No. 799,265. PATENTED SEPT. 12, 1905.

S. A. REEVE.

STEAM BOILER.

APPLICATION FILED APR. 19, 1904.

3 SHEETS—SHEET 1.

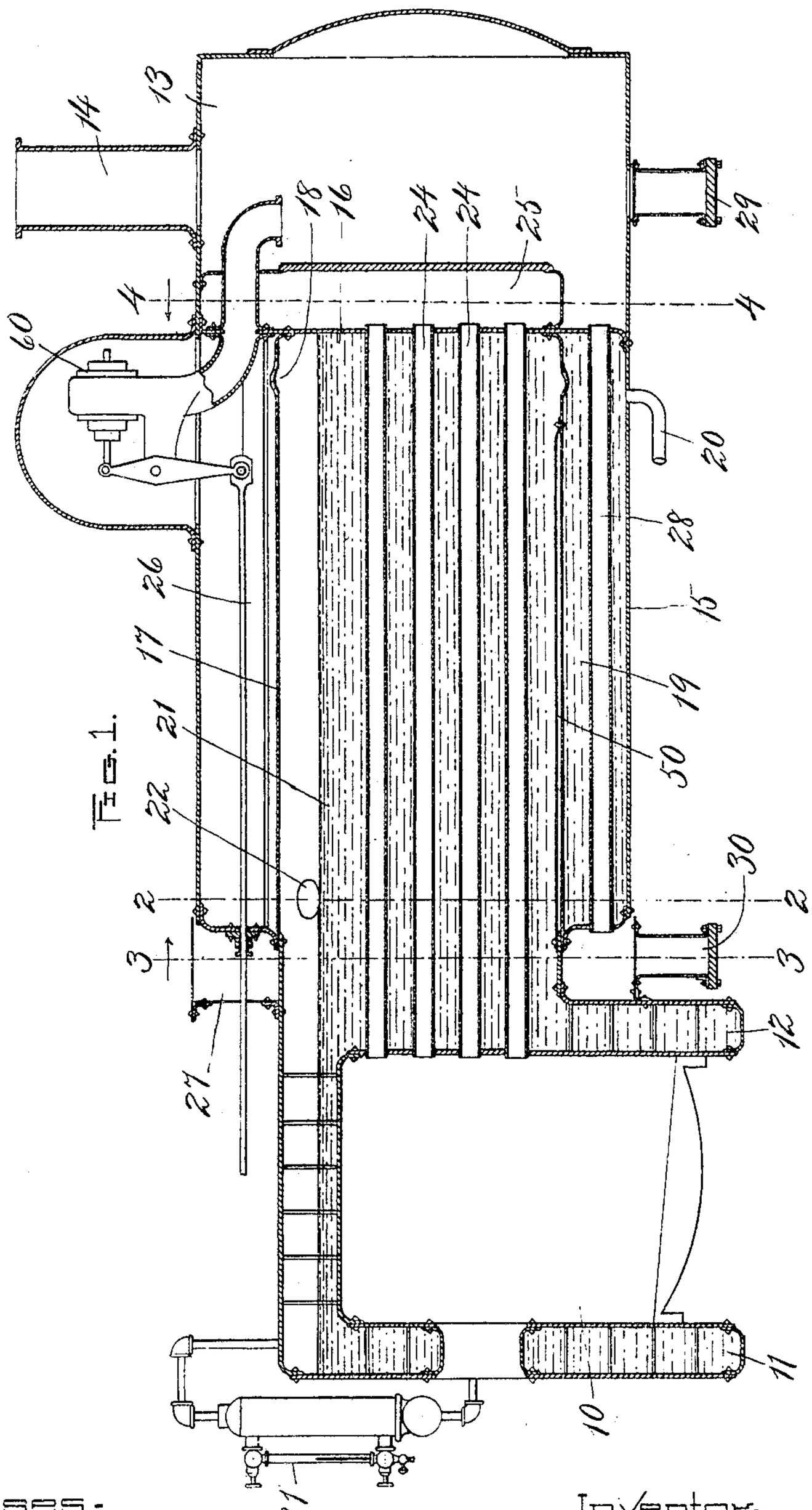

FIG. 1.

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3 SHEETS—SHEET 2.

Fig. 3.

