No. 760,373. PATENTED MAY 17, 1904.

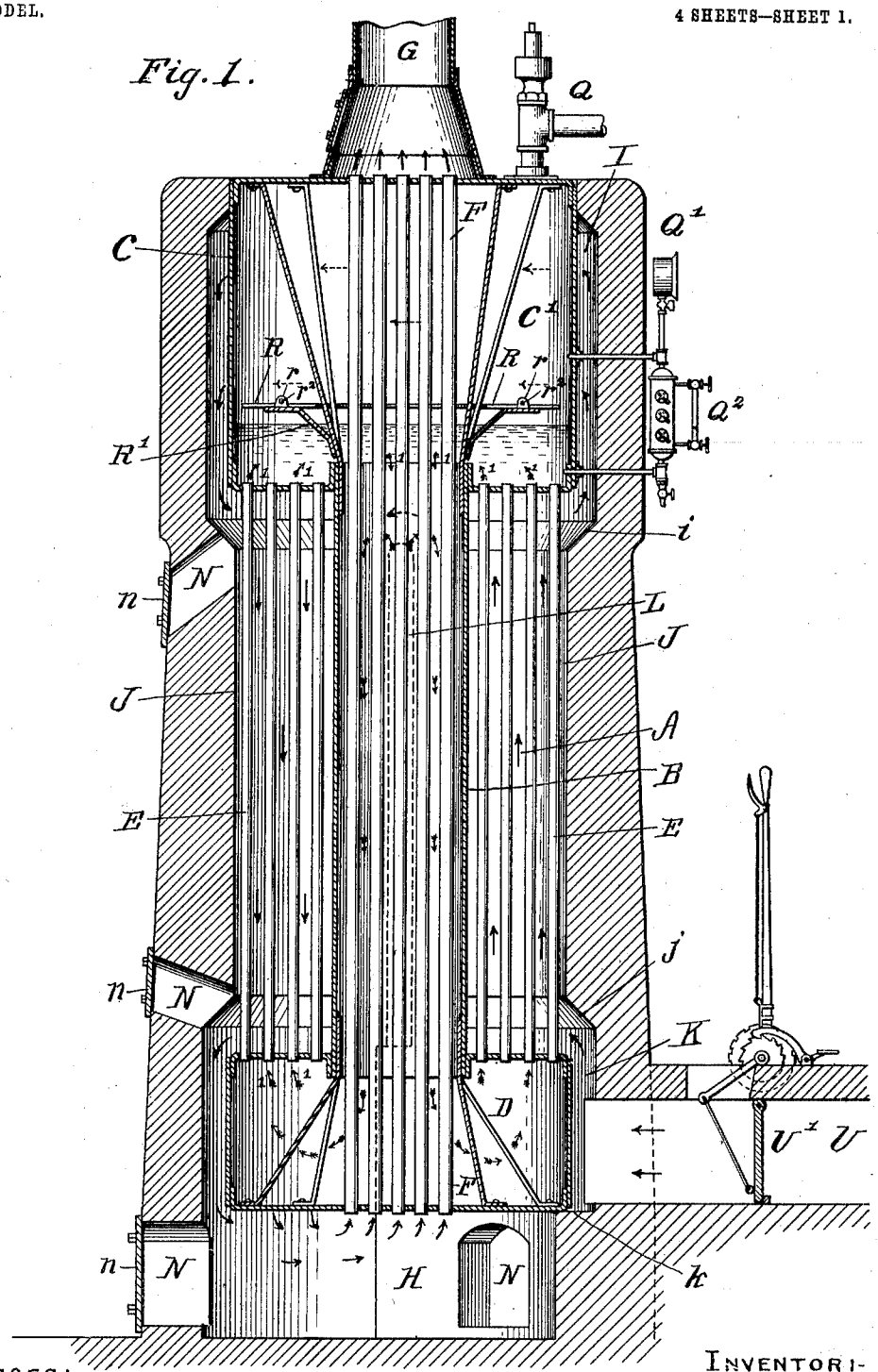
J. B. BEAM.

STEAM GENERATOR.

