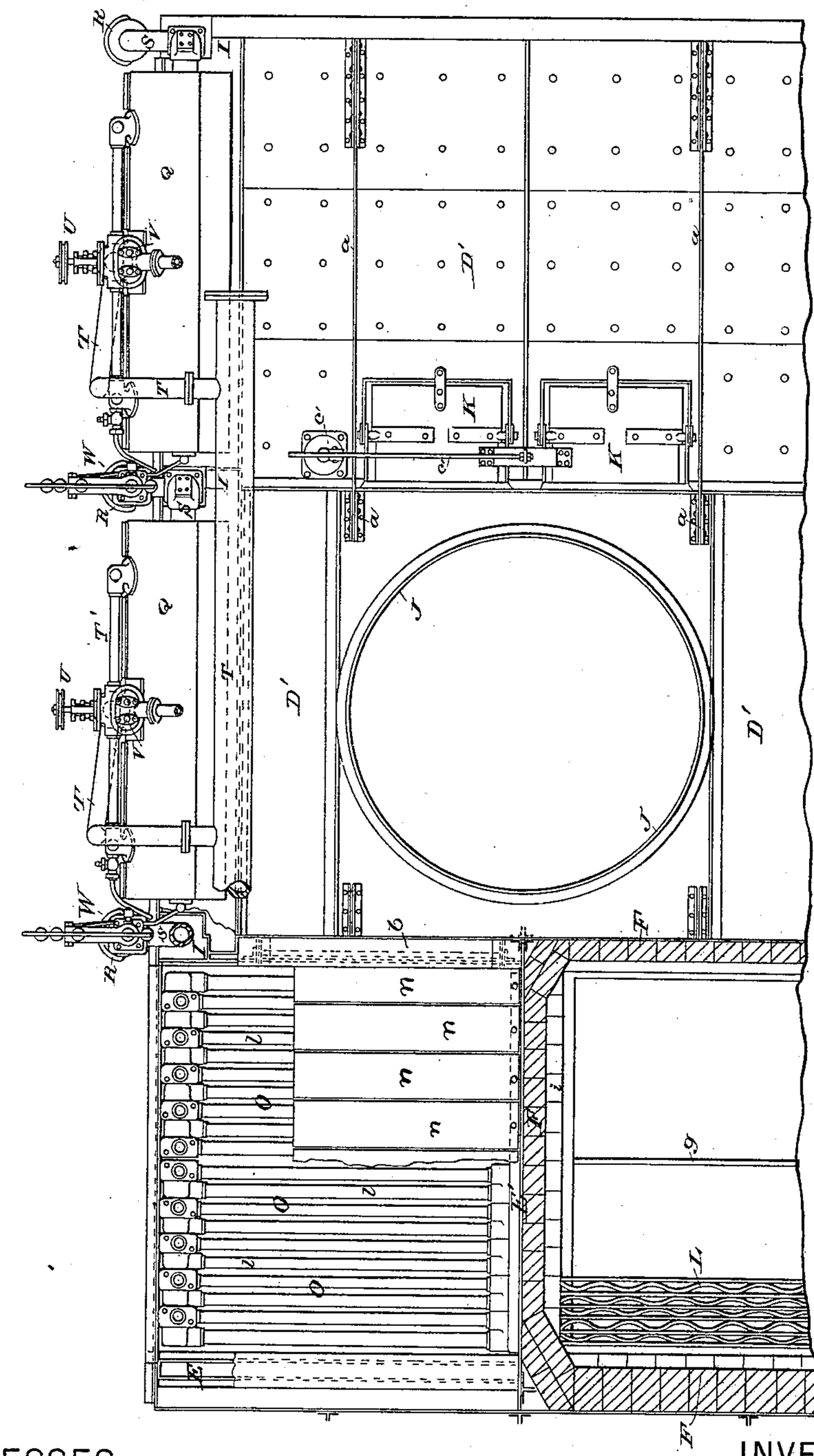
(No Model.) 5 Sheets—Sheet 1.

J. F. BELLEVILLE.

STEAM GENERATOR.

No. 336,282. Patented Feb. 16, 1886.

Fig. 1.



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(No Model.)

