

(No Model.)

3 Sheets—Sheet 1.

P. BENTZEN & C. F. OLSEN.
TUBULOUS BOILER.

No. 541,829.

Patented July 2, 1895.

Fig 1.

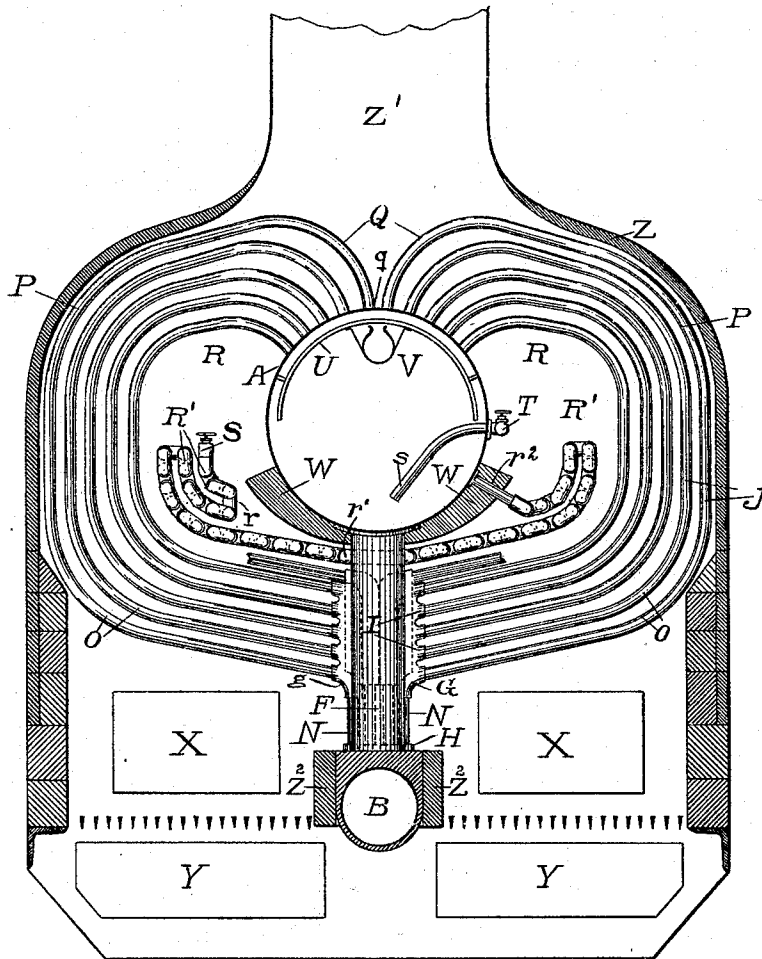
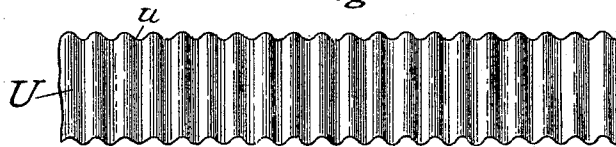


Fig 3.