APPLICATION FILED AUG. 22, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:-

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H. B. Fenning

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Baldwin Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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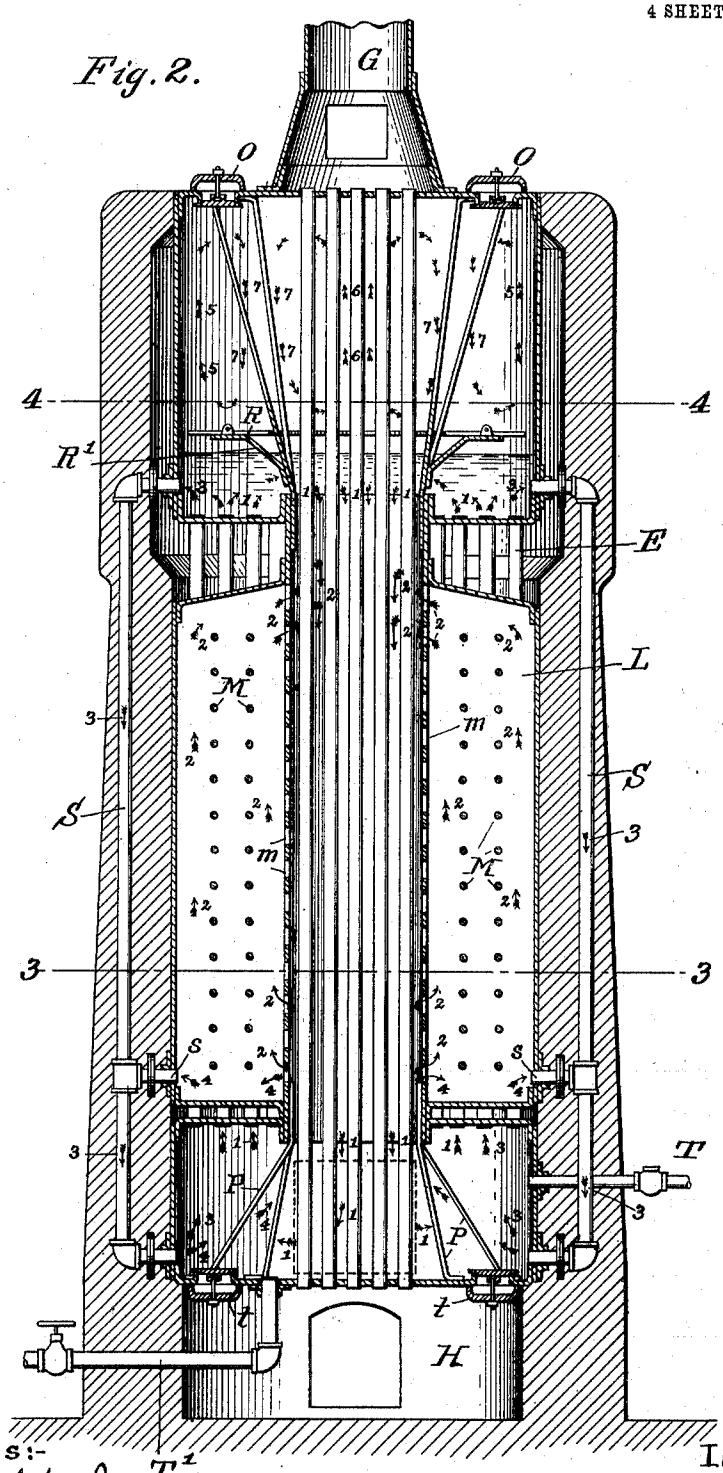
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NO MODEL. 4 SHEETS—SHEET 2.

Fig. 2.



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NO MODEL. 4 SHEETS—SHEET 3.

Fig. 3.