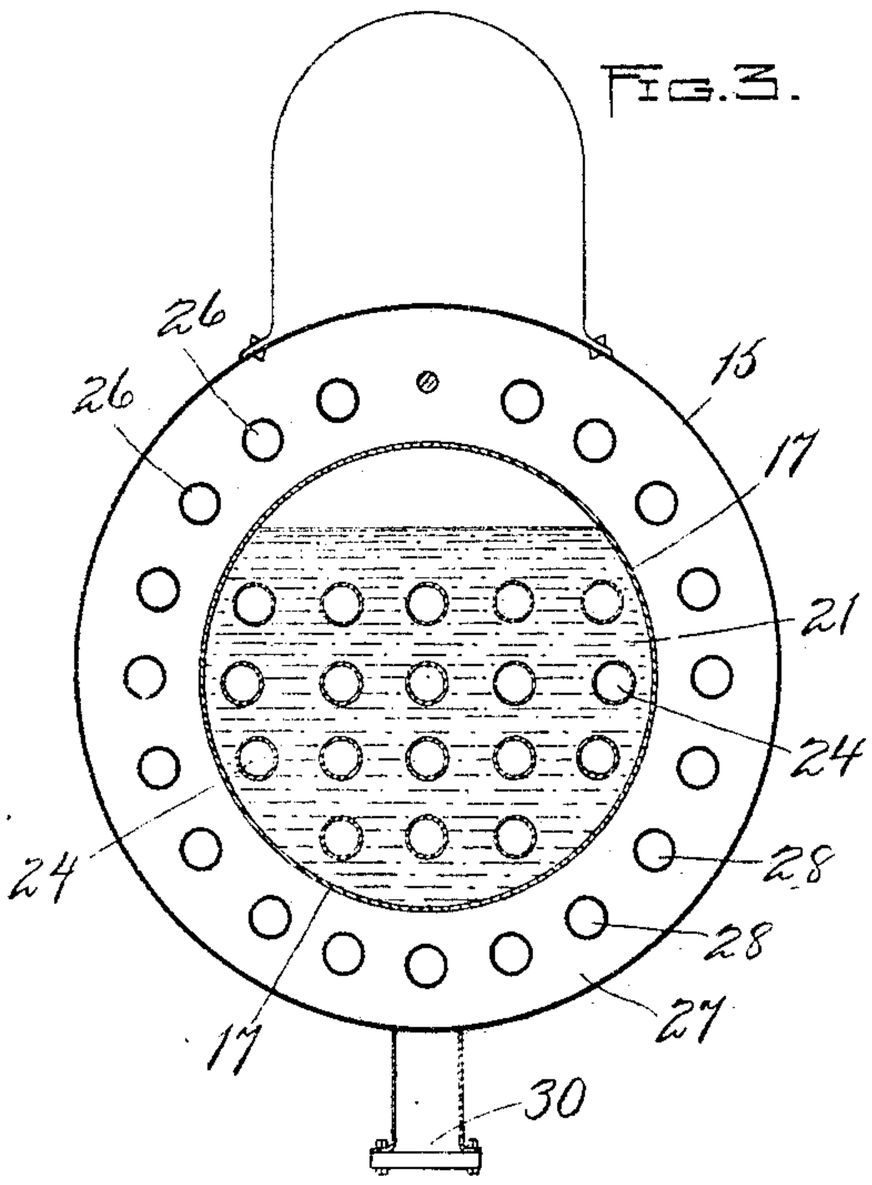


Fig. 4.