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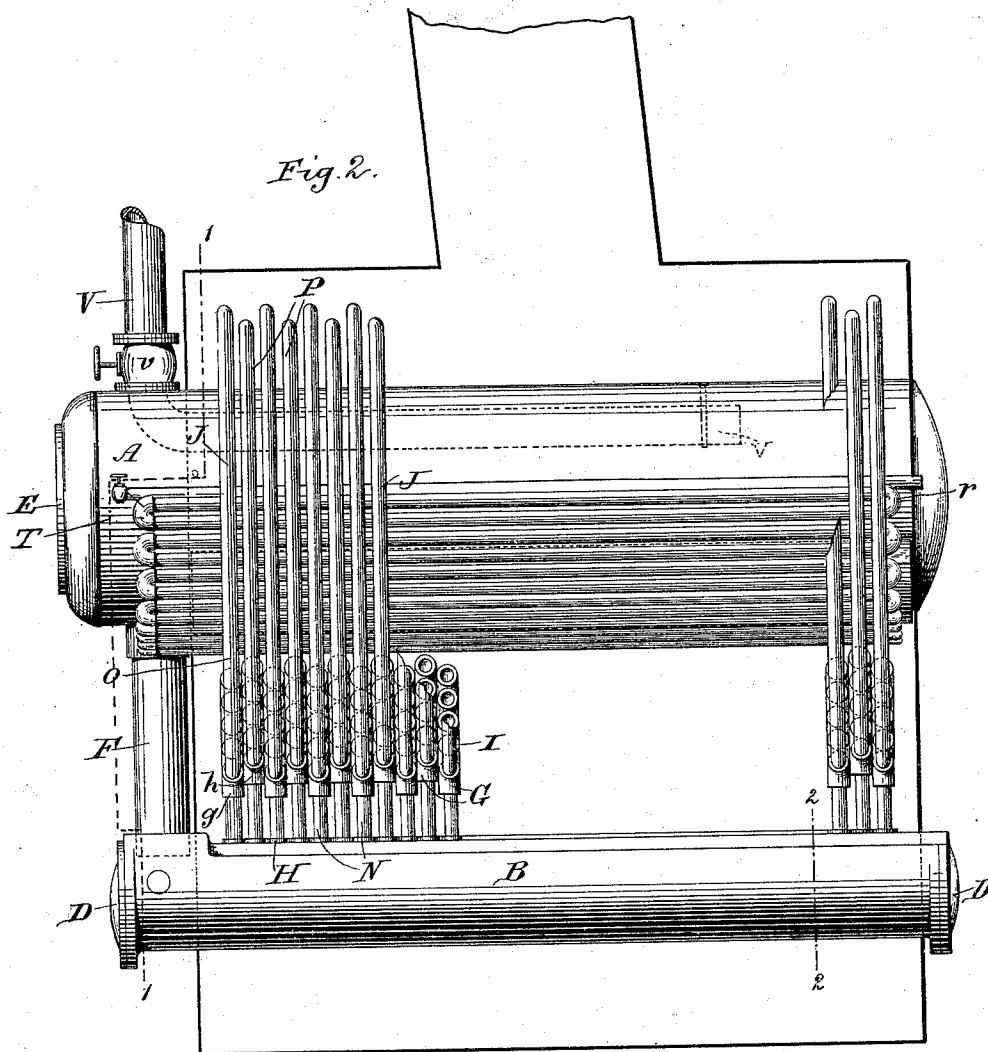
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3 Sheets—Sheet 2.

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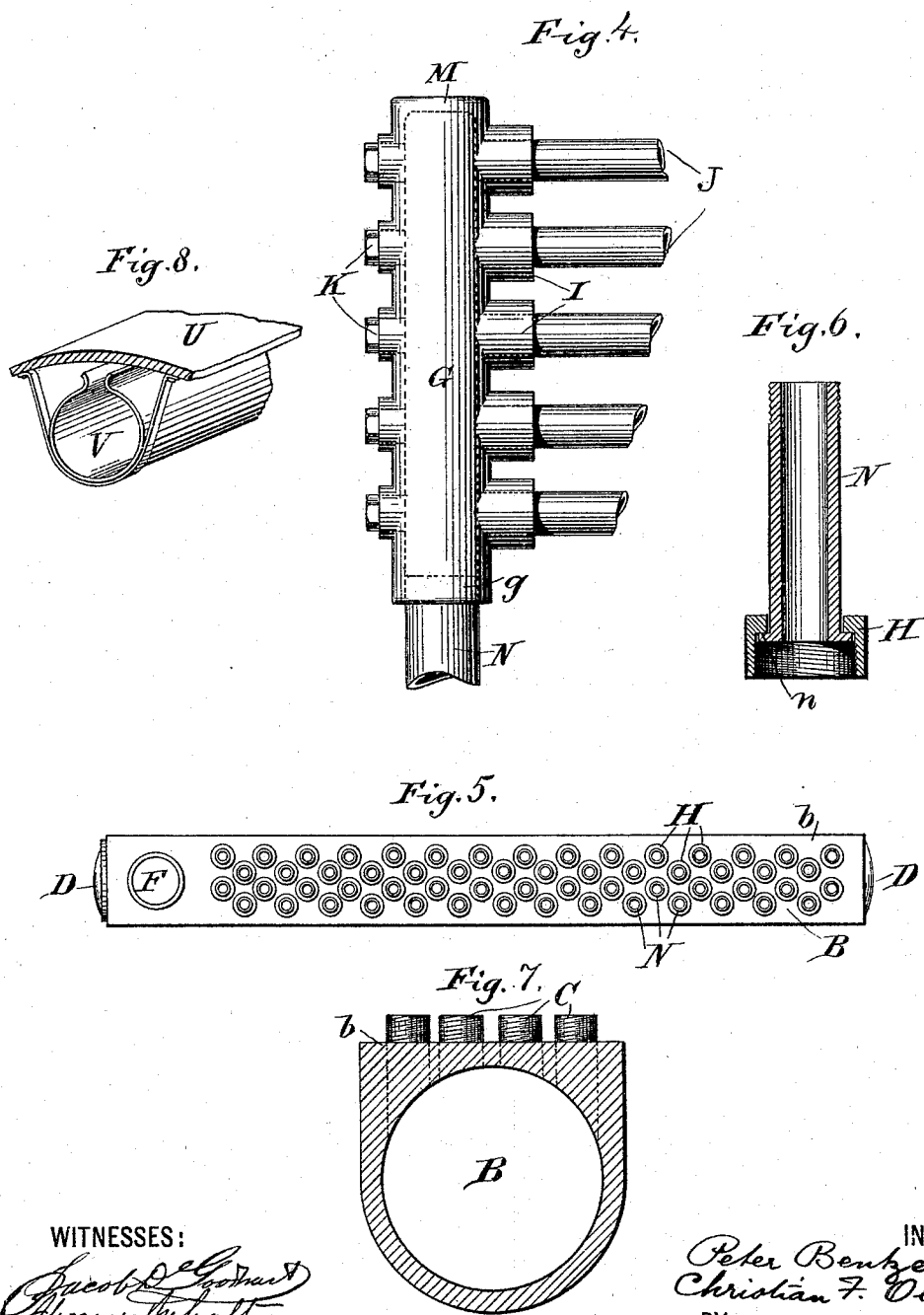
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TUBULOUS BOILER.