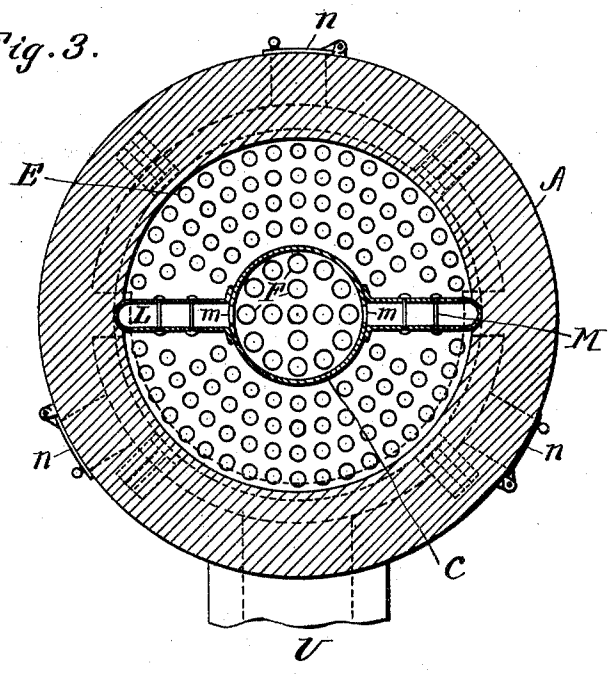
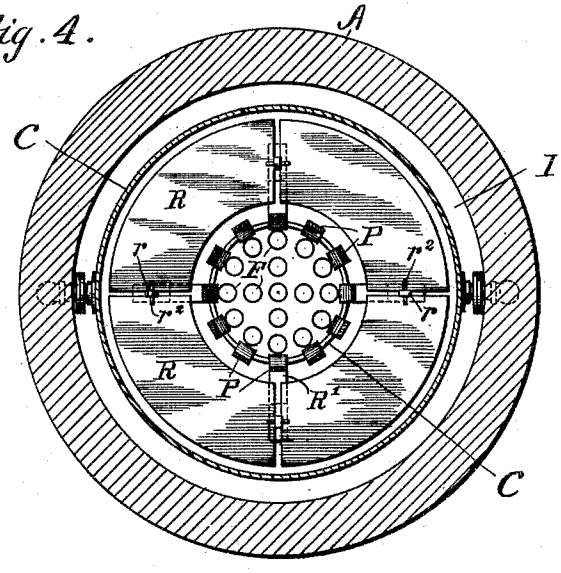


Fig. 4.



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NO MODEL. 4 SHEETS—SHEET 4.

Fig. 5.