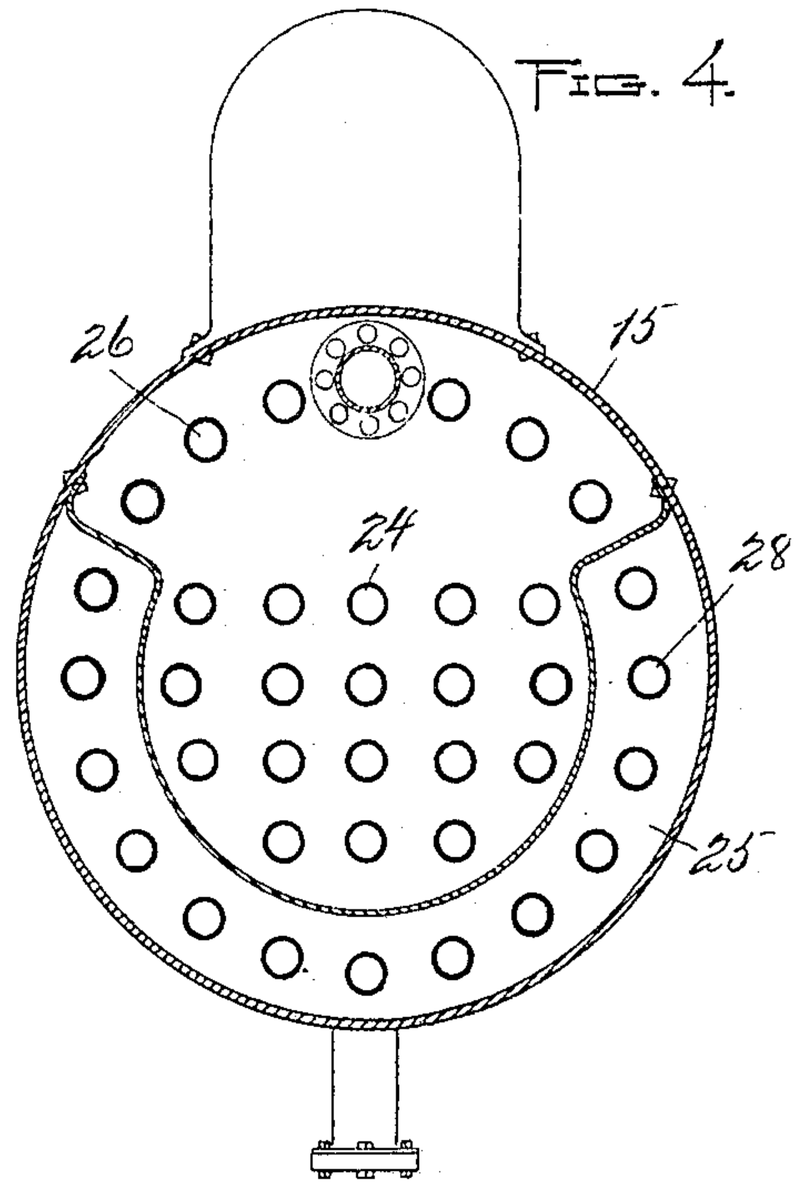


Fig. 2.