SPECIFICATION forming part of Letters Patent No. 541,829, dated July 2, 1895.

Application filed September 28, 1894. Serial No. 524,413. (No model.)

To all whom it may concern:

Be it known that we, PETER BENTZEN, residing at Newport, in the county of Newport and State of Rhode Island, and CHRISTIAN FREDERIK OLSEN, residing at Attleborough, in the county of Bristol and State of Massachusetts, subjects of the King of Denmark, have invented certain new and useful Improvements in Tubulous Boilers, of which the following is a specification.

Our invention relates more particularly to that class of generators known as tubulous boilers, and in which a steam receptacle and separator and a water vessel are connected by tubes in which the steam is generated; the objects of our invention being, first, to so construct the said generator and its parts that it shall be extremely simple and inexpensive; second, to provide an enlarged furnace or grate area by special arrangement of parts; third, to render it possible to readily detach a generator tube; fourth, to render it possible to readily detach from the steam separator or receptacle and water vessel a complete section of tubes without molesting the remaining tubes; fifth, to so arrange all parts that ready access may be had to the same for purposes of repair, &c., and sixth, to connect the generator tubes to manifolds, which communicate each with the water vessel, to provide a far larger escape area for the steam than the area of the inlet water. With these objects in view, reference is had to the annexed drawings, and to the specification, in which—

Figure 1 is a vertical front section of the improved generator taken on the line 1 1 of Fig. 2, and illustrating the arrangement of a section of generator tubes and the relation of parts. Fig. 2 is a side elevation of Fig. 1, with the outer casing removed, and a number of sections of the generator tubes of Fig. 1 displaced. Fig. 3 is a perspective view of a corrugated separator plate to be placed within the steam separator. Fig. 4 is an enlarged elevation view of a manifold, showing the manner of tube connections, as set forth in Fig. 1. Fig. 5 is a top view of a position of the water vessel showing the relative portion of the outlet with which the manifolds are connected. Fig. 6 is an enlarged view of a

union joint. Fig. 7 is an enlarged vertical sectional view of the water vessel taken on the line 2 2 of Fig. 2. Fig. 8 is an enlarged view of a portion of the steam pipe detached.

