No. 692,436. Patented Feb. 4, 1902.

C. H. FOX.

STEAM GENERATOR.

(Application filed May 25, 1901.)

(No Model.) 2 Sheets—Sheet I.

Fig. 1.

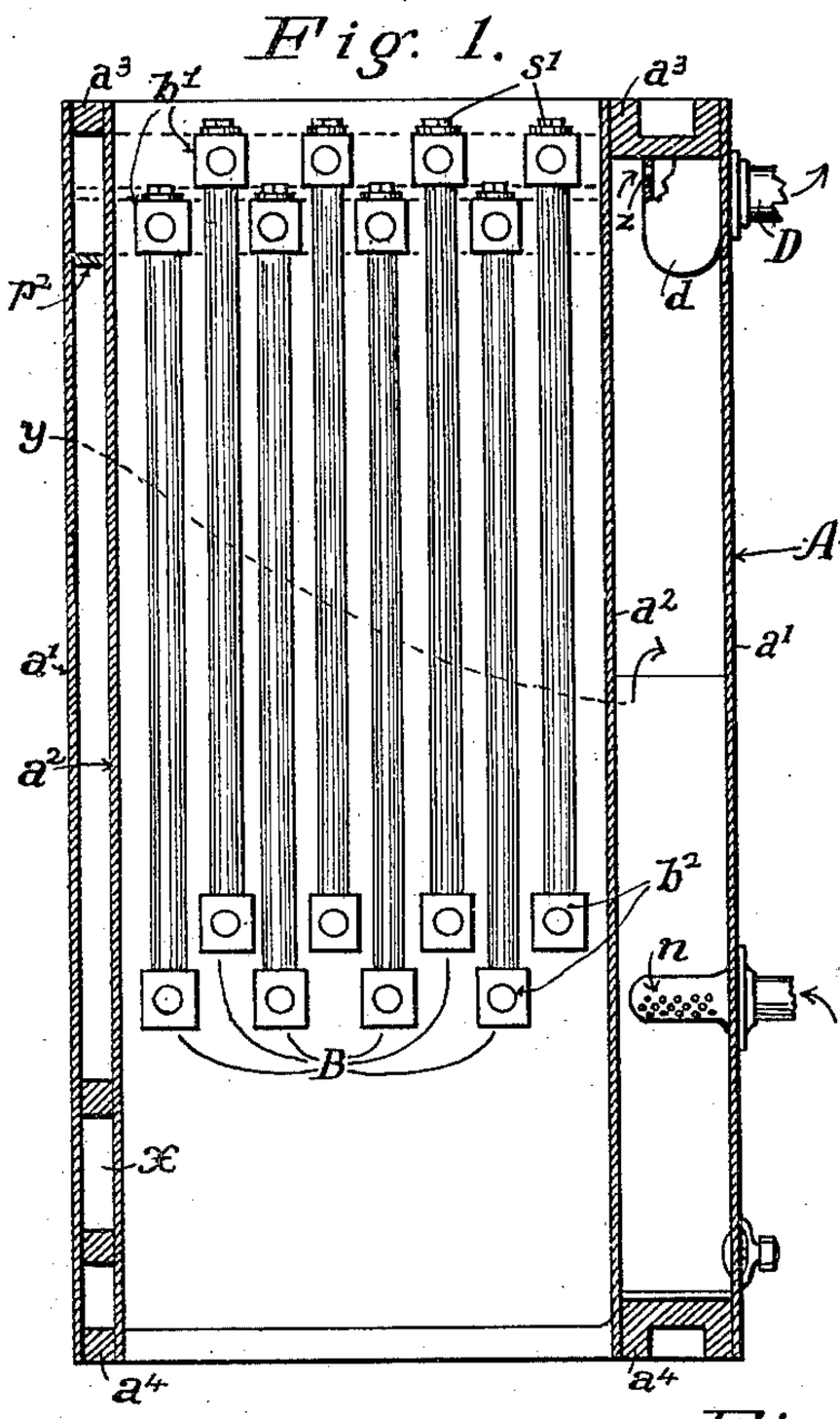


Fig 2.

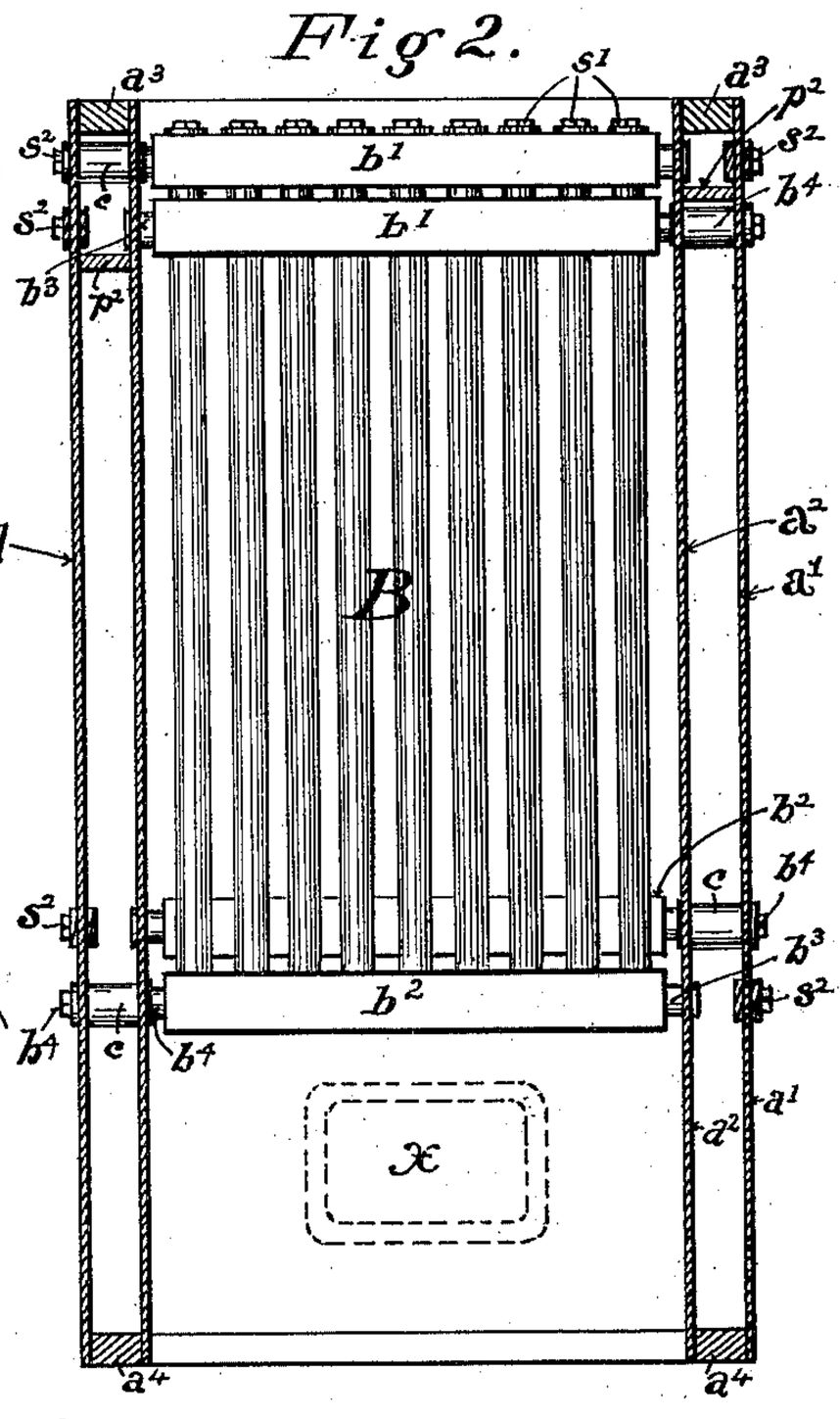
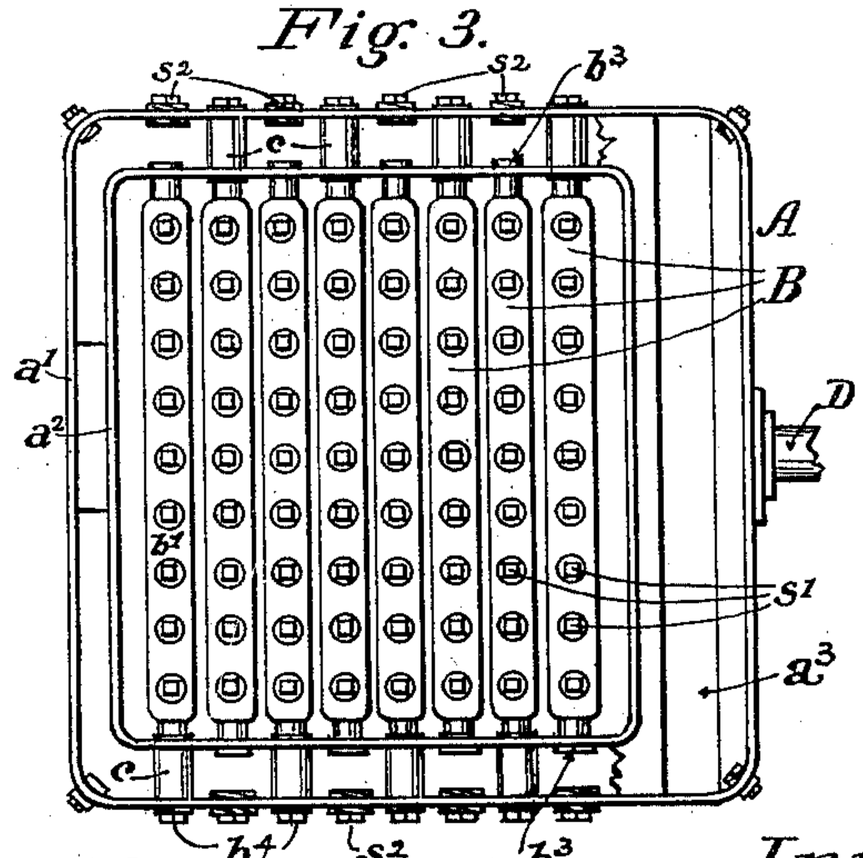


Fig. 3.



Witnesses
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Inventor:
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Fig. 4.

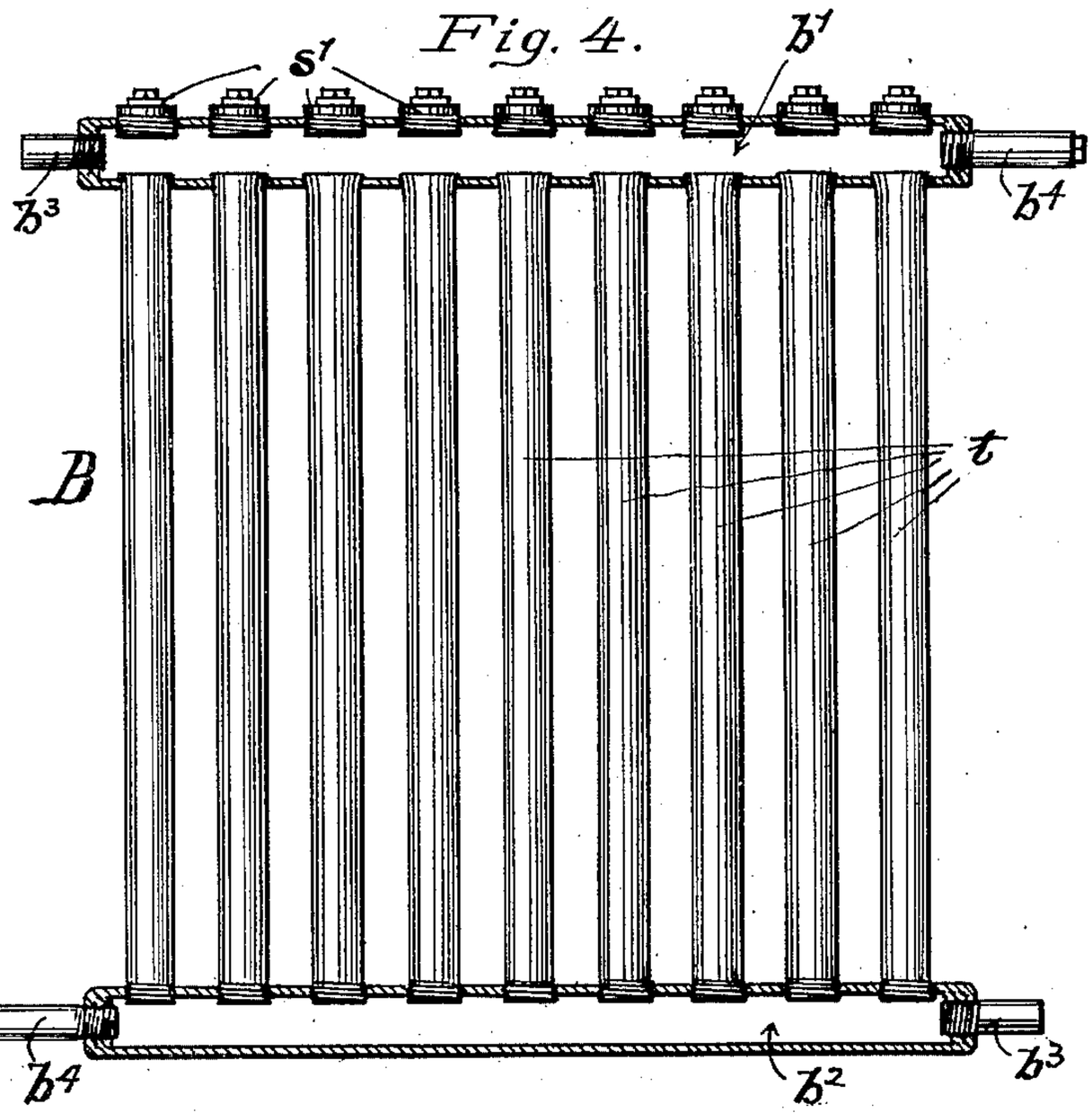


Fig. 5.

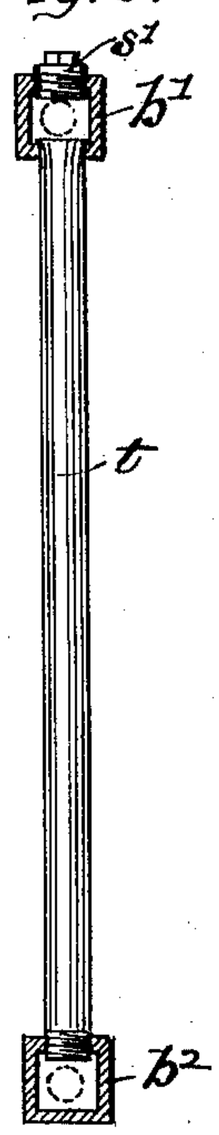


Fig. 6.

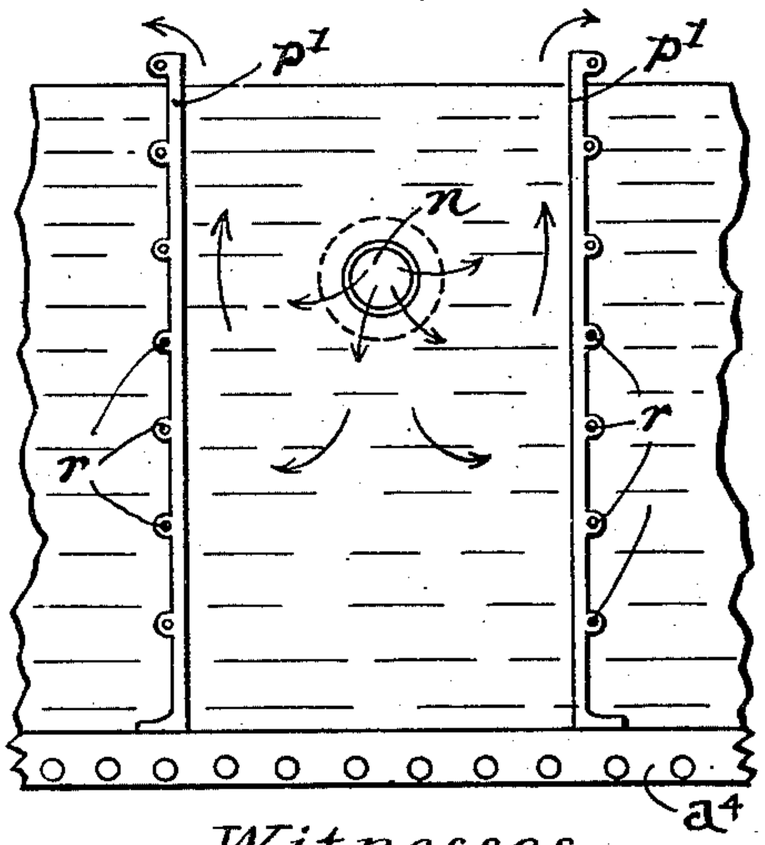
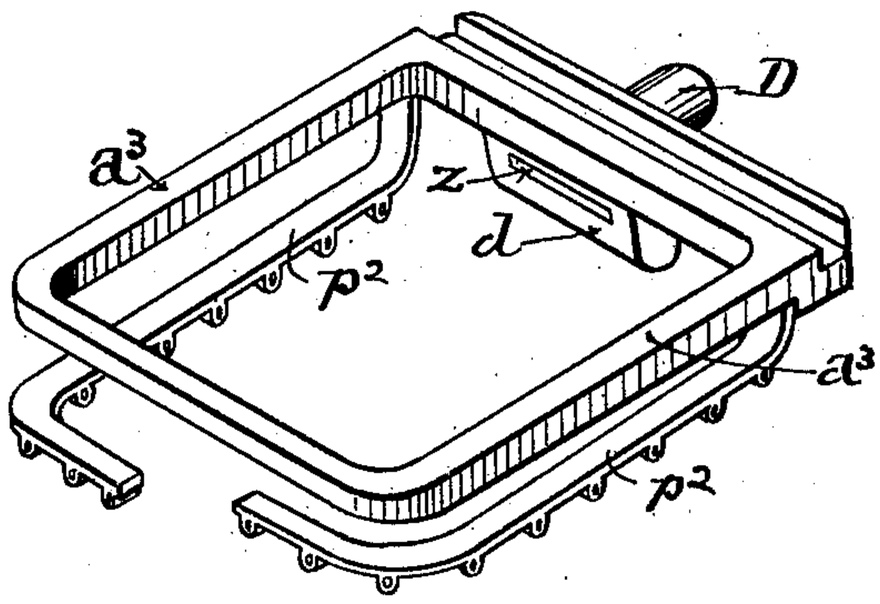


Fig. 7.



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UNITED STATES PATENT OFFICE.

CHARLES H. FOX, OF CINCINNATI, OHIO.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 692,436, dated February 4, 1902.

Application filed May 25, 1901. Serial No. 61,867. (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, in the county of Hamilton and State of Ohio, have invented new and useful Improvements in Steam-Generators, of which the following is a specification.

My invention relates to steam-generators, its object being to produce a structure combining special advantages in respect to concentrating a maximum of steaming capacity into a minimum space, maximum of durability through avoidance of such features as "crown-sheet," smoke-flues," complicated joints, and connecting parts ordinarily liable to produce leakage under strains, facility for rapid and easy dismemberment of such parts as may require renewal, capacity for continued service in emergencies with members removed, interchangeability of parts for ease of substitution in renewals, accessibility of all parts for effective cleaning, &c., general arrangement of parts to promote rapid circulation throughout, and other features hereinafter referred to.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation sectioned across through the water-jacketed housing in front of the tube units, showing the tube units in end elevation and the relative arrangement of the upper and lower series of said units; Fig. 2, a front elevation cross-sectioned from front to rear through the housing in front of the tube units, showing the tube units in side elevation; Fig. 3, a top view of the boiler, showing the water-jacket shells in horizontal section, showing details of construction; Fig. 4, a side elevation of a tube unit detached, showing the headers in longitudinal section; Fig. 5, an end elevation of a tube unit detached, showing the headers in cross-section; Fig. 6, a rear view of a portion of the water-jacket with the rear shell removed, showing the "receiving-bay" for feed-water formed by the partitions; and Fig. 7 a perspective view, detached, of the upper "ring" of the water-jacket, showing the conducting-partitions and the receiving device for dry steam.

Referring to the drawings, A designates the outer element or water-jacket of the boiler, formed by outer and inner shells a' and a^2, disposed in substantially rectangular form and spaced apart at top and bottom by rings a^3 a^4, secured to and between the shells by riveting in the usual manner. I prefer to enlarge the water-space by giving increased width between the outer and inner shells a' and a^2, respectively, at the sides of the jacket and still more at the rear, as indicated in the drawings, for reasons made apparent later herein. There is thus formed an annular water-jacketed housing interiorly open above and below, of substantially rectangular form without and within, which constitutes a reservoir for water and steam and a separate element of the general structure. The fire-door opening o is formed in the usual manner through the front of the housing, and the feed-water is delivered and steam taken from the rear portion, as hereinafter explained.

The second principal element of the structure is a system of heating and circulating tubes constructed and arranged as follows: The general tube system is an aggregation of similar so-called "units" B, Figs. 4 and 5, placed side by side, each connected at top and bottom, but at opposite ends of the unit to the water-jacket. Each unit B consists of two horizontal tubular headers b' b^2, connected by vertical tubes t, placed side by side in series parallel. Each tubular header b' or b^2 is provided at one end with a pipe connection b^3 to pass through and engage with the inner shell a^2 of the housing and at the other end with a projecting stud b^4, these being arranged at relatively opposite ends in the two headers of a unit. Concentrically opposite each vertical tube t in the upper header b' is an aperture fitted with a removable screw-plug s', whereby access may be had to each tube of the unit from above to insert a cleaning-rod, &c. Through the outer shell a' of the housing, opposite the pipe connection b^3 of each header b' or b^2, is a slightly-enlarged aperture fitted with a removable screw-plug s^2, whereby the pipe connection b^3 may be inserted and screwed into the tubular header from the outside. After screwing the short tube into place a "tube-expander" is introduced through said opening and the tube "expanded" to a tight joint with the inner shell a^2. It may be at any time removed by suitable tools inserted in like manner through this

outer opening. Through an opposite opening in the housing A passes the stud b^4, whose function is merely to assist in supporting the weight of the unit B. To accommodate this last-mentioned construction, the outer and inner shells a' a^2 are provided with a somewhat-enlarged hollow stay-bolt c, through which the stud b^4 is inserted and screwed home into its header. The stud may be solid or a tube with outer end closed; but it is slightly smaller than the aperture of the hollow stay-bolt c in order to permit the movements of the unit under expansion and contraction. As already stated, the units B thus constituted are placed in the housing side by side, and in order to allow the gaseous products of combustion a sufficiently free vent upward through the nest of tube units I arrange the units in two series at different elevations, as indicated in the drawings, and I may, if thought desirable, shorten slightly the tubes of the upper series, so as to bring the upper headers relatively closer together, in order to decrease the final exit area above, so as to retard the escape of the combustion products at the point of exit into the smoke-flue.

The feed-water is preferably introduced at a point in rear about opposite the fire-door through a peculiarly-formed nozzle or hood n, closed excepting for numerous minute perforations at the under side, whereby the feed-water is discharged in minute streams radially, but in a general downward direction. At both sides of the feed-water nozzle are vertical partitions p' p', held between the outer and inner shells a' a^2 by stay-bolt rivets r and extending from the bottom ring a^4 upward to a point preferably just above the normal water-level. There is thus formed a sort of receiving-bay within the general water-space of the jacket confining the feed-water between the side partitions p, from which space it ultimately overflows over the sides of the partitions, as indicated by arrows in Fig. 6. It is thus somewhat delayed and becomes heated before being permitted to mingle freely with the general circulation of the boiler.

The steam-discharge D is preferably arranged at the rear and at the extreme top of the steam-space through a trough d, depending from the upper ring a and closed against the same, except for a horizontally-elongated slot z opening into the same adjacent to the inner shell a. In order to conduct the water which is carried upward by the tube units and discharged into the water-jacket at opposite sides of the boiler to the front side as far as possible away from the steam-outlet, I provide the following construction: The tube units of lower series are arranged to discharge at one side of the boiler and the upper series at the opposite side. For each series, at appropriate elevations, I provide a partition p^2, approximately horizontal or inclining downward from rear to front. These partitions, similar in construction and mode of insertion between the outer and inner shells of the water-jacket to the partitions p' already described, are shown in perspective in connection with the upper ring a^3, which they join by upward bands at the rear, as in Fig. 7. They serve to concentrate the discharge of the entire series and convey it to the front. This construction and arrangement also tends to assist in producing a general circulation downward at the front of the water-jacket and upward and forward at the rear and sides, a result to which the relatively increased width of water-space toward the rear contributes, and which also beneficially coöperates with the distribution of the feed-water in facilitating the freest possible circulation through the tube units and permitting no "dead-spaces" in any part of the boiler.

Having thus outlined the specific features of construction, their functional importance may now be briefly considered.

First. The construction readily lends itself to variations in either horizontal or vertical dimensions, so that a boiler of great steaming capacity can be constructed to fit a laterally-confined space or may be extended vertically. It will be observed, also, that the combustion-chamber extends to the upper limit of the boiler, giving the greatest opportunity for absorption of heat from the gaseous products of combustion by the heating-surfaces of the generator.

Second. The simplicity of all structural features and the absence of smoke-flues and their joints, crown-sheet, &c., reduce the liability of leakage to a minimum. The tube units are duplicates of each other, so that in case of injury to any part of the tube system a unit can be removed and the aperture of the shells temporarily plugged and the boiler still used, or a spare unit may be inserted and the removed unit repaired and held as a spare unit for the next break. These changes can be readily effected by any ordinary "steam-fitter" without special skill or other than ordinary tools and with very little delay, so that a brief stoppage only is required for repairs. These advantages are especially important in marine and mining service for obvious reasons.

Third. The facilities afforded for reaching every part of the tube system for cleansing purposes is also to be noted. Both ends of each hollow header being accessible from without enables the operator by using a bent rod to reach each end of each vertical tube, and thus loosen and remove any incrustation or accumulation of sediment.

Fourth. The provisions for constant and thorough circulation have already been adverted to; but it may be noted that in action the aggregated effect of the tube units exhausting from both sides of the water-jacket below and discharging above by a concentration at a point in front farthest removed from the feed-water supply is to draw the feed-water directly downward and forward from its receiving-bay into the tube units, through

which it is carried upward and discharged in front in the narrowest portion of the water-jacket, so that the water-level is relatively highest at the front and thinnest portion of the water-jacket and lowest at the rear, as indicated by the curved dotted line *y* in Fig. 1. This favors the accumulation of dryest steam at the point of take-off where the outlet D is located.

All these conditions of structure therefore tend to render the generator economical in cost and maintenance and efficient and safe in operation.

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

1. A steam-boiler embodying a straight vertical water-jacketed shell approximately vertical horizontally, and open interiorly above and below; combined with a system of tube units such, substantially as described, placed in closely-adjacent parallel series at different elevations, each tube unit being connected at its diagonally opposite ends to the water-space of the jacket, substantially as set forth.

2. A steam-boiler embodying a straight, vertical, water-jacketed shell approximately vertical horizontally, and open interiorly above and below, combined with a system of tube units, such substantially as described, placed in closely-adjacent parallel series at different elevations, each tube unit being connected at its diagonally opposite ends to the water-space of the jacket, and having at the remaining ends a resting-support upon the water-shell by a stud projecting through the same, substantially as set forth.

3. In a steam-boiler, of the character indicated, a water-jacket composed of substantially rectangular outer and inner shells arranged to give a relatively increasing width of water-space from front to rear, in combination with a series of adjacent tube units opening into the water-jacketed space above and below, substantially as set forth.

4. In a steam-generator of the character indicated, in combination with an inclosing water-jacketed shell open above and below, a plurality of independent detachable steam-generating units composed of horizontal headers connected endwise by a direct horizontal connection with the water-space of the jacket and the outer shell of the jacket being provided with a plugged opening in the projected axis of the header connection, substantially as set forth.

5. In a steam-generator of the character indicated, in combination with an inclosing water-jacketed shell open above and below, a plurality of independent detachable steam-generating units composed of horizontal headers connected by parallel vertical tubes, each header being connected endwise at one end with the water-space of the jacket, and at the other with a removable stud extending through a hollow stay-bolt connecting the outer and inner shells of the jacket in the prolonged axis of the header, substantially as set forth.

6. In a steam-generator, of the character indicated the combination of an inclosing water-jacket, a plurality of tube units, such substantially as described, extending from side to side of the jacket and connected to the water-space above and below, and guiding-partitions such as, p^2, to collect the discharge from a series of tube units, and conduct the same to a predetermined point of final discharge into the water-space of the jacket, substantially as set forth.

7. In a steam-generator, of the character indicated, a "bay" or inclosed space formed by partitions adjacent to the water-feed opening and carried slightly above the normal water-level and over the upper edges of which partitions the water flows into the water-space, substantially as set forth.

8. In a steam-generator of the character indicated, a "bay" or inclosed space partitioned to a point above the normal water-level, and an inlet-nozzle perforated at the lower sides thereof and entering said "bay" from without, for the admission and distribution of the feed-water, substantially as set forth.

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

CHARLES H. FOX.

Witnesses:
L. M. HOSEA,
WALTER A. KNIGHT.