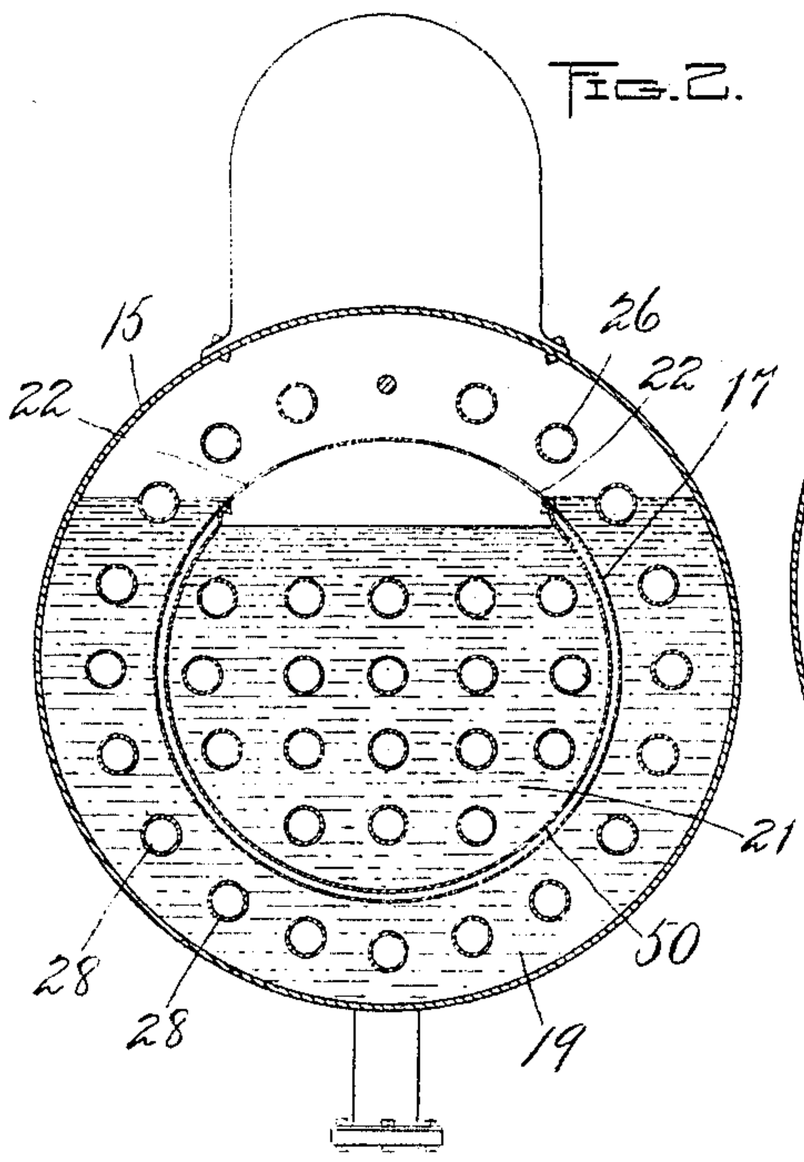
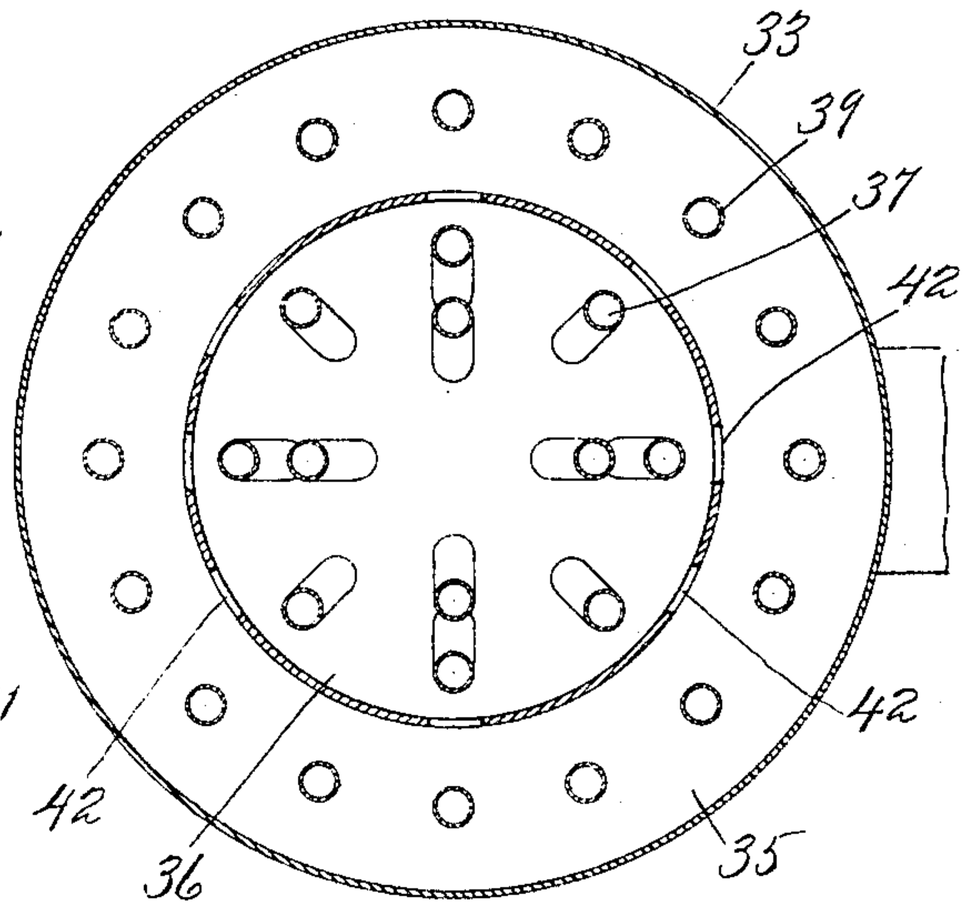


Fig. 6.