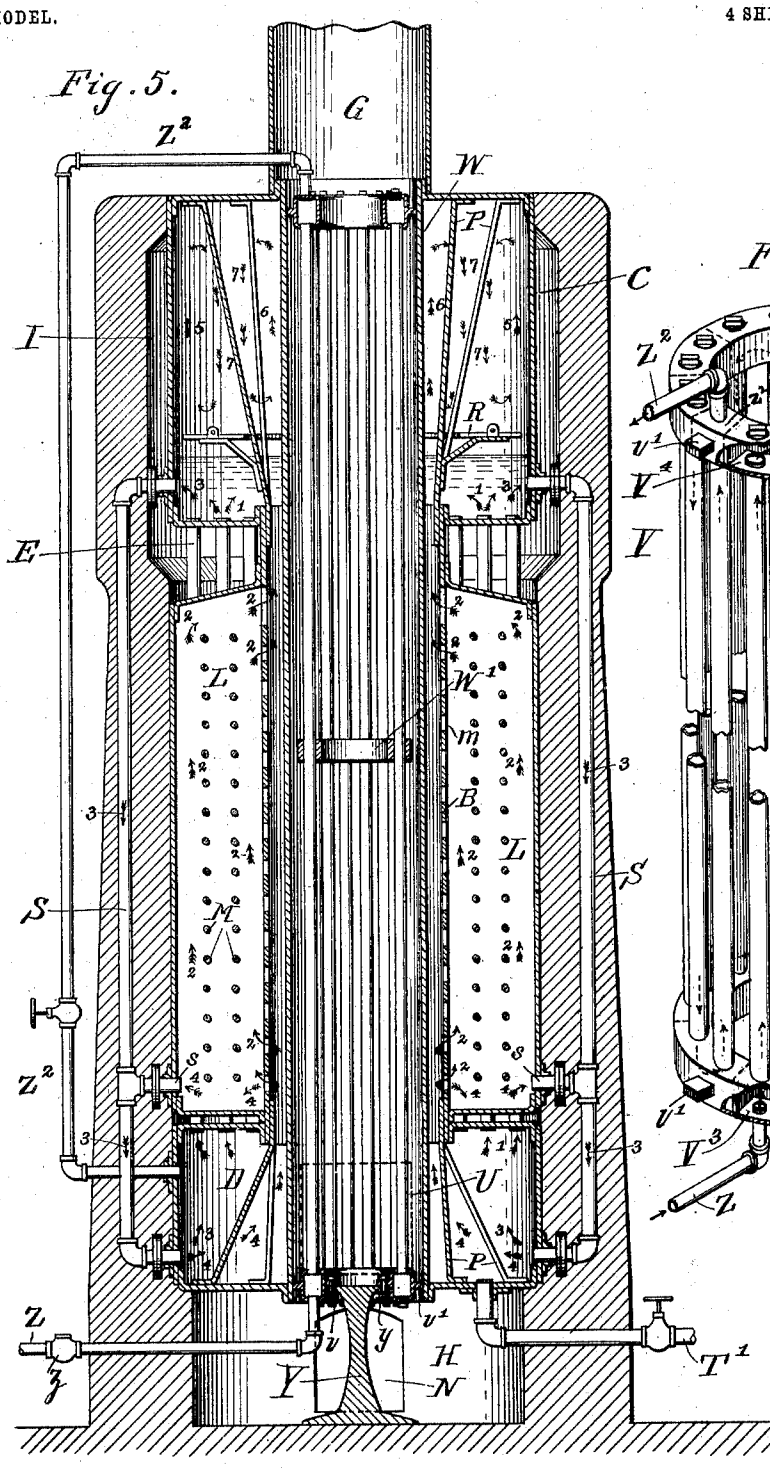
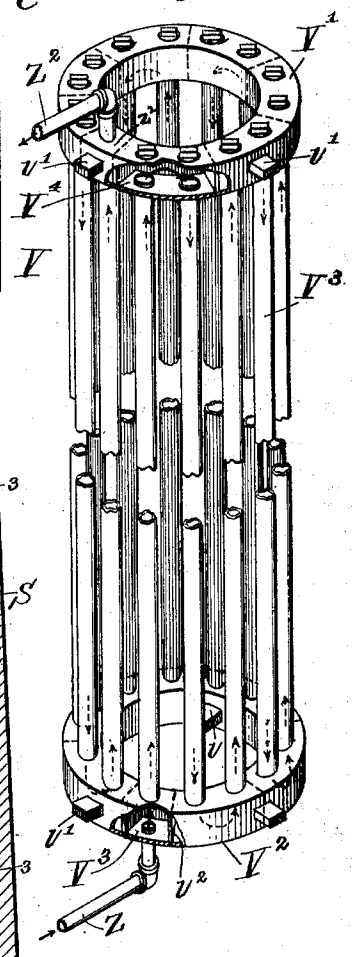


Fig. 6.



WITNESSES:-

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[illegible]

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No. 760,373. Patented May 17, 1904.

UNITED STATES PATENT OFFICE.

JACOB B. BEAM, OF BIGRUN, PENNSYLVANIA, ASSIGNOR TO THE BEAM COKE OVEN STEAM BOILER POWER COMPANY, OF PUNXSUTAWNEY, PENNSYLVANIA, A CORPORATION OF NORTH DAKOTA.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 760,373, dated May 17, 1904.

Application filed August 22, 1903. Serial No. 170,384. (No model.)

To all whom it may concern:

Be it known that I, JACOB B. BEAM, a citizen of the United States, residing at Bigrun, in the county of Jefferson and State of Pennsylvania, have invented certain new and useful Improvements in Steam-Generators, of which the following is a specification.

The object of my invention is to provide a steam-generator in which the boiler and its setting are so arranged that the maximum heating effect is obtained from the fuel, a more thorough circulation of water and steam is effected, and extra-dry steam under high tension is obtained.

Another object of my invention is to provide a steam-generator which may efficiently use the waste gases from coke-ovens.

