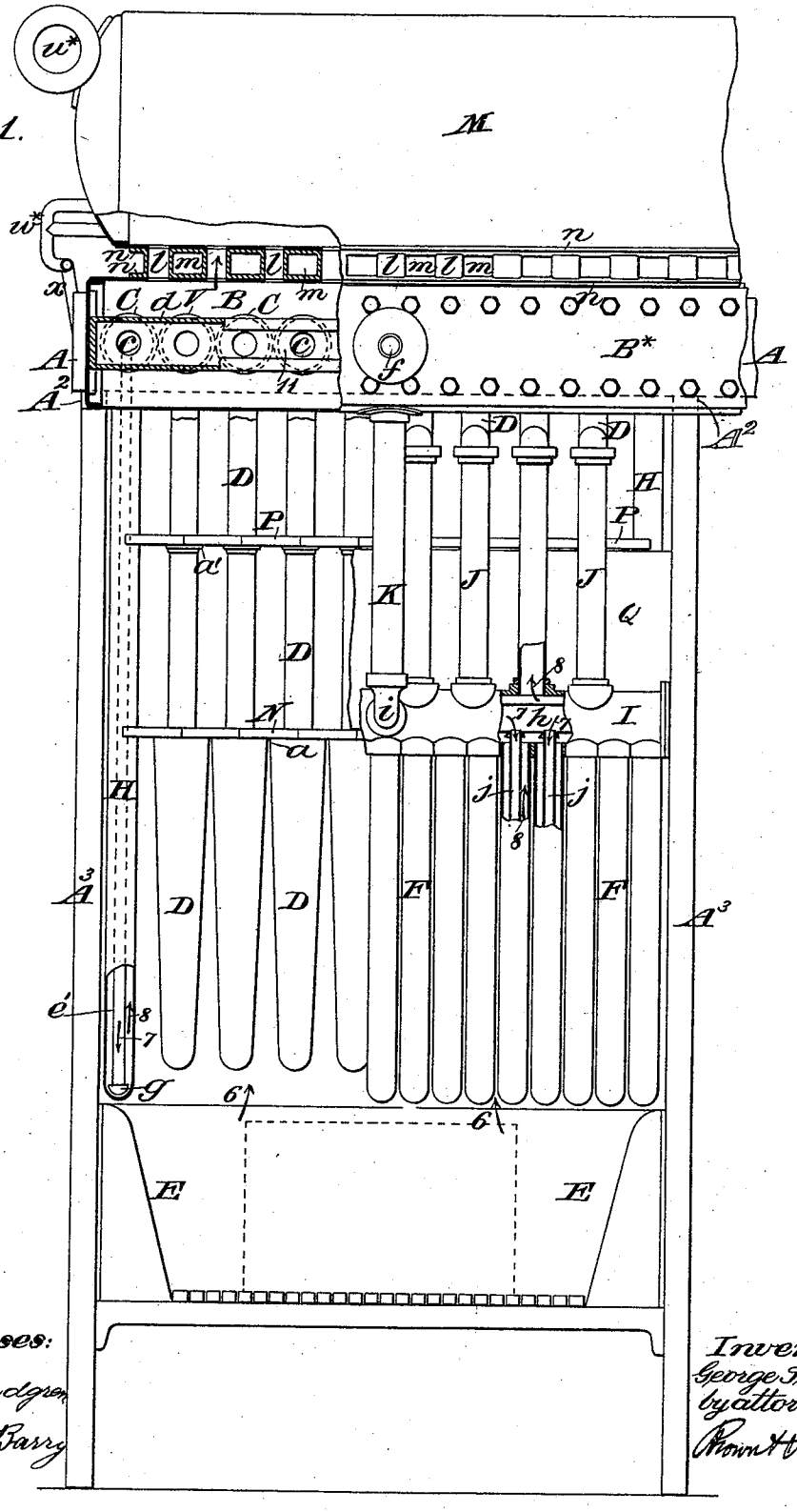
(No Model.) 4 Sheets—Sheet 1.

G. SEWELL.

STEAM BOILER.

No. 527,729. Patented Oct. 16, 1894.

Fig. 1.