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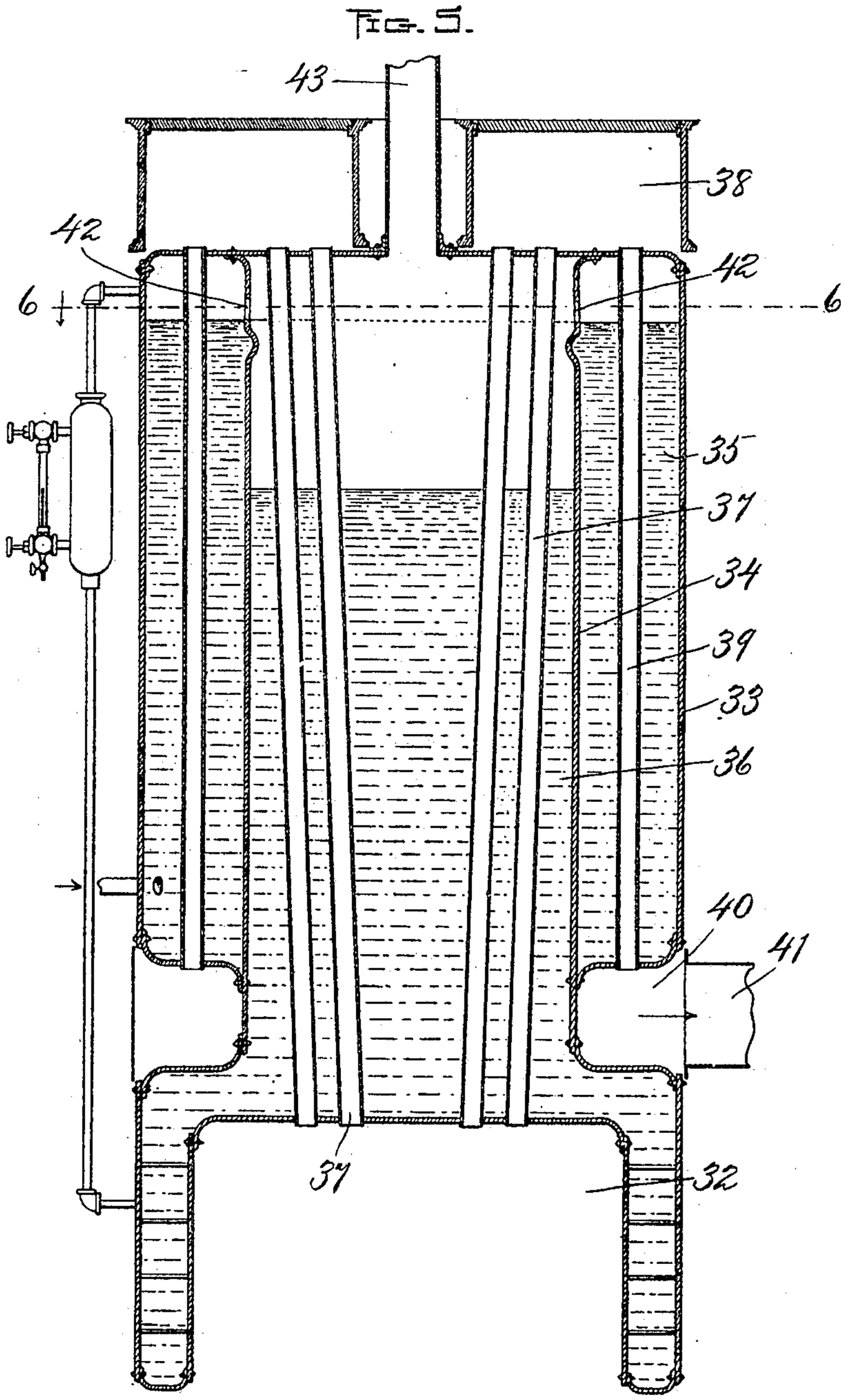
3 SHEETS—SHEET 3.

Fig. 5.



Witnesses;
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UNITED STATES PATENT OFFICE.

SIDNEY A. REEVE, OF WORCESTER, MASSACHUSETTS.

STEAM-BOILER.

No. 799,265. Specification of Letters Patent. Patented Sept. 12, 1905.

Application filed April 19, 1904. Serial No. 203,917.

To all whom it may concern:

Be it known that I, SIDNEY A. REEVE, of Worcester, in the county of Worcester and State of Massachusetts, have invented certain new and useful Improvements in Steam-Boilers, of which the following is a specification.

This invention relates to the arrangement of heating-surface in steam-boilers, more especially to those internally fired, as of the locomotive and Manning types; and it aims at improvement in the following directions: first, the utilization of a greater portion of the heating power of the gases of combustion by their reduction to a lower temperature than is possible in ordinary construction without the use of an economizer; second, the provision of a steam-supply superheated to a considerable yet stable degree; third, the development of greater power from a given fire; fourth, accomplishment of all of these ends without a wide departure from standard construction.

Of the accompanying drawings, Figure 1 represents a longitudinal section of a locomotive-boiler constructed according to my invention. Fig. 2 represents a section on line 2 2 of Fig. 1. Fig. 3 represents a section on line 3 3 of Fig. 1. Fig. 4 represents a section on line 4 4 of Fig. 1. Fig. 5 represents a vertical section showing the application of the invention to the Manning type of boiler. Fig. 6 represents a section on line 6 6 of Fig. 5.

The same reference characters indicate the same parts in all the figures.

Describing first the locomotive-boiler, 10 is the fire-box or furnace, surrounded by the water-legs 11 12. 13 is the smoke-box at the opposite or front end of the boiler, having a stack 14, and 15 is the outer tubular shell, so constructed as to properly resist the pressure carried in the boiler. 16 is the front plate or tube-sheet. Within the outer shell is an inner shell or partition 17, whose forward end is attached to the tube-sheet 16, this inner shell 17 being made elastic in a longitudinal direction by suitable means, such as the corrugation 18, or by bending the flange which attaches it to the plate 16 to a curve of long radius, this construction serving to properly take care of expansion and contraction. The lower part of the space between the outer and inner shells 15 17 constitutes a preheating-chamber 19, into which feed-water is introduced by a pipe 20, connected with the usual injector or pump apparatus. The space inclosed by the inner shell 17 constitutes a vaporizing-chamber 21 in the same horizontal zone with the preheating-chamber, and the space above the water-line *x x*, Fig. 2, in the two shells constitutes a steam-space. The inner shell 17 is perforated by large apertures 22 in its upper portion, designed to furnish communication between the upper portions of the inner and outer spaces. An outlet from the steam-space is provided at 23.