Similar letters refer to similar parts throughout the specification and drawings, in which—

A represents a steam receptacle and separator, and B a water vessel and mud drum. This water vessel is preferably made cylindrical in form internally, but with a flattened longitudinal top *b* as in Figs. 1, 2, 5 and 7. Rising from the flat top *b* are threaded tubular projections C, which are arranged in alternate rows with relation to each other along the said top *b*, and provided with openings communicating with the interior of the water vessel B. This water vessel B is preferably made of malleable iron or steel, and when the generators are made in large sizes the water vessel may be made of several parts, securely fastened or screwed together. A door or head D is placed at each end and securely seals the openings of the said water vessel. The separator is preferably formed of steel and is provided with a removable head E, which permits access to the interior of the said separator or steam receptacle; and at a certain position of, and preferably directly underneath, the separator, one or two pipes F connect the said separator A with the water vessel B. The pipe F is preferably placed near one end of the said separator or receptacle, as shown in Fig. 2.

To each projection C is secured a manifold G (see Fig. 4) which is connected at its lower end *g* by means of a short tube N and a union joint H, which latter is shown in enlarged form in Fig. 6. The manifolds G by means of being connected to said projections are thus arranged in alternate rows and, at alternate heights, as shown at H Figs. 1 and 2. These manifolds are preferably provided with five tubular projections I, which are adapted to receive the expanded lower ends of the generator tubes J, which in Fig. 4 are shown partly broken. If it is desired, of course the said manifolds may be formed to receive a greater number of generator tubes than the number here shown. Opposite the end of each generator tube J as described, is formed a hole opening into the interior aper-

ture of the manifold G and adapted to receive a plug K to close the said opening. These openings and plugs K correspond in number to the number of generator tubes J entering a manifold, and with the latter comprise what will hereinafter be termed a section. The object of the said construction is that by removing any one of the plugs K the end of the corresponding generator tube J is thereby exposed, and readily gotten at, for the purpose of expanding it within the projection I, or to assist in removing the said tube. Into the lower end *g* of each manifold is preferably screwed or expanded a tube N, which tube connects the manifold, by means of a flange *n* and a union nut H, with the water vessel B, by the said nut screwing on to the outwardly threaded projections C. By means of this construction it will be readily seen that, if the union joint is disconnected a complete set or section of tubes are thus released at their lower ends, and can then be readily detached from the separator A, at their upper ends, for purposes of repair &c. The said tubes, in connecting with the upper part of the said separator, pass from the said manifold in series of five almost horizontally above and across the fire grates, and, by means of a bend at O of preferably a large radius, pass about vertically until bent again similarly at P, thence almost horizontally over the starting place until gradually curved downwardly at Q, to be connected by means of expansion within and with the separator A, at *q*.

The advantage over other forms of generators of connecting the generator tubes to vertical manifolds which are arranged in rows longitudinal with the water vessel B, and the separator, centrally and between the said separator and water vessel, is that the lower portions of the said tubes at their places of connection with the said manifolds, are raised a considerable distance above the fire grates, thereby utilizing and economizing space and greatly adding to the furnace area. One of the essential features of this construction is that it provides a greater escape area for the steam in proportion to the inlet area for water than other forms of steam generators. The steam will in consequence thereof find a more even and easy escape. Besides this advantage the manner in which the tubes are connected and the easy bends and shapes which they are thus enabled to assume reduces their cost both in manufacture and repair. It is also seen that a large heating surface is thereby presented to the furnace flames and gases, and a quicker generation of steam is the consequent result.

The aforesaid manifolds are made of steel or other suitable material able to withstand the subjected heat and pressure.

In larger generators of course the number of tubes and of sections of tubes may be increased, proportional to the working pressure and volume of steam required for service.

Within the radius formed by the bend of

the innermost of the tubes J, between the said tubes and the separator or receptacle A, along each side of the latter is formed a hollow space R, R, and within these spaces are arranged parallel feed water heater pipes R', R', which run the length of the separator or steam receptacle and are connected together at their ends as shown at *r*. The said pipes on each side of the said separator or receptacle connect as at *r'*, by means of a cross pipe. The said pipes are preferably arranged in layers, as shown, and one end thereof is connected with the separator A, as at *r*². The other end thereof, as at the valve S passes outside of the boiler casing and is adapted to connect with an injector or water supply pipe. From a valve T, extending downwardly within the separator, is preferably arranged a short pipe *s*, and connected with this valve T is a pipe leading from the outside of the boiler casing from a donkey pump. The forward end of the feed heater pipes R' as at the valve S, is intended to extend outside of the generator casing and connect with a feed pump or injector, which are not shown. The many parallel lengths of the feed heater pipe and its many folds furnish a grate surface area for the action of the heat for heating the injected water, which ordinarily passes through the said pipes before it reaches the separator A, and finally, the water vessel B. This arrangement can of course be varied, but the arrangement as set forth is considered the most satisfactory.