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(No Model.) 4 Sheets—Sheet 2.

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Fig. 2.

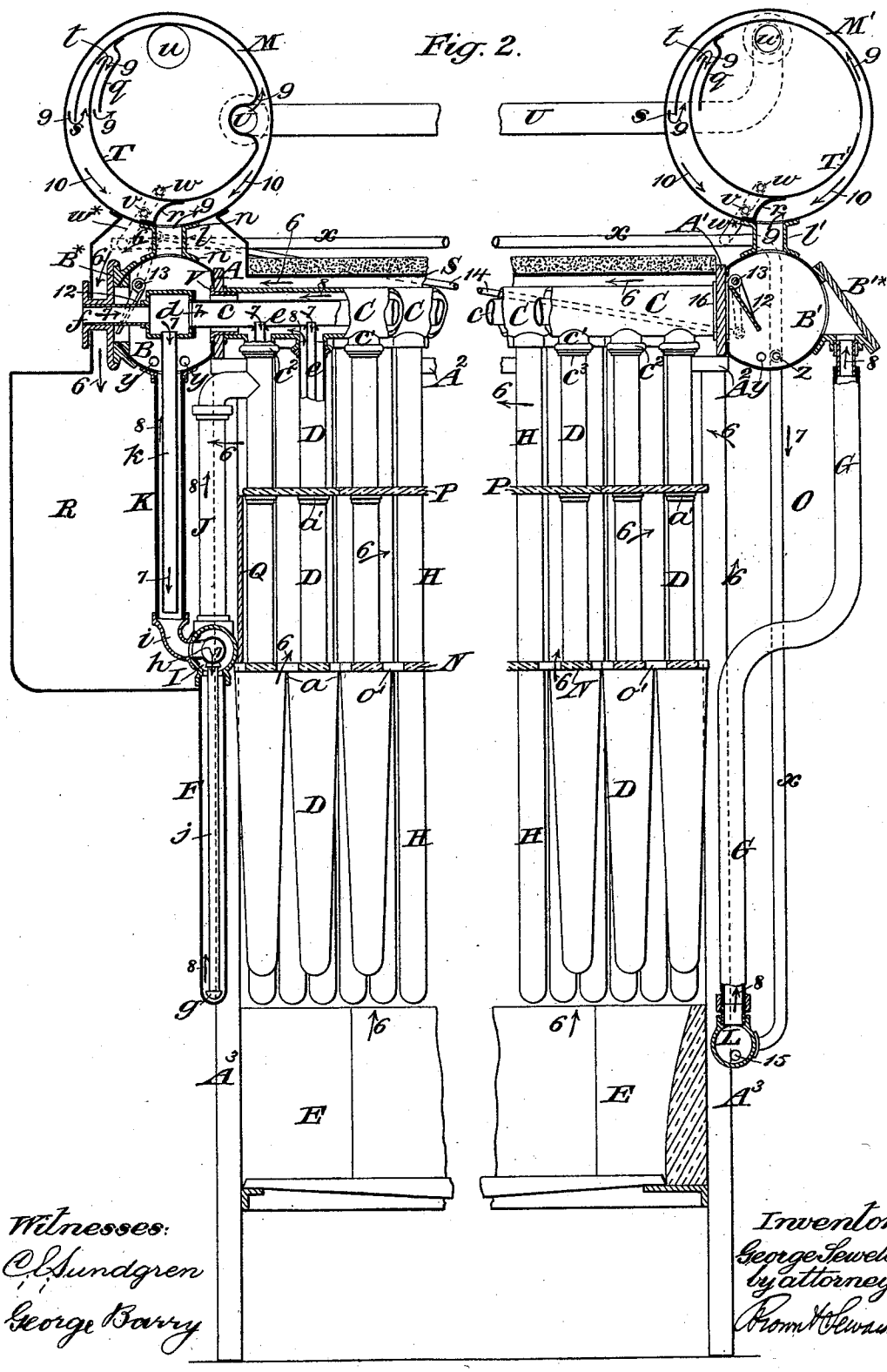

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Fig. 3.