In Figs. 1 to 4 three sets of fire-tubes are provided for the passage of the products of combustion, the first set 24 connecting the fire-box 10 with a chamber 25 at the front end of the boiler within the smoke-box 13, these tubes traversing the vaporizing-chamber inclosed by inner shell 17, a second set of tubes 26, which connect the chamber 25 with an annular chamber 27 of a similar character at the rear of the boiler in front of the fire-box and traversing the steam-space above the water-line *x x*, and a third set of tubes 28, connecting the chamber 27 with the smoke-box 13 and traversing the preheating-chamber 19. The chambers 25 27 serve as collectors of the ashes and other solid matter carried by the flue-gases and are provided with clean-out openings and doors 29 30 in their lower portions. 31 is a gage-glass for indicating the water-level in the vaporizing-chamber 21. In operation the feed-water is supplied through pipe 20 to the preheating-chamber 19 until it fills up said chamber and overflows through the perforations 22 into the vaporizing-chamber 17. In this form of boiler it is preferable to keep the water-level the same in both the preheating and vaporizing chambers 19 21; but it is possible and at times may prove desirable to keep the level lower in the vaporizing-chamber 21 than in the outer preheating-chamber 19. This can easily be done without extra appliances or attention. The products of combustion from fire-box 10 traverse the vaporizing-flues 24, chamber 25, superheating-flues 26, chamber 27, preheating-flues 28, smoke-box 13, and stack 14 in the order named. Since the water entering the boiler is prevented by the shell 17 from mingling with the rest of the water in the body of the boiler, but must first pass slowly up and over these parts, it is evident that the mean temperature in the bottom of the chamber 19 will be considerably below that within the chamber 21, and, in fact, with properly-proportioned surfaces the inner space may be fed with water quite raised to its boiling-point by

the tubes 28, while the water at the bottom of chamber 19 will be substantially at the temperature of the feed. Since the only reason why according to present practice the flue-gases must be thrown away so hot is because substantially all of the water in the boiler is at the boiling-point corresponding with the pressure carried, it is plain that the total heating-surface in my boiler may considerably exceed that usually apportioned to the given grate area and yet may all be profitably active in the transmission of heat. The tubes 28 and chamber 19 perform the office of an economizer whose function is to segregate the feed-water from the water being evaporated until it shall have reached boiling temperature. The path of the gases is such that between the heating-surface exposed to water undergoing vaporization in chamber 21 and that exposed to cooler feed-water in chamber 19 they traverse a portion of heating-surface exposed only to steam—namely, the superheating-tubes 26.

Figs. 5 and 6 show the application of the invention to the Manning or vertical type of fire-tube boiler, in which 32 is the fire-box; 33, the outer shell; 34, the inner shell; 35, the preheating-chamber inclosed between the shells; 36, the vaporizing-chamber inclosed by the inner shell; 37, the tubes traversing the interior of the inner shell and connecting fire-box 32 with chamber 38 at the top of the boiler, and 39 the tubes traversing the outer chamber 35 and connecting upper gas-chamber 38 with a lower gas-chamber 40, which connects with stack 41. 42 represents the perforations in inner shell 34, connecting the inner space with the outer space. In this case there are only two sets of tubes 37 and 39, and the upper portions of each set constitute superheating-surfaces occupying the steam-space above the water-line *x x*. The second gas-chamber 40 communicates in this instance directly with the stack 41. 43 is the steam-outlet. In this form of boiler it is preferable to carry the water-level within the vaporizing-chamber 36 at a lower level than within the preheating-chamber 35.

