above the same is occupied by a series of adjacent manifolds C, of peculiar construction, as follows: Each consists of a series of tubes c^3 , connecting a top header c' and bottom header c^2 , the headers being proportioned in length to the position occupied in the series and extending across as a chord of the arc subtended. The top header c' is utilized as a suspending beam upheld at its extremities from the top of the boiler-casing by straps s and increases in vertical width (increasing the area of its interior passage) toward the center, where it receives its discharge-pipe c^4 , extending thence to the steam-space of the casing A. The lower header c^2 is divided about midway of its length into two approximately equal parts either by

a partition or, as preferred and shown, by construction as two independent portions, each having at the end adjacent to the boiler-casing a pipe connection c^5 to the water-leg of the casing A.

Each tube of the manifold-sections carries within itself a smaller circulating-tube t , constituting an annular partition extending longitudinally from the bottom of the lower header c^2 upward to a point somewhat below the normal water-level. These inner tubes are entirely open above and centered in relation to their containing-tubes by radial prongs p , Fig. 5, and at the bottom are closed to an approximate point by notching the lower end t^2 into two opposite V-shaped points, which are then drawn together, Fig. 4. Just above the pointed end t^2 , within the inclosing tube, the inner tube is perforated at opposite sides, as at t' . The effect and function of this construction is indicated by the arrows. As the greatest heat is at the exterior of the tubes c^3 , a natural circulation is established, assisted by the annular partition formed by the inner tube t , within which the water descends and outside of which it ascends. The pointed ends of the inner tubes t , besides serving as a resting-post supported at the bottom of the lower header c^2 , also tend to deflect the ascending currents outwardly, and thus assist the discharge of the inner descending current through the lateral orifices t' from within the inner tube t . While I have shown the application of the tubular partition only in the manifolds C, it will be understood that it is applied to the other manifolds herein shown and that it constitutes an independent feature of the invention applicable to other water-tube generators. Its beneficial action in preventing priming by facilitating the separation of entrained water from the steam and carrying it to the bottom of the manifold will be readily understood.

The top headers c' are provided with screw plugs or caps at their upper side opposite the several tubes for access to the same, as required, and for setting the tube ends into the header by expansion and upsetting.

As a means of retaining the several manifolds of the central group in adjacent relations against displacement in fire-engine and similar service I may insert backing-screws x in bosses or protuberances of the headers at corresponding points to rest in contact with the adjacent header as adjustable spacing-blocks.

The segmental spaces adjacent to each side of the central system of tube-units are occupied by tube-sections D of substantially the same construction as those first described, but extending the full height of the boiler-casing.

In the present illustration of my invention I have shown the top connections of the manifolds C as extended into superheating-coils S, which may be carried up for any desired distance, according to the height of the casing

A. These coils are attached at their ends by cleats s' to the straps s , the whole constituting stiffening-braces supporting the upper headers of the manifolds C, each such manifold, with the hanger-frame thus constituted, being removable as an entirety by disconnecting the lower connections c^5 of a manifold C and the upper connections s^2 of a superheating-coil connection. The upper end of each superheating-coil is shown in the present case as carried over the casing A and turned downward into a connecting-flange between the shells a' a^2 for convenience of construction.

The action of the generator has been sufficiently indicated, and attention need be called only to the fact that the disposition and construction of all parts are such as to facilitate a free and natural circulation without a circulating-pump. The tube-sections B, connecting with the casing above and below the water-line, constitute an inner independent water-jacket for the fire-box and insure a constant downward circulation in the outer jacket A. Within the circle inclosed by this inner jacket is placed the system of independent steam-generating units C, directly over the hottest part of the fire and in the axis of greatest heat in the ascending column of incandescent gases.

The practical construction and arrangement of the whole are such that any one of the manifolds can be removed, the casing-apertures of its connections plugged, and the boiler used while the manifold is being repaired.

Lastly, the construction is economical in cost and durable to a greater degree than has been heretofore attained for equal steaming capacity.

I claim as my invention and desire to secure by Letters Patent of the United States—

1. In an upright boiler, the combination of inner and outer shells forming an annular water and steam space, an annular series of circulating tubes or tube-sections below the normal water-level and communicating above and below with the water-space, and an independent central system of tubes or tube-sections extending from the top of the boiler down within the series of circulating tubes or sections, said central tube-sections connected with the steam-space of the boiler above and with the water-space of the boiler below, substantially as set forth.

2. In a steam-generator, in combination with a vertical open-ended water and steam jacketed shell, of a plurality of independent, detachable steam-generating units each consisting of a number of parallel vertical tubes in a common axial plane, opening into headers above and below, arranged within the inclosing shell in parallel series extending from side to side, each unit having a central connection at the top, to the steam-space of the shell, and opposite end connections from the bottom, to the water-space of the shell, substantially as set forth.

3. In a steam-generator, in combination with a vertical water and steam jacketed inclosing casing, of a plurality of independent detachable generating-units, each consisting of a number of parallel vertical tubes in a common axial plane, connected by headers, and communicating with the casing above and below the water-level, respectively, each of said tubes being provided with means for circulation of water in opposite directions within the same below the normal water-level, substantially as set forth.

4. In a steam-generator, in combination with a vertical open-ended steam and water jacketed inclosing shell, of a plurality of independent detachable generating-units each consisting of a number of vertical tubes in a common axial plane, connected by headers communicating with the shell below and above the water-line, in combination with a corresponding plurality of independent superheating-coils arranged above the generating-units in the inclosing shell, and constituting the steam connections of said units respectively with the inclosing shell, substantially as set forth.

5. In a steam-generator, in combination with an open-ended cylindrical water and steam jacketed inclosing casing, of a plurality of independent detachable steam-generating units arranged in parallel series from side to side, each consisting of a series of vertical tubes united by a common top header, having a central connection thence with the steam-space of the inclosing casing, and two independent bottom headers, each connected with the water-space of the inclosing casing, substantially as set forth.

6. A steam-generator embodying in combination, a vertical open-ended casing consisting of a plain cylindrical outer shell and an inner shell contracted above the immediate fire-box giving an enlarged annular steam-space; a concentric series of tube-manifolds arranged within and contiguous to the lower part of the inner shell and opening above through the connecting-shoulder of the shells into the enlarged annular space below the normal water-line, and opening below into the fire-box water-leg; a series of vertical manifolds within the circular space thus inclosed, and extended above the normal water-line connecting below with the fire-box water-leg and above with the annular steam-space of the casing, substantially as set forth.

7. In a boiler of the character indicated, in combination with the vertical tubes of a tube-manifold extending from a point above to a point below the normal water-level, a shorter open-ended tube in each and concentric therewith extending from the lower header upward to a point below the water-level, and constituting an annular circulating-partition, substantially as set forth.

8. In combination with the upper and lower headers of a tube-manifold, and tubes con-

necting the same, of inner concentric tubular
partitions, extending in each tube upwardly
from the lower header to a point below the
normal water-level, closed below by inclined
5 surfaces and having lateral lower openings
abovesaid surfaces, substantially as set forth.

In testimony whereof I have hereunto set

my hand in the presence of two subscribing
witnesses.

CHARLES H. FOX.

Witnesses:

L. M. HOSEA,
HERBERT J. ALLSUP.