T represents a feed valve located, as stated, at one side of the separator or steam receptacle A and intended to connect with a donkey pump as a matter of safety for water supply.

Within the separator or steam receptacle A is placed a separator plate U provided with lateral corrugations *u*. This plate U extends almost the entire length of the separator A, and is arched into a semicircular form as shown in Fig. 1. (See also dotted lines, Fig. 2, and detached perspective view, Fig. 3.) The office of the plate U is that when the moisture laden steam issues from the generator tubes J, against the said plate, the said moisture and condensed water will be separated from the dry steam as it comes into contact with the surface of the said plate, as the moisture will thereby adhere to it while the steam passes on around over its ends and up under its sides toward the steam feed pipe V. The corrugations *u* are formed in the plate U so that a greater surface will be presented to the issuing steam, and the water will more readily drain off from its surface, running thence back into the water vessel B, through the pipe F.

The steam pipe V as shown in Fig. 2, is provided with an ordinary regulator valve *v* and is secured to and enters the separator A and then passes parallel with and under the separator plate U, and is provided with an opening or slot for its entire length, under said plate, along its upper portion, the parallel edges thus formed being preferably turned

backward, as shown in Fig. 1, and in Fig. 8, enlarged view.

The lower part of the separator A is covered with a protecting material W to preserve the metal from the injurious action of the flames; and the outer sides of the fire boxes are walled with or formed of suitable fire bricks, or other non-conducting material. The necessary draft or other self-closing doors are provided as shown at X, X, and Y, Y for the fire box and for the ash receptacle. A jacket Z is placed over the whole, and the funnel Z' is continued therefrom. A lining of fire brick Z² is also placed along each side of the water vessel B to protect the same. It is obvious that this form of steam generator containing no waste spaces, can be made relatively smaller in size than generators heretofore constructed, at the same time providing a larger heating surface and fire box area in proportion to such full size than others have provided. As previously set forth its parts can be readily gotten at for replacement and repair, and on account of their simplicity are cheap in construction, while the steam escape area is large and free. In cases where a generator of this construction is used in steam ships in which the coal bunkers are placed at the sides of said generator, the walls of the said coal bunkers located adjacent to the said generator can be made in parts so that they can be easily removed, to make room for the removal of any number of tubes, or sections thereof with their respective manifolds.

Since the *modus operandi* of our invention needs no further description, having set forth the essential construction on which we desire Letters Patent, what we therefore claim is—

1. A steam generator having a water vessel, a steam receptacle, and continuous bent generator tubes connected with said steam receptacle said tubes being detachable from and indirectly connected with said water vessel, substantially as set forth.

2. A steam generator having a water vessel, a steam receptacle, and continuous bent generator tubes connected with said steam receptacle, a series of upright manifolds connected only with said water vessel and with said generator tubes, and a connection formed between said tubes and said manifolds, thereby connecting the said steam receptacle, by means of the said tubes and said manifolds, with the said water vessel, substantially as set forth.

3. A steam generator having a water vessel and a steam receptacle, a plurality of bent generator tubes connected at one end in series with said steam receptacle, and connected at their other ends in series with a manifold, and a connection formed between said manifold and said water vessel said manifold having direct connection only with said generator tubes, and with said water vessel, substantially as set forth.

4. A steam generator having a water vessel and a steam receptacle, generator tubes connected with said receptacle, rows of manifolds

connected with and supported by said water vessel, and a connection formed between the said generator tubes and the said water vessels, by means of said manifolds, said manifolds directly connected only with said generator tubes, and said water vessel, substantially as set forth.

5. A steam generator having a water vessel and a steam receptacle, generator tubes connected with said receptacle, rows of manifolds connected detachably with said water vessel, and a connection formed between said tubes and said water vessel, said manifolds connecting directly only with said generator tubes and said water vessel, substantially as set forth.