Among the advantages of my invention are, first, increased efficiency of importance in all types of boilers; second, increased capacity, which is probably of the greatest importance in locomotive-boilers where the rigidly-fixed limits of grate area are at present the chief limitations in locomotive capacity and train-loads; third, a higher degree of superheat than is possible in boiler-superheaters supplied by waste gases which have been discarded after doing all of the evaporative work possible or profitable; fourth, less danger of burning out the superheating-surfaces than is the case with superheaters placed in the furnace, because there is always enough water-cooled surface between the fire and the superheating-surface to cool the gases to a safe temperature; fifth, stability of superheat, because when the steam-draft is light, which is the time of danger, the gases which are then slowed down passing through the first tube set will be more thoroughly cooled and the highly-superheated steam will have opportunity to exchange its surplus heat with saturated steam or water; sixth, soot and ash-dust are easily deposited without detriment and removed with little trouble; seventh, the shell 17 not being exposed to bursting strains may be made of a light and elastic form; eighth, because of the peculiar arrangement of the heating-surface there is marked economy of space for a given boiler capacity or efficiency; ninth, because of the second set of tubes 26 in the locomotive-boiler the water-level may be carried much deeper over the crown-sheet than is ordinarily compatible with a supply of dry steam, a point contributive to safety and longevity of the boiler.

It will be observed, Fig. 1, that the perforations 22 in the inner shell 17 are located at the rear end of the superheating-space, so that the saturated steam from the inner chamber 21 is compelled to traverse the entire length of the superheating-tubes 26 in passing to the steam-outlet 60 and in the opposite direction to the flow of the hot gases through these tubes, so that the superheating effect is cumulative.

In the locomotive type of my invention, since there is additional steam-space forward of the crown-sheet of the furnace, the water may be safely carried to a greater depth over said crown-sheet than heretofore and the crown-sheet may be accordingly arched to give it increased strength.

It will be observed that the inner shell 17 of the locomotive type is shown as slightly eccentric to the outer shell 15, its center being below that of the outer shell. In practice this eccentricity will preferably be greater than that shown, the object being to obtain more superheating tubes or surface between the inner and outer shells without depressing the water-line.

In Figs. 1 and 2 it is seen that the inner shell 17 is made double below the water-line by the addition of a sheet or plate 50, separated by a space from the outer plate, whereby the conduction of heat between the inner and outer bodies of water through this wall is minimized.

I claim—

1. A steam-boiler having vaporizing and preheating chambers located in the same horizontal zone and communicating at their upper ends with a common steam-space, a furnace, and flues traversing the interiors of both the vaporizing and the preheating chambers.

2. A steam-boiler having vaporizing and preheating chambers located in the same horizontal zone and communicating at their upper ends with a common steam-space, a furnace,

and a flue structure emanating from the furnace and traversing the vaporizing-chamber, the steam-space and the preheating-chamber in the order named.

3. A steam-boiler comprising a pressure-retaining shell provided with vaporizing and preheating chambers having respectively steam-spaces above them forming a common steam-space, a furnace, and means whereby the furnace-gases are caused to traverse the vaporizing-chamber, and later the preheating-chamber.

4. A fire-tube boiler having vaporizing and preheating chambers communicating at their upper ends with a common steam-space, a furnace, and a flue structure emanating from the furnace and comprising fire-tubes traversing the vaporizing-chamber, the steam-space and the preheating-chamber in the order named.

5. A steam-boiler comprising compartments or chambers for vaporizing water and for feed-water respectively having a common steam-space, means whereby the vaporizing-compartment is fed by gravity-overflow from the feed-water compartment, and a flue structure having an anterior portion traversing the vaporizing-compartment and a posterior portion traversing the preheating-compartment.

6. A steam-boiler comprising compartments or chambers for vaporizing water and for feed-water respectively having a common steam-space and the feed-water compartment arranged to discharge by gravity into the vaporizing-compartment, a furnace common to said compartments for heating the latter, and fire-tubes traversing said compartments for carrying the furnace-gases therethrough.

7. A steam-boiler comprising compartments or chambers for vaporizing water and for feed-water respectively having a common steam-space and the feed-water compartment arranged to discharge by gravity into the vaporizing-compartment, a furnace, fire-tubes traversing the vaporizing-compartment for carrying the furnace-gases therethrough, and fire-tubes traversing the feed-water compartment and connected to receive the gases which have traversed the tubes of the vaporizing-compartment.

8. A steam-boiler comprising compartments or chambers for vaporizing water and for feed-water respectively having a common steam-space and the feed-water compartment arranged to discharge by gravity into the vaporizing-compartment, a furnace, and means whereby the furnace-gases are caused to heat first the vaporizing-compartment and then the feed-water compartment.

9. A steam-boiler comprising a tubular shell, vaporizing and preheating compartments therein having a common steam-space, a partition separating said compartments and arranged for gravity-discharge of feed-water thereover into the vaporizing-compartment, a feed-water inlet to the preheating-compartment, and a furnace for heating said compartments.