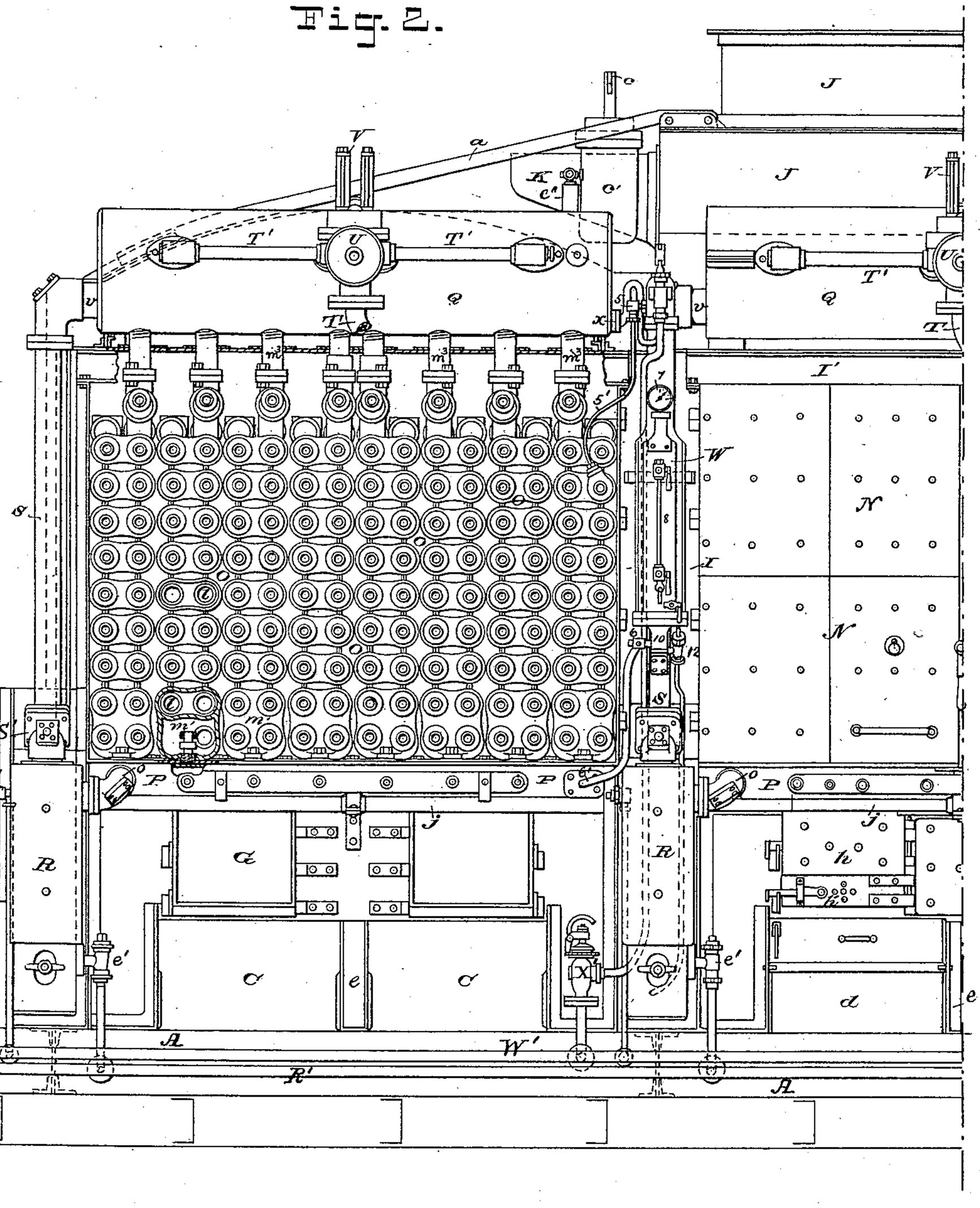
5 Sheets—Sheet 2.

J. F. BELLEVILLE.

STEAM GENERATOR.

No. 336,282. Patented Feb. 16, 1886.

Fig. 2.