6. A steam generator having a water vessel and a steam receptacle, bent generator tubes secured in series to said receptacle, and manifolds connected with and projecting upwardly from the upper part of said water vessel, said manifolds having direct connections each only with a series of said generator tubes and with said water vessel, substantially as set forth.

7. A steam generator having a water vessel and a steam receptacle, generator tubes secured to said receptacle, manifolds connected with said water vessel and arranged in alternate rows upon same, and connections formed between said tubes and said manifolds, substantially as set forth.

8. A steam generator having a water vessel and a steam receptacle, generator tubes connected with said receptacle, manifolds connected with said water vessel, and a union nut joint for effecting such connection, the said tubes being connected with said manifolds, substantially as set forth.

9. In a steam generator having manifolds, tubes secured thereto, and a longitudinal aperture extending through said manifolds, lateral openings formed opposite the place of connection with said tubes, and screw plugs to fit detachably therein to close the said openings, substantially as set forth.

10. In a steam generator having manifolds, and tubes secured thereto, a longitudinal aperture extending through said manifolds, one end of said manifolds connecting with a water vessel, and the opposite end of said manifolds having an orifice and a screw plug detachably connected, to close said orifice, substantially as set forth.

11. In a steam generator having manifolds and tubes connected laterally therewith, a short tube connecting each of said manifolds directly with a water vessel placed adjacent to said generator tubes, the said water vessel supporting said manifolds, the said manifolds directly connecting only with said water vessel and said generator tubes, substantially as set forth.

12. A steam generator having an elongated water vessel and steam receptacle, generator tubes connected with said receptacle, manifolds connected with and located along the upper portion of said water vessel, the said gen-

erator tubes connected laterally with the said manifolds the said manifolds being detachably connected with said water vessel, substantially as set forth.

5 13. A steam generator having an elongated water vessel and steam receptacle, the latter located above the former, generator tubes connected with the steam receptacle and passing in a partially curved form to and connected
10 with the said water vessel, parallel water heater pipes connected with bended ends and located adjacent to the said steam receptacle and within arches or concavities formed by the said generator tubes, the said pipes connecting with a feed valve and with the said
15 steam receptacle, and adapted to connect with an injector, substantially as set forth.

14. A steam generator having an elongated water vessel and steam receptacle, the latter
20 located above the former, generator tubes connected with the steam receptacle and passing in a partially curved form to and connected with the said water vessel, parallel water heater pipes connected with bended ends and
25 located adjacent to the said steam receptacle, on opposite sides thereof, and within arches or concavities formed by the said generator tubes, the said heater pipes connecting with a feed valve and with the said steam receptacle, and adapted to connect with an injector,
30 substantially as set forth.

15. In a steam generator a water vessel and a steam receptacle, generator tubes connected at one end with said receptacle and at their
35 other ends with manifolds supported by and connected with said water vessel, and one or more return pipes connecting the said receptacle with the said water vessel, substantially as set forth.

40 16. In a steam generator having a steam receptacle and a water vessel and generator tubes connecting the said parts with each other, a steam and water separator made in

the form of a plate placed and extending longitudinally within said receptacle, and conforming laterally to the upper semicircular curve of the said receptacle, the said plate being corrugated laterally, and located adjacent to the ends of the said generator tubes, substantially as set forth.

17. In a steam generator having a steam receptacle and a water vessel and generator tubes connected with said steam receptacle and by means of manifolds connecting with said water vessel, means located within said steam receptacle for separating the moisture from the steam entering same, substantially as set forth.

18. In a steam generator having a steam receptacle and a water vessel connected therewith by means of tubes, and having a water and steam separator, a steam pipe entering said receptacle and passing longitudinally within said receptacle, horizontally under said separator, the said steam pipe being slotted along its upper surface for a portion of its length, substantially as set forth.

19. In a steam generator having a steam receptacle and having a water vessel arranged in a horizontal line, manifolds extending in a row along the upper surface of said water vessel, continuous bent generator tubes connected with and running from said manifolds to and connecting with said steam receptacle, and the combination of a fire box formed and extending longitudinally each side of said water vessel and manifolds, substantially as set forth.

In witness whereof we have hereunto set our hands this 3d day of September, 1894.

PETER BENTZEN.

CHRISTIAN FREDERIK OLSEN.

Witnesses:

ORVILLE P. RICHARDSON,
GEORGE A. ADAMS.