10. A steam-boiler comprising a tubular shell, vaporizing and preheating compartments therein having a common steam-space, a partition separating said compartments and arranged for gravity-discharge of feed-water thereover into the vaporizing-compartment, a furnace, and fire-tubes traversing said compartments for carrying the furnace-gases therethrough.

11. A steam-boiler comprising a tubular shell, vaporizing and preheating compartments therein having a common steam-space, a partition separating said compartments and arranged for gravity-discharge of feed-water thereover into the vaporizing-compartment, a furnace, fire-tubes traversing the vaporizing-compartment for carrying the furnace-gases therethrough, and fire-tubes traversing the preheating-compartment and connected to receive the gases after they have traversed the tubes of the vaporizing-compartment.

12. A steam-boiler comprising a single pressure-retaining tubular shell, a partition structure supported within said shell and dividing its interior into a vaporizing-compartment and preheating-spaces flanking said vaporizing-compartment on both sides in the same horizontal zone and having a common steam-space therewith, means for supplying feed-water to the preheating-spaces, and means for heating said compartment and spaces.

13. A steam-boiler comprising a single pressure-retaining tubular shell, a partition structure supported within said shell and dividing its interior into vaporizing and preheating compartments having a common steam-space, the preheating-compartment having portions flanking the vaporizing-compartment on opposite sides and a portion underneath said vaporizing-compartment, means to supply feed-water to the preheating-compartment, and means for heating said compartments.

14. A steam-boiler comprising a pressure-retaining shell, vaporizing and preheating compartments therein having a common steam-space, fire-tubes in the several compartments, a furnace, and means for causing the furnace-gases to traverse in succession the tubes of the said compartments and steam-space.

15. A steam-boiler comprising a pressure-retaining shell, vaporizing and preheating compartments therein having a common steam-space, fire-tubes in the several compartments, a furnace, and means whereby the furnace-gases successively traverse the tubes of the vaporizing, superheating and preheating compartments in the order named.

16. A fire-tube boiler having an outer tubular shell, an inner partition dividing the space within the outer shell into an outer pre-

heating-chamber and an inner vaporizing-chamber, said chambers connecting at their upper ends with a common steam-space, means to supply feed-water to the preheating-chamber, and a flue structure including fire-tubes traversing the vaporizing-chamber, the steam-space and the preheating-chamber in the order named.

17. A fire-tube boiler having an outer tubular shell, an inner longitudinally-elastic partition structure attached to the outer shell, a furnace, and fire-tubes traversing the space inclosed by the partition structure and the space between the latter and the outer shell.

18. A steam-boiler comprising a tubular pressure-retaining shell, vaporizing, superheating, and preheating chambers within said shell, groups of flues traversing said chambers, a chamber connecting the groups of vaporizing and superheating flues, and a second chamber connecting the groups of superheating and preheating flues.

19. A horizontal fire-tube locomotive-boiler comprising outer and inner water-chambers connected by a steam-space, a furnace at the rear end of the boiler, a smoke-box at the front end having a stack, ash-collecting chambers in the gas-circuit at the front and rear ends having openings for the removal of collected matter, a set of fire-tubes traversing the inner water-chamber and connecting the furnace with the front collecting-chamber, a second set of fire-tubes traversing the steam-space and connecting the front and rear collecting-chambers, and a third set of fire-tubes traversing the outer water-chamber and connecting the rear collecting-chamber with the smoke-box.

20. A steam-boiler having vaporizing and preheating spaces, a passage connecting the two mainly at one end of the superheating-space, a steam-outlet from the opposite end of the superheating-space, a furnace, and a gas-course including flues traversing successively the vaporizing and superheating spaces.

21. A horizontal boiler having inner and outer walls inclosing inner and outer water-spaces, the inner space having its center below that of the outer space, a furnace, and a gas-course including flues traversing successively said inner and outer spaces.

22. A steam-boiler having an outer shell inclosing a preheating-space, an inner partition structure inclosing a vaporizing-space and of double-wall construction to provide a heat-insulating space, a furnace, and a gas-course including flues traversing said spaces successively.

23. A steam-boiler comprising a shell having a vaporizing-space and a superheating-space immediately above and open to said vaporizing-space, a furnace at one end of said shell, a flue structure emanating from said furnace and having an anterior portion traversing the vaporizing-space and a posterior portion traversing the superheating-space, a steam-outlet from the superheating-space located at the end portion of the shell opposite the furnace end, and a throttle-valve controlling said outlet.

In testimony whereof I have affixed my signature in presence of two witnesses.

SIDNEY A. REEVE.

Witnesses:
R. M. PIERSON,
A. C. RATIGAN.