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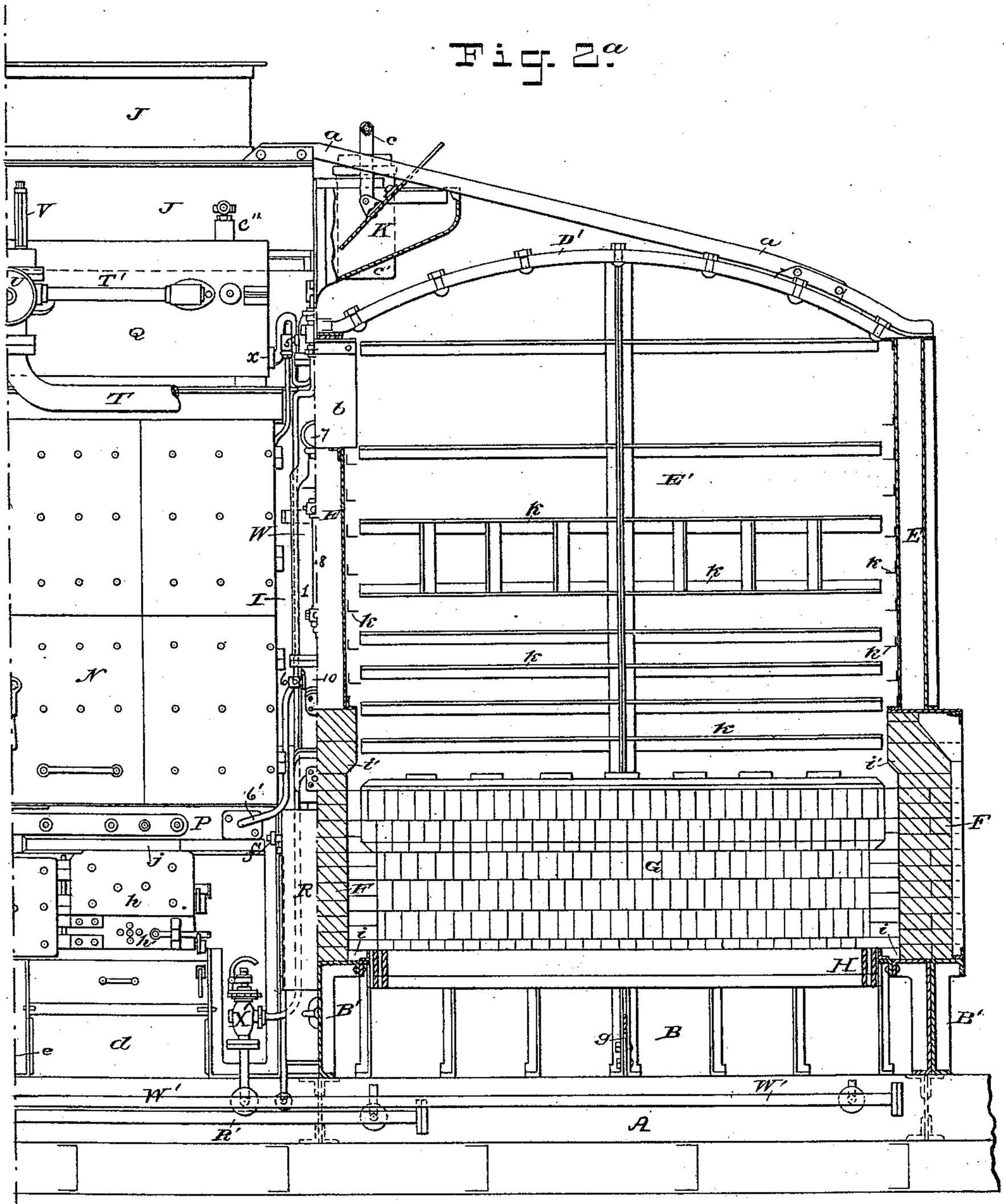
STEAM GENERATOR.

No. 336,282. Patented Feb. 16, 1886.

Fig. 2.ª



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5 Sheets—Sheet 4.

J. F. BELLEVILLE.

STEAM GENERATOR.

No. 336,282. Patented Feb. 16. 1886.