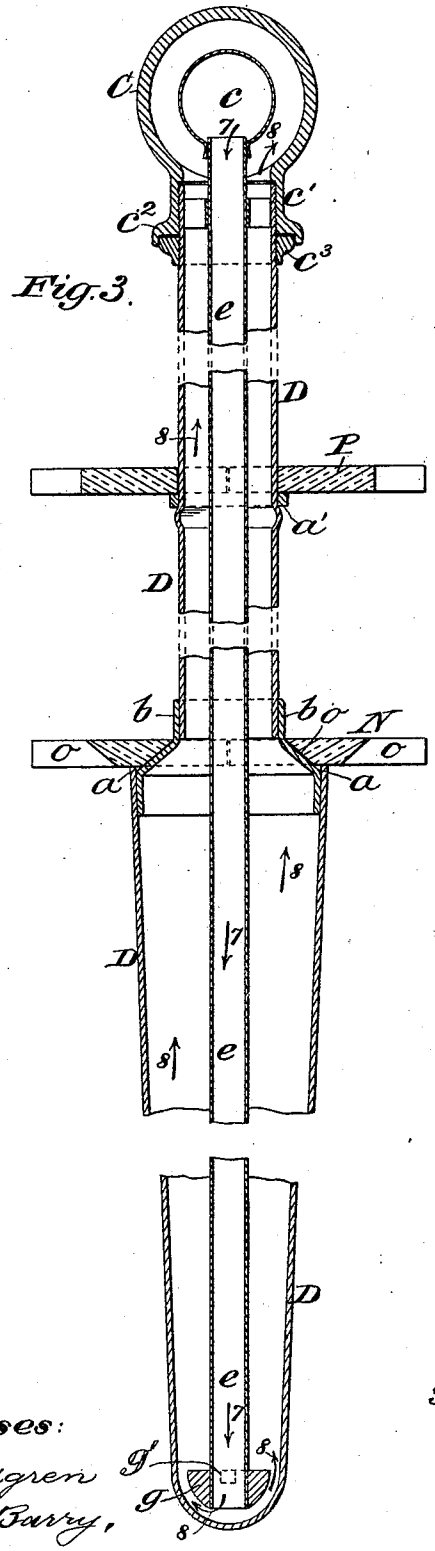


Fig. 4.

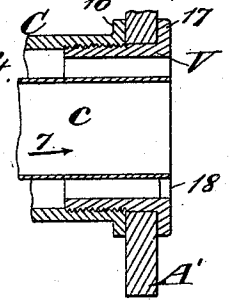
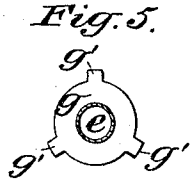


Fig. 5.



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(No Model.) 4 Sheets—Sheet 4.

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Fig. 6.

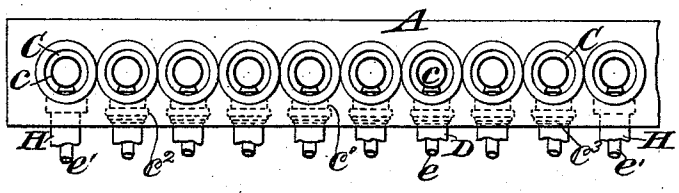
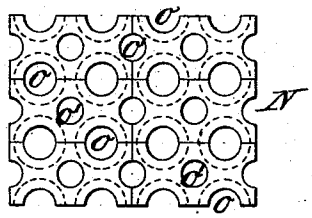


Fig. 7.



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UNITED STATES PATENT OFFICE.

GEORGE SEWELL, OF BROOKLYN, NEW YORK, ASSIGNOR TO EMELINE CORNELIA SEWELL, OF SAME PLACE.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 527,729, dated October 16, 1894.

Application filed April 4, 1893. Serial No. 469,073. (No model.)

To all whom it may concern:

Be it known that I, GEORGE SEWELL, of the city of Brooklyn, in the county of Kings and State of New York, have invented a new and useful Improvement in Steam-Boilers, of which the following is a specification.

This invention relates to that class of steam boilers known as "sectional" or "pipe" in which the water to be converted into steam is contained within tubes or pipes the external surfaces of which are exposed to the heat by which the steam is to be generated.