In carrying out my invention in the way now best known to me I cause the gases from coke-ovens or other sources of heat to pass into the generator near its lower end and thence pass vertically upward along one side of the boiler, then downward on the opposite side thereof, and then upward through the shell or central portion of the boiler. The boiler comprises a vertical central portion or shell having at each end an enlarged head or drum which communicate with the shell and which communicate with each other by means of vertical water-tubes surrounding the shell. In one form of the invention vertical smoke-tubes are arranged to pass through the shell and convey the hot gases or products of combustion from the lower portion of the generator to a stack at the top thereof. In another form of the invention these smoke-tubes are omitted and a feed-water heater is placed within the shell for the purpose of raising the temperature of the water before it is delivered to the boiler. This heater consists of two annular heads connected by vertical tubes, the heads being divided into sections, so that water admitted at the bottom of the heater will be caused to traverse the tubes successively. The upper boiler-head or drum is of somewhat greater dimensions than the lower one, the water-level therein being sufficiently low to afford a large steam-space in the upper portion of the drum, through which the escaping gases are conducted in such manner as to superheat the steam. The shell of the boiler is provided on opposite sides with hollow wings, which are closed on all sides except those next the boiler-shell, with the interior of which they communicate. These wings are so arranged as to form partitions in the casing, which divide it into two parts and cause the gases or products of combustion which enter on one side of the partitions to pass upward in contact with the tubes and shell on one side and then downward in contact with the tubes and shell on the opposite side, thus causing the water on one side to be heated to a greater degree than on the opposite side, and as the hot gases pass out through the center of the boiler this part thereof receives the least degree of heat, so that the water is caused to circulate most efficiently. The lower part of the upper head or drum is connected on each side by a vertical pipe with the lower portion of the lower drum and also with the lower portion of one of the hollow water wings or partitions, so that an outside circulation may be effected, and in case the water-level falls very low a circulation may be carried on between the water-wings and the lower drum. The organization is such that several distinct circulations of water are maintained at the same time, owing to the different degrees of heat to which different parts of the water are subjected and to the special provisions for effecting such circulation. Circulation of steam is also maintained in the steam-space of the upper drum, and bubbling or splashing of water is prevented from saturating the steam by means of baffle-plates placed over the upper ends of the water-tubes.

The organization of the generator as a whole is such as to obtain a large capacity for steam-generation within a small space. All parts of the boiler except a limited portion at the top are exposed to the direct action of hot gases, and there are no dead spaces where the heat of such gases is lost before entering the smoke-box.

In the accompanying drawings, Figure 1 shows a vertical central section through the preferred form of steam-generator made in accordance with my invention. Fig. 2 shows a similar section taken at right angles to that shown in Fig. 1. Fig. 3 shows a transverse section on the line 3 3 of Fig. 2. Fig. 4 shows a transverse section on the line 4 4 of Fig. 2. Fig. 5 shows a vertical central section of a modification in which the smoke-tubes shown in Fig. 1 are replaced by a vertical feed-water heater. Fig. 6 is a view in perspective with parts broken away of the feed-water heater shown in Fig. 5.

In the several figures the unfeathered arrows indicate the courses of the hot gases, while the feathered arrows indicate the circulation of water and steam.

The boiler setting or casing A may be built of any suitable material and is adapted to accommodate my improved upright water-tube boiler, which comprises a shell B, connected at opposite ends with upper and lower drums C D. The upper drum is of much larger capacity than the lower one, so as to provide a steam-space in its upper portion. Surrounding the shell are vertical water-tubes E, which communicate with the drums. In Figs. 1 and 2, F indicates smoke-tubes which pass vertically through the shell and through both drums and open at their upper ends into the smoke-stack G or a smoke-box below the stack. At their lower ends the smoke-tubes open into a chamber H below the lower drum D. The upper drum C is surrounded by a space or annular chamber I in the casing, through which the hot gases pass, and this chamber is contracted at *i* just below the upper drum and there communicates with a somewhat narrower chamber J, through which the water-tubes and shell extend. This chamber is enlarged at *j* and communicates with the enlarged annular chamber K, surrounding the lower drum D. This chamber is closed at the bottom on one side by the ledge or shelf *k*, on which the drum rests; but on the opposite side it opens into the chamber H below the lower drum. The chamber J is divided by vertical partitions L M, which extend from near the top of the lower drum to a point just below the upper drum, preferably just at the lower end of the contracted part *i* of the chamber I. These partitions form wings projecting from the shell and extending laterally therefrom to the casing A, with which they make close contact. The wings or partitions are hollow and closed on all sides except those next the shell, with the interior of which they communicate by means of orifices *m*. The setting or casing is provided with suitable cleaning-holes N, closed by doors *n*, and the upper drum is provided with hand-holes having removable covers O, by means of which access may be had to the interior of the upper drum and to the water-tubes. The shell is braced at opposite ends by rods P, and a steam-escape pipe Q is provided and fitted with a safety-valve of ordinary construction.