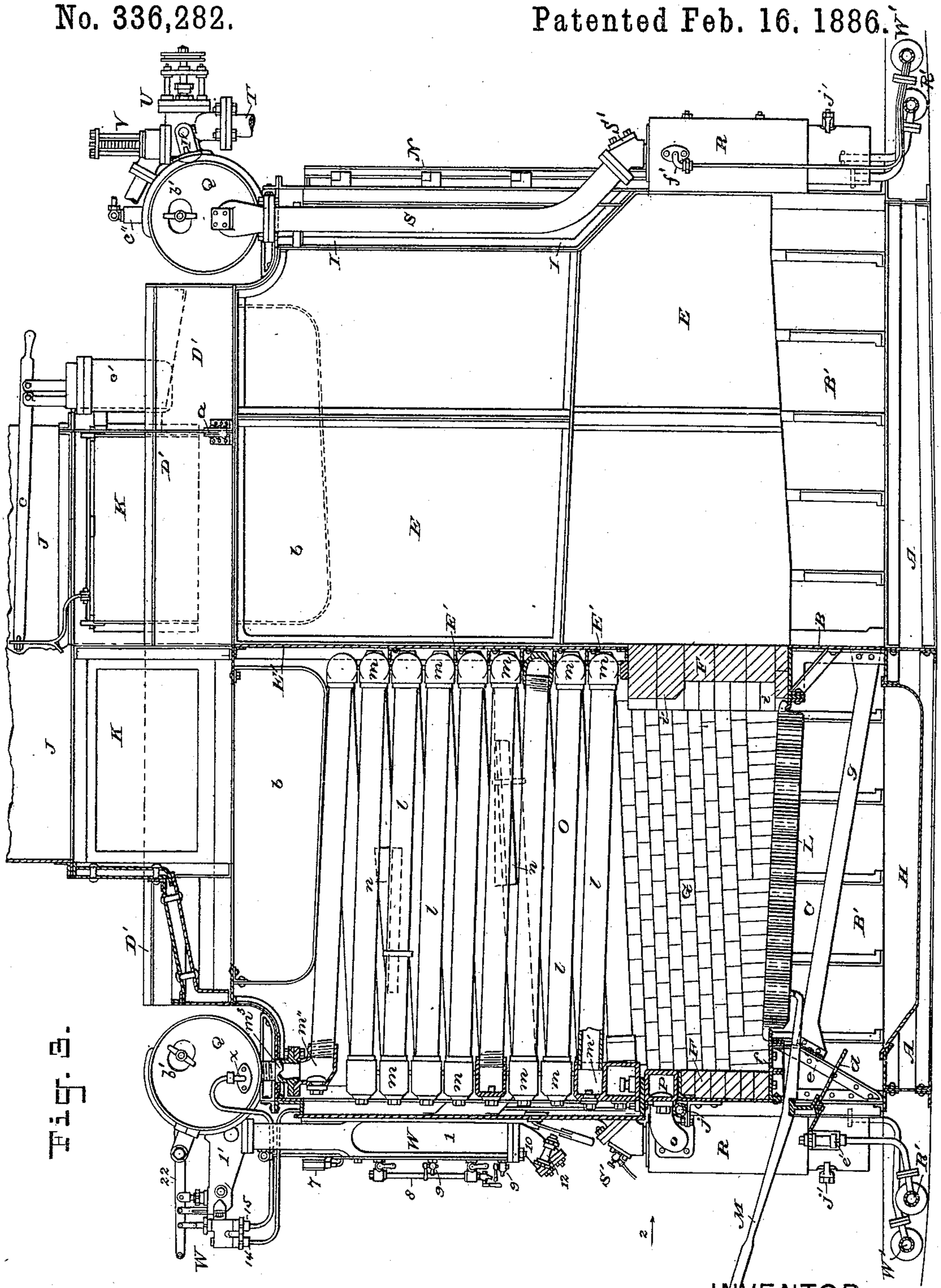

Fig. 5.

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(No Model.)

5 Sheets—Sheet 5.

J. F. BELLEVILLE.

STEAM GENERATOR.

No. 336,282. Patented Feb. 16, 1886.

Fig. 4.

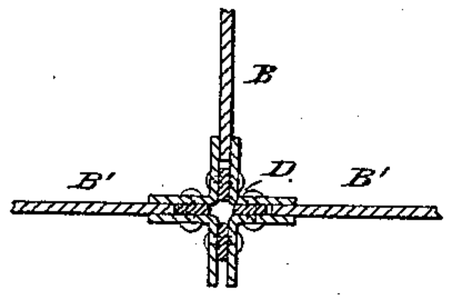


Fig. 5.

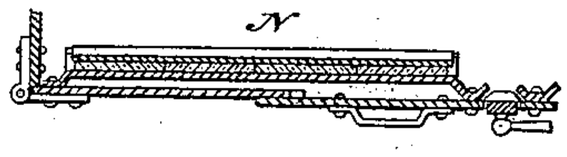
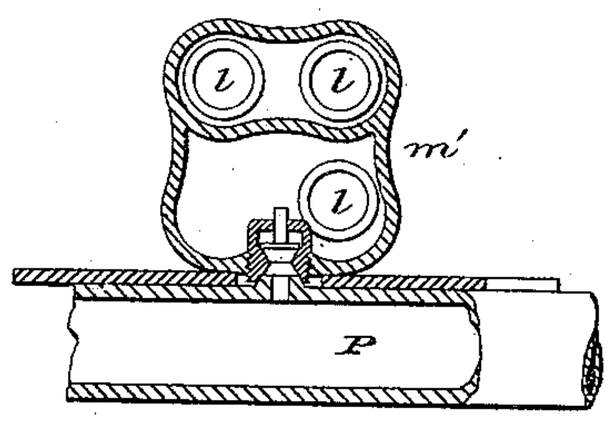


Fig. 6.



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UNITED STATES PATENT OFFICE.

JULIEN FRANÇOIS BELLEVILLE, OF PARIS, FRANCE.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 336,282, dated February 16, 1886.

Application filed February 5, 1885. Serial No. 155,028. (No model.) Patented in France July 12, 1884, No. 163,274.

To all whom it may concern:

Be it known that I, JULIEN FRANÇOIS BELLEVILLE, a citizen of the French Republic, and a resident of Paris, France, have invented certain Improvements in Steam-Generators, of which the following is a specification.

My invention relates to that class of steam-generators wherein the generator elements are in the form of coils of water-tubes arranged in a fire-box. It is especially adapted and designed for use as a marine boiler, and many of its advantages arise from its use on shipboard; but it may also be used on land as well. I have herein shown it constructed for use as a marine boiler, and will describe it with especial reference to such use; but I do not of course limit myself to any special application of my invention.

The characteristic features of my generator are these: Each generator is ordinarily made up of several separate and distinct generators, each of which is complete in itself. These individual generators—say six in number, as herein shown—are arranged in a group comprising two tiers or rows of three each, extending fore and aft the vessel, the two rows being placed back to back. Thus the backs of the generators are in the longitudinal axis of the vessel, and the fire-fronts or façades face outward toward the sides of the vessel. One chimney, common to all the generators, is arranged over the center of the group. The iron-work of the fire-boxes, ash-pans, &c., is constructed in a novel manner, as will be herein described, for reasons that will be fully set forth. The brick-work of the furnaces has also novel features of construction that will be described. The generating elements are made up of tubes and tube-boxes connected at their lower ends to a feed-water collector common to all the generating elements of an individual generator, and at their upper ends to a steam-drum. Each individual generator is usually made up of a number of these tubular elements, all of which are capable of being readily removed and replaced. Each tube may be readily cleaned, and ample provision is made for expansion and contraction.

All of the above features will be fully described hereinafter in connection with the annexed drawings, and their novel features will be definitely set forth in the claims.

In the drawings which serve to illustrate my invention, Figure 1 is a plan view, partly in section, designed to illustrate six of my improved generators grouped to form what may be called a "compound" generator. Only three of the generators are shown in full outline, the other three being broken away to save repetition and to economize space. The generators to the right are shown in plan. The upper one to the left is in horizontal section above the generator-tubes, and the lower one at the left is in horizontal section just above the furnace-grate. Figs. 2 and 2ª, taken together, represent the frontage or façade of three of the six boilers, as seen from the position of the stokers or firemen. Fig. 2 shows one half of the middle generator in elevation, and the left-hand generator with the fire-box doors removed. Fig. 2ª shows the other half of the middle generator in elevation and the right-hand generator in vertical section, taken parallel with the longitudinal axis of the vessel and midway of the depth of the furnace. The generator-tubes and grates are omitted from this generator, the better to illustrate the other features. Fig. 3 is a transverse vertical section, as to its left half, of one of the generators, the section being taken midway of the width of the generator-front, and as to its right half a side elevation of a generator. The plane of this figure is at right angles to the longitudinal axis of the vessel, and illustrates the arrangement of two generators back to back, with their back walls on the line of the keel. Figs. 4, 5, and 6 illustrate some minor details of construction that will be more particularly referred to hereinafter.

First. Concerning the particular functions of the individual generators: The tubular apparatus is fractional for each generator. Each element of this apparatus is composed of a suitable number of tubes, usually of iron, inclined and superposed in two vertical ranges. The tubes of each range are parallel with each other, but the tubes of the ranges in one element have contrary inclinations. The extremities of the tubes of the two ranges are at the same level. Communication is established between the tubes of the two ranges by means

of horizontal tube-boxes, usually of malleable iron, in each of which are fixed the ends of two tubes—one belonging to each vertical range—that are in the same horizontal plane. When mounted and connected in this manner, the various tubes of the two ranges forming the element, together with their tube-boxes, form a single elongated zigzag steam-and-water chamber, which gradually ascends from base to summit, and through this elongated chamber the water circulates. In the annexed drawings I have shown eight of these elements arranged in the fire-box of each generator; but more or less may be employed. The elements forming the generator receive water from one feed-water collector common to all, with which they communicate at their bases, and they all deliver their steam into one reservoir or drum, with which they communicate at their upper ends. On this reservoir is mounted the valve which controls the supply of steam to the engines, and also the safety-valve. Each boiler is supplied with an automatic regulator for controlling the supply of feed-water, and with its special furnace, ash-receiver, &c.

Second. Concerning the grouping of the generators to form a compound generator: Each individual generator is mounted in an appropriate casing or envelope formed of plate and angle iron, with a wall of fire-brick about the furnace. For generators where the circumstances require several individual generators the envelopes are constructed to form but one group, which is compact, staunch, and occupies comparatively little space. Thus the generators may be placed back to back, with the furnaces of one tier arranged side by side, and partitions in common for adjacent generators. Each generator of the group may be readily cut off from the others, and thus one may be repaired while the others are in operation. There is no communication between the generators of the group, except as to the general feed-water and steam pipes, and as to the chimney with which they all connect. The feed-water and steam pipes are provided with valves, whereby any generator may be cut off and isolated from the rest. This grouping of the generators presents the following advantages as compared with marine boilers as ordinarily arranged—that is, at the sides of the hull and facing inward toward the center or axis: The heat lost by radiation is noticeably less. The stokers are not confined between two radiating surfaces, and do not incommode each other in stoking. The generators on one side may be isolated and repaired without the workmen interfering with the stokers operating those on the other side, which may be worked as usual. The weight is considerably diminished by the use of parts of the envelope in common, and greater compactness and strength are attained. The chimney may be firmly mounted on the group of generators, and the flues connecting the fire-boxes with it are very short. The longitudinal bunkers are perfectly isolated, and are thus less liable to be heated by the generators. Finally, the stokers may draw their coal directly from the bunkers, arranged in front of the boilers, without having to be supplied by coal-heavers, as is usually the case. As marine boilers are ordinarily arranged, the service of these latter becomes very onerous in the case of forced firing.

Referring to the principal figures of the drawings, A is the bed-plate or platform which supports the entire group of generators. This is made up of a grid composed of three longitudinal beams and four transverse beams, each of which is composed of plate and angle iron riveted together. One longitudinal beam lies in the axis of the vessel, and the other two lie under the respective fire-fronts or façades of the boiler. Two of the transverse beams are arranged at the ends of the group, and the others are arranged under the transverse partitions between the generators.

Mounted on the base A are paneled wall-plates B and B′, Figs. 2ª and 3, the former serving as partitions to separate the ash-boxes C of the generators placed back to back, and the latter performing the same function for the generators placed side by side. These partitions are made up of plate and angle iron, and are bolted down to the base A.

At the angles of the generators are placed upright posts D, which are best shown in the detached cross-section, Fig. 4. These posts are made up of angle-irons, which are riveted together, with strips of iron plate interposed, so as to leave "keepers," to receive the edges of the plates B and B′, which are bolted to the said posts. The air circulates freely through the axes of the posts, which are bolted permanently to the base A.

All the holes for the bolts used in constructing the plates B and B′, (except those at the middle of B and those near the front end of B′,) and those used for attaching the plates to the posts D, are elongated, in order to allow play for expansion and contraction. The posts D rise only as high as the plates B and B′.

E, Fig. 3, are transverse double partitions of plate-iron, which are mounted over the plates B′ and separate the fire-boxes of the generators placed side by side. At their ends these are fixed to the posts of the fire-fronts or façades, and they rest on the tops of the posts D.

E′ are the longitudinal partitions, not double, mounted over the plates B, and arranged to separate the fire-boxes of the generators placed back to back. These are secured to partitions E. These partitions E and E′ rest on the masonry of fire-brick F, which forms the walls about the furnace G, and this masonry rests on cap-plates secured to the tops of the plates or partitions B B′, as clearly shown. All the bolt-holes whereby the partitions E E′ are secured are elongated, to permit of expansion and contraction.

H, Fig. 3, is the ash-pan, which is arranged

in the base A, and supported at front and rear by flanges on the said base.

I, Figs. 2 and 3, are the uprights of the fire-front or façade. These are fixed at their lower ends to the base A, and to them are secured the edges or ends of the transverse partitions E. The upper portions of these uprights are bent or set back, as shown at the right in Fig. 3, in order to provide a space for the automatic feed-regulator and other parts that will be hereinafter referred to.

I′ are girders or tie-bars, which connect the tops of the uprights I, and thus serve to form with the latter the frames of the façades. The holes for the attaching bolts or rivets are elongated to allow for expansion and contraction.

D′ are the arched roof-plates of the fire-boxes of the end generators of the group. These are arranged at some distance above the generating-tubes, and are made double, of plate-iron, and rest on the tops of the extreme transverse partitions or walls of the envelope at their one ends, and at their others upon suitable bent or bracket plates back of the purifiers. The riveting is constructed to allow for expansion and contraction, in order that they may not in expanding exert an injurious thrust on their bearings.

In Figs. 1, 2, and 2ª, *a* are collar-beams, which connect the extremities of the roof-plates with the base of the chimney; and *b* in Fig. 3 are smoke-flues arranged above the transverse partitions, to connect the fire-boxes of the extreme or end generators with the chimney.

J, Figs. 2 and 3, is the base or foundation of the chimney and the collar upon which the chimney is mounted. This is supported upon the transverse partitions below and the general structure forming the envelope.

K, Fig. 3, are dampers to admit cold air into the chimney. These dampers are each controlled automatically by means of a lever, *c*, connected at one end to the hinged damper, and at the other or shorter end to a piston or diaphragm arranged in a cylinder, *c′*. Steam from the generator is admitted under the piston, and a spring acts on its other side to resist the steam-pressure. Thus the damper is regulated and controlled by the tension of steam in the generator, and may be made to regulate the draft in such a way as to control the tension of the steam and maintain it within certain limits.

d are the ash-box doors. (Shown in Figs. 2, 2ª, and 3.) These are provided with hinged rack-bars that pass through slots in the doors, and by making a notch in the rack-bar engage the margin of the slot the doors may be held open at any desired angle. The doors are pivoted on horizontal axes.

e, Fig. 3, is a bracket, which supports the front of the furnace, notably the brick-work between the fire-doors. This bracket also supports the channel-iron girder *f*, which serves to support the front ends of the grate-bars L, and said bracket is connected to the back wall of the ash-box by a bar, *g*. The rear ends of the grate-bars have hooks formed on them which take over a ledge formed on the supporting-plate at the back of the ash-box. This construction permits the front ends of the grate-bars to be raised and shaken without danger of the bars falling into the ash-box.

h are the fire or charging doors, and *h′* the stoking-holes, of the furnace.

M, Fig. 3, is a lever, which may be inserted into the ash-box and under the grate, to raise the front ends of the bars, two at a time, in order to break up the clinkers and clear up the air-passages. This lever finds a fulcrum on a bar over the ash-box doors.

The fire-brick masonry F around the furnace is provided at its base with a projecting ledge, *i*, to prevent clinkers from adhering to and injuring the masonry, and with an overhanging cornice, *i′*, to prevent the hot gases from rising along the walls of the fire-boxes.

j in Figs. 2 and 3 is a steam-pipe supported on brackets along the front of the furnace, to supply jets of steam to the latter to augment the combustion in a well-known way.

It will be sufficient to say that the fire-boxes of the generators are each bounded by the four walls formed by the fire-front or façade and the longitudinal and transverse partitions E and E′. Each fire-box is over the furnace G and under the roof-plate D′, and it contains the generator elements made up of tubes.

N N are the doors in the façade that close the front of the fire-box. These are best seen at the right in Fig. 2. Each door is of double thickness with an air space between the plates. The outer plate is in two overlapping parts to allow for unequal expansion and contraction without warping. On the inner door is mounted a raised plate corrugated horizontally, to allow of expansion and contraction, and between this corrugated plate and the plate behind it is placed some bad conductor of heat. These doors N are hinged to the uprights of the façade and are provided with suitable fastenings. At the left in Fig. 2 the fire-box doors are wholly removed in order to show the tubular generating elements within the fire-box. Fig. 5 shows the door N in horizontal section.

k k are angle irons affixed horizontally to the walls of the fire-boxes, (see at the right in Fig. 2ª,) to serve as screens to deflect the hot gases away from the walls of the boxes. On the back of the fire-box I usually arrange, also, some angle-irons *k* vertically, for the purpose of assisting in the spacing and setting of the generator elements.

I will now describe in a general way, and with reference to the general views of the drawings, the generator elements and their attachments and appurtenances.

O O are the tubular generator elements, eight of which are shown in the generator at the left in Fig. 2. Each element is formed of two tiers or ranges of tubes, *l l*, all of which are inclined. The tubes of each tier are parallel with each other, and the inclination of one tier

is opposite to that of the other tier. This will be seen at the left in Fig. 3. The tubes of the two tiers on the same level are connected in pairs, both front and back, by tube-boxes *m*, usually of malleable iron, into which the tubes are screwed. The lower tube-box, *m'*, at the front has an upper and lower chamber, and only one tube enters the lower chamber, whereat the lower end of the serpentine element starts. There are hand-hole covers opposite the ends of the tubes on all the tube-boxes, in order to afford access for cleaning.

P, Fig. 3, is the feed-water collector common to all the elements of one generator. This collector is in the form, as here shown, of a square tube, which is mounted on the furnace-front, and on this tube rest the several double tube-boxes *m'*, through which the generator is supplied with water. The box *m'* is connected to the collector P by means of a coupling, which should be provided with a check-valve. This will prevent the sediment from the generator from working back into the collector and clogging it. This construction is best shown in Fig. 6, which is a section of the box and collector. The box has a conical hole or seat, which engages a coned ajutage on the collector, and the box and collector are secured together by a single bolt. A tinned-copper washer, cone-shaped, may be interposed between the cone and its seat in order to insure a water-tight joint. The construction of the check-valve is so well illustrated as to require no further description.

In Figs. 2 and 3, *m''* are eduction-elbows, which connect the upper tubes of the elements with the steam-drum Q.

n indicates thin metal plates that I usually insert between the elements and above the tubes in such a manner as to deflect the hot gases to and among the tubes. These may or may not be employed.

R, Figs. 2 and 3, is a dejecteur or sediment-collector, and S is the return-pipe which connects the dejecteur with the drum Q, whereby the feed-water which passes through drum Q and water separated from the steam in Q is led from the latter down to the dejecteur R.

o is the bent pipe which connects the dejecteur R with the collector P, under the generator elements.

T is the main steam-pipe, which takes steam from the drum Q to the engines. U is the main steam-valve in pipe T, and V is the safety-valve.

W represents in general the feed-water regulator.

W' represents the main feed-water pipe, and R' the main blow-off pipe, from the dejecteur R.

The feed-water apparatus comprised in the drum Q, dejecteur R, and feed-water regulator W form no part of my present application, and therefore will require no description herein.

My generator is not liable to explode, and if it should give way at some point under an excessive internal pressure, very little danger need be apprehended for the following reasons: The comparatively small quantity of water in the generator; the facility and rapidity with which one generator of the group may be cut off from the rest; the escape of steam from a break in the generator tubes or boxes will be less likely to penetrate through the envelope forming the walls of the fire-boxes than to pass up the chimney; no bursting of the generator is at all likely to project parts of the generator among the stokers or other operatives. Each tubular element may be removed with very little trouble, in case it is desired to renew it in whole or in part. The element is fastened in but two places—namely, at the top to the spud in the drum Q, and at its base to the collector P—as shown in Fig. 6. This allows ample play for expansion and contraction, and the element may change its shape considerably without in any way compromising its solidity or the staunchness of its joints.

To dismount the elements, I take out the screw-plug (see Fig. 6) in the double box *m'* and remove the screw or bolt which secures the flanged box to the collector P. I then remove the two bolts which secure the eduction-elbow of the element to the spud fixed on the drum Q, and by exerting a little pressure, as with a lever, free the parts at the joints. The element may then be removed. It may be replaced by a reversal of these operations.

Having thus described my invention, I claim—

1. A steam-generator wherein the generating element is formed of connected tubes arranged within a sheet-metal fire-box, as described, and the refractory walls F of the furnace are constructed with an inwardly-projecting cornice, *i'*, to deflect the hot gases from the sheet-metal walls of the fire-box, substantially as set forth.

2. A steam-generator wherein the generator element is formed of connected tubes arranged within a sheet-metal fire-box arranged above the furnace, and wherein the sheet-metal walls of said fire-box are provided with deflecting-strips of metal *k*, to interrupt the flow of the heated gases upward in close contact with said walls, substantially as described.

3. A steam-generator wherein the generator element is formed of connected tubes arranged within a fire-box, whereof the sides and back are of sheet metal, and wherein the front of the fire-box is formed of doors N, whereby, when said doors are thrown open, free access may be had to the whole interior of the fire-box and the generating elements, substantially as described.

4. The combination, to form the envelope of a tubular steam-generator, of the iron plates B and B', forming the back and side walls of the ash-box C, and provided with cap-plates for the masonry, the masonry F, forming the walls of the furnace G, the longitudinal and transverse sheet-metal partitions E' and E, mounted on the masonry, the double-arched

roof D′, and the façade or fire-front and its several doors, all constructed and arranged substantially as shown and described.

5. A marine boiler comprising a group of generators constructed substantially as described, placed back to back, as shown, with their charging-fronts placed toward the sides of the vessel, and the base J, to support the chimney mounted thereon, substantially as and for the purposes set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

JULIEN FRANÇOIS BELLEVILLE.

Witnesses:
ROBT. M. HOOPER,
AMAND RITTER.