I will first describe my invention with reference to the accompanying drawings, in which—

Figure 1 represents a front elevation of a boiler embodying my invention having the furnace-front and smoke connection removed to expose the tubular structure to view and having certain of the front tubes omitted and the front water chamber partly in section. Fig. 2 represents a vertical section at right angles to Fig. 1. Fig. 3 represents a central vertical section on a larger scale than Figs. 1 and 2, of one of the upright tubes employed in the boiler and a transverse section of a horizontal tube from which it depends. Fig. 4 represents a vertical section at right angles to Fig. 3, of a portion of the horizontal tube last mentioned and its connections. Fig. 5 is a plan view partly in section, of a circulator employed within the vertical tubes of which one is shown in Fig. 3. Fig. 6 represents a front view of one of the two upper tube sheets and parts of the tubes thereto connected. Fig. 7 is a plan view of parts of what I call the "calorimeter plate" which will be hereinafter described.

The entire boiler structure of which my steam boiler consists is suspended from two heavy steel plates A A′ (Figs. 2 and 6) which are of a length equal to the width of the boiler and which are set up edgewise in parallel vertical planes, one A for the front and the other A′ for the rear of the boiler.

The plates A A′ may have any suitable support provided for them that will afford proper space for the tubular structure which constitutes the boiler. In the example represented this support consists of columns or uprights A^3 and horizontal beams A^2 which are supported on said columns and on which the ends of the front and rear boiler plates A A′ rest. Only one of the beams A^2 is visible in the drawings. (See Fig. 2.) The said plates A A′ constitute tube sheets for the reception of the ends of a series of horizontal water tubes C C which are arranged close or nearly close together in a horizontal tier. The ends of the said tubes may be secured in the holes provided for them in the plates A A′ in any suitable manner but preferably in the manner which I shall hereinafter describe with reference to Fig. 4.

From each of the horizontal tubes C, except the two outermost ones, there depends a row of vertical water tubes D D of the kind known as "drop-tubes" closed at the bottom and having their lower ends immediately over the fire chamber E. Fig. 3 represents one of the horizontal water tubes C and one of its depending vertical water tubes D in section on a larger scale than Figs. 1 and 2. The upper parts of these tubes D D are represented as of uniform size and smaller than the horizontal tubes C, but the lower parts of the said tubes D D commencing at about the middle of their length, are abruptly enlarged as shown at *a a* and thence tapered downward in their rounded closed lower ends. In other words, the lower parts of the said tubes D may be said to be of inverted conical form and their upper parts to be abruptly contracted and of cylindrical form. The largest parts of the said tubes are of the same or about the same size as the horizontal tubes C C so that all of said tubes D D in a row come close together and those of the adjacent rows come close together leaving between them only the spaces unavoidably left between grouped circles. The lower parts of the said tubes D D thus nearly fill the entire space above the fire chamber E inclosed by the front and rear wall tubes F G and the side wall tubes H H (see Figs. 1 and 2) which will be presently explained. For convenience of construction the larger lower parts and the smaller upper parts of the said tubes D D are represented as separately constructed and united by couplings *b*.

On the outside of the front tube sheet or plate A is secured a drum B running the whole width of the boiler and on the outside of the rear tube sheet A′ is secured a similar drum B′, the said drums constituting water chambers and being ordinarily in free com-

munication with the horizontal water tubes C C. Within each of the tubes C C there is an inner tube *c* running entirely through it, the said tubes *c c* all opening at their rear ends into the rear water chamber B′ and opening at their front ends into a box *d* which runs the whole length of the water chamber B and which is closed at its ends. To the box *d* is attached the feed pipe connection *f*.

Within each vertical water tube D is a smaller tube *e*, the lower end of which is connected with and supported by a circulator *g*. (See Figs. 3 and 5.) The upper parts of said tubes *e e* are in communication with the inner horizontal water tubes *c c*, through holes provided for them in the latter. It would be almost impossible to make tight joints between the said tubes *e e* and *c c* and moreover tight joints are not necessary. All that is necessary is that the tubes *e e* shall fit easily in the holes in the tubes *c c* which center the said tubes *e e* in the drop tubes D while the said tubes *e e* derive their support wholly at their lower ends from the circulators *g* at the bottoms of the drop tubes as will be hereinafter further explained.