Q′ indicates a steam-gage, and Q^2 a water-gage.

Ordinarily the water stands at the level indicated, and in order to prevent the water from being thrown up from the water-tubes E into the steam-space C′, I provide baffle-plates R, which surround the smoke-tubes and stand immediately over the water-tubes. These baffle-plates are preferably made in four segments, resting at their ends on brackets R′. The ends of the plates come quite close together, but do not touch, there being interposed between them vertical lugs *r*, which project from the brackets. These lugs are perforated transversely and receive pins r^2, which serve to lock the plates in place. When it is desired to clean the tubes E, the covers O may be removed, and by withdrawing the pins r^2 the plates R may be lifted from the brackets and set to one side, thus exposing the tubes and permitting of their being inspected and cleaned.

S indicates two pipes set in the casing A on opposite sides of the boiler and each communicating at its upper end with the lower portion of the upper drum C and at its lower end with the lower portion of the lower drum D. Each such pipe also communicates, by means of a branch pipe *s*, with the lower portion of a wing or partition L or M.

T indicates the feed-water pipe, and T′ the blow-off pipe.

t indicates hand-holes in the lower drum, by means of which access may be had to this drum and to the lower ends of the water-tubes.

The hot gases or products of combustion are admitted through a flue U, which may be opened and closed by a valve U′. The flue opens into the chamber K above the ledge *k*, and the hot gases traverse the course indicated by the unfeathered arrows. The gases first pass up through that side of the chamber J immediately over the flue U, and they are confined by the wings or partitions L M to one-half of this chamber. They then pass into the chamber I surrounding the upper drum, and thence pass down through the chamber J on the opposite side of the partitions L M. These gases then pass into the annular chamber K and thence to the chamber H, from which they rise through the smoke-tubes F and pass into the smoke box or stack G. By this arrangement the water-tubes on the right-hand side of the boiler as viewed in Fig. 1 will be intensely heated. Those on the left-hand side will also be heated to a high temperature, but in less degree, while the water in the shell will receive the least heat. This method of circulating the hot gases produces several currents of hot water and steam. These are indicated by feathered arrows. In

Fig. 1 the arrows 1 indicate a water circulation caused by the unequal heat in the water-tubes and the shell. It will be observed that on both sides of the wings the hot water rises through the tubes and descends through the shell. In Fig. 2 the arrows 2 indicate a separate circulation through the wings L and M. The wings being most highly heated, the water will rise in the wings and descend within the shell. There is also a separate water circulation through the pipes S. In Fig. 2 the arrows 3 show how the water rises from some of the water-tubes, passes down through the pipes S, and thence into the lower drum, from which it rises into the water-tubes. Should the water-level by any chance fall below the upper drum, a circulation of water may still be maintained in the manner indicated by the arrows 4. In this case the water will rise from the lower drum into the shell, thence pass through the wings L and M into the branch tubes *s*, and thence downward through the lower portions of the pipes S. Such latter circulation, however, does not normally occur. It only occurs when the water-level is low. These separate water circulations do not in any way interfere with each other, as those portions of the water which ascend in one circulating system are adjacent to those portions which ascend in other circulations. The construction is such also as to produce a circulation of steam in the steam-space C'. This is indicated in Fig. 2. The arrows 5 show how the steam ascends near the outside of the drum, where the heat is greatest. The arrows 6 indicate how the steam ascends near the central part of the drum surrounding the smoke-tubes, where the heat is also great. The arrows 7 show how the steam descends at that part of the drum where the heat is least and the steam is not so dry as in other parts of the steam-space. In this way I am enabled to obtain superheated steam at high tension and in large quantities from a comparatively small quantity of water or from water contained within a comparatively small space.