Across the front of the group of water tubes D D and parallel with the water chamber B, is arranged a drum or water box I closed at its ends. This water box I is connected by a number of tubes J with the upper parts of the front water tubes D D, and from the bottom of said water box depend the front wall tubes F F which are arranged as closely together as convenient and the lower ends of which are on or about on a level with the roof of the fire chamber, leaving room beneath them for the furnace door. Through this water box I there runs a horizontal tube *h* which is closed at its ends and which communicates through an elbow *i* and an upright pipe K with the front water chamber B. Within this pipe K there depends from the inner box *d* of the water chamber B, a tube *k* which is open at the top and bottom.

Within the front wall tubes F, there are pipes *j* which are open at the bottom and which communicate at their upper ends with the horizontal tube *h* above mentioned. These tubes *j* are furnished at their bottoms with circulators *g* like that shown in Figs. 3 and 5 which will be hereinafter described.

In rear of and behind the fire chamber E is arranged a horizontal drum or water box L and between this drum L and the rear water chamber B′, there is a row of tubes G arranged close or nearly close together constituting the rear wall tubes of the boiler, the upper parts of the said tubes being curved and set back as shown in Fig. 2, to form a smoke connection O in rear of the group of tubes. The side wall tubes H H (see Figs. 1 and 2) depend from the two outermost of the horizontal water tubes C C and are arranged as close together as convenient, their closed lower ends terminating about the level of the top of the fire chamber. Within each side wall tube H there is a smaller tube *e′* (see Fig. 1) which is like the tubes *e* within the tubes D, and is connected with and supported by a similar circulator *g* to be presently described, the said tubes *e e′* communicating at their upper ends with the inner tubes *c c* of the said outermost horizontal water tubes C C to receive water from said tubes *c c*.

Above the water chambers B and B′ are two steam drums M M′, which are connected with the said chambers by box-like castings *l l′* having flanges *n n* at the top and bottom which are connected respectively with the said chambers and drums. The connection *l′* extends uninterruptedly the whole or any suitable part of the length of its respective chamber B′ and drum M′, but the connection *l* has in it as shown in Fig. 1, numerous partitions which divide it into upright steam passages *l l* and horizontal channels *m m*, the latter providing for the exit of the gases of combustion over the top of the water chamber B to the smoke connection R which will be hereinafter described.

Resting on and supported by the shoulders formed by the enlargements of the tubes D D at *a a*, there is a horizontal plate N which I call a calorimeter plate and which resembles the calorimeter plate which is illustrated in my Letters Patent No. 256,602, dated April 18, 1882. This plate occupies the whole of the horizontal space within the wall tubes and between the tubes D D and constitutes the crown of the fire-chamber. The said plate, a portion of which is shown in Fig. 7, has in it openings *o* for the reduced upper portions of the tubes D D and between these openings it has smaller holes *o′* for the passage of the flame and heated gaseous products of combustion from the furnace. For convenience of insertion and of removal when necessary said plate N is made in sections as shown in Fig. 7. The tube openings *o* are made half in one section and half in an adjacent one. Some distance above this plate N, there is a second horizontal plate P supported on shoulders *a′* provided on the tubes. This plate P, like N, fills the whole of the horizontal space within the wall tubes and it has in it openings for the tubes D D but it has no intervening openings as it is intended to close the space below it between the said tubes.

At the rear ends of the two plates N and P, there is a bulkhead plate Q which closes the front of the chamber constituted by the space between the said plates N and P but at the rear of the said plate Q the space between the said plates N and P has a lateral outlet to the smoke-connection O which is also in communication with the space or chamber above the plate P between the tubes D D. In front of the boiler is the front smoke-connection R which is in communication with the smoke stack. The space above the plate P and between the tubes D D and C, has in front an outlet above the bulkhead plate Q leading to the said smoke connection R.

The whole tubular structure is inclosed at the top by a cover S which also includes the front water chamber B and the space within which is in communication with the front smoke-connection R. This smoke connection R also incloses