In Figs. 5 and 6 I have shown a modification. The only difference, however, between the boiler-shell in Figs. 1 to 4, inclusive, and that shown in Figs. 5 and 6 is that the smoke-tubes F are omitted and a feed-water heater V is employed. Therefore the parts shown in Fig. 5, which correspond to those shown in Figs. 1 to 4, are similarly lettered. A large cylinder W passes centrally through both drums and through the shell B, opening at its lower end into the chamber H and at its upper end into the smoke-stack G. The products of combustion or hot gases enter at U, pass up along one side of the partitions M, through the chamber I, and down on the opposite sides of the partitions into the chamber H. Thence they pass up through the cylinder W and out through the smoke-stack G. Within the cylinder W the feed-water heater V is located. It comprises upper and lower annular heads V' V^2, connected by vertical tubes V^3. The lower head V^2 is located at the lower end of the cylinder W and is supported by a standard Y, which is formed with lugs *y*, bolted to lugs *v*, projecting laterally from the interior of the head V^2. The lower head is centralized by means of laterally-projecting lugs *v'*, and similar lugs centralize the upper head V', which is located near the top of the cylinder W. The tubes therefore extend from the bottom of the lower drum to the top of the upper drum, and they may be held in position about midway between their ends by a spacing-ring W'. Water is supplied under pressure or by means of an injector through a pipe Z, provided with a check-valve *z* and communicating with the lower head V^2. The heated water is taken from the upper head V' by a pipe Z^2 and conveyed to the lower drum D. In order to cause the water to traverse all the tubes successively, each head V' or V^2 is divided into sections in the manner indicated in Fig. 6 by means of plates or partitions v^2. The pipe Z enters a compartment v^3, which communicates with a single tube. From this compartment the water passes up through the tube immediately over it and into a compartment v^4 in the upper head V', which communicates not only with the tube last mentioned, but also with one other tube, so that the water is caused to descend through this adjacent tube in the manner indicated in Fig. 2 and pass down into another compartment in the lower head V^2, which communicates with one other tube, causing the water to pass up this tube and through another compartment communicate with a tube which conveys the water downward. The other compartments are similarly arranged, so as to cause the water entering at Z to successively traverse all the tubes and finally reach a compartment z^2, which communicates only with one tube—namely, that through which the water last passes. From this compartment the water passes into the pipe Z^2, through which it is conveyed to the boiler. The circulation of steam and water is indicated by the feathered arrows in Fig. 5, it being similar to that shown in Figs. 1 and 2; but in this construction the steam is not heated to as high a degree as is the case in the construction shown in Figs. 1 and 2. Nevertheless the organization as a whole is such as to quickly raise water to the boiling-point, liberate steam therefrom, and to superheat the steam to such a degree as to make it most efficient.

I claim as my invention—

1. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, and a boiler therein consisting of a shell, drums at opposite ends thereof and communicating therewith, vertical water-tubes connecting the drums, parti-

tions dividing the gas-circulating chambers, and a central passage through the shell and drums for the escape of gases.

2. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, and a boiler therein consisting of a shell, drums at opposite ends thereof and connected therewith, vertical water-tubes connecting the drums, vertical partitions dividing the gas-circulating chambers into uptake and downtake passages for the gases and smoke-tubes extending through the shell and drums through which the gases escape.

3. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, and a chamber below the boiler, and a boiler within said casing consisting of a shell, drums at opposite ends thereof and communicating therewith, vertical water-tubes connecting the drums, partitions dividing the gas-circulating chambers and a central passage through the shell and drums and communicating with the chamber below the boiler for the escape of gases.

4. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, and a chamber below the boiler, partitions dividing the gas-circulating chamber into two parts, one of which communicates with an entrance-flue and the other of which communicates with a chamber below the boiler, and a boiler consisting of a shell, drums at opposite ends thereof and communicating therewith, vertical water-tubes connecting the drums, and a central passage communicating with the chamber below the boiler and extending through the shell and drums.

5. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, a boiler therein consisting of a shell, drums at opposite ends thereof and connected therewith, vertical water-tubes connecting the drums, partitions dividing the gas-circulating chambers, a central passage through the shell and drums and an outside pipe connecting the lower portion of the upper drum with the lower portion of the lower drum.

6. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, a boiler therein consisting of a shell, drums at opposite ends thereof, and communicating therewith, vertical water-tubes connecting the drums, partitions dividing the gas-circulating chambers, a central passage through the shell and drums, an outside pipe connecting the two drums and a branch pipe connecting said outside pipe with the shell.

7. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, a boiler therein consisting of a shell, drums at opposite ends thereof and communicating therewith, vertical water-tubes connecting the drums, partitions dividing the gas-circulating chambers, a central passage through the shell and drums, outside pipes connecting the drums and branch pipes from said outside pipes connected with the interior of the shell.

8. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, a boiler therein consisting of a shell, having a lower drum and an upper drum provided with a steam-space in its upper portion, connections between the shell and drums, vertical water-tubes connecting the drums, and an escape-passage for the gases extending centrally through the shell and the drums and serving to heat the water in the shell and drums and also the steam in the upper drum.

9. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, a boiler therein consisting of a shell, a lower drum and an upper drum having a steam-space in its upper portion, connections between the drums and the shell, vertical water-tubes connecting the drums, partitions dividing the gas-circulating chambers, a chamber below the boiler, and smoke-tubes connected with said chamber and extending through the lower drum, the shell, and through the steam-space of the upper drum.

10. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, and a boiler therein consisting of a shell, drums at opposite ends thereof and communicating therewith, vertical water-tubes connecting the drums, and hollow partitions or wings dividing the gas-circulating chambers and communicating with the interior of the shell.

11. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases and a boiler therein consisting of a shell, drums at opposite ends thereof and communicating therewith, vertical water-tubes connecting the drums, hollow partitions or wings dividing the gas-circulating chambers and communicating with the interior of the shell, and a central passage through the shell and drums for the escape of gases.

12. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases and a boiler therein consisting of a shell, drums at opposite ends thereof and communicating therewith, vertical water-tubes connecting the drums, hollow wings or partitions dividing the gas-circulating chambers and communicating with the interior of the shell, a chamber below the boiler and smoke-tubes communicating with said chamber and extending through the shell and drums.

13. A steam-generator comprising a casing

or setting having chambers around the boiler for the circulation of gases, a boiler therein consisting of a shell, drums at opposite ends thereof and communicating therewith, vertical water-tubes connecting the drums, hollow partitions or wings dividing the gas-circulating chambers and communicating with the interior of the shell, a central passage through the shell and drums for the escape of gases, and outside pipes connecting the drums and connected with the wings of the shell.

14. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, a boiler therein consisting of a shell, drums at opposite ends thereof and communicating therewith, vertical water-tubes connecting the drums, partitions dividing the gas-circulating chambers, a central passage through the shell and drums for the escape of gases and baffle-plates surrounding the central passage and arranged over the water-tubes.

15. A steam-generator comprising a casing or setting having chambers around the boiler for the circulation of gases, a boiler therein consisting of a shell, drums at opposite ends thereof and communicating therewith, vertical water-tubes connecting the drums, partitions dividing the gas-circulating chambers, a chamber below the boiler, smoke-tubes communicating with said chamber and extending through the shell and drums, a steam-space in the upper drum and baffle-plates surrounding the smoke-tubes and arranged over the water-tubes.

16. A steam-generator comprising a casing or setting having a central chamber communicating with enlarged chambers at opposite ends, partitions dividing the central chamber, and a chamber at the lower end of the casing communicating with the lower enlarged chamber, a boiler-shell within the middle chamber, drums communicating with the shell and arranged in the two enlarged chambers at opposite ends of the middle chamber, water-tubes connecting the drums and smoke-tubes communicating with the bottom chamber and extending through the shell and drums.

In testimony whereof I have hereunto subscribed my name.

JACOB B. BEAM.

Witnesses:
LLOYD B. WIGHT,
K. H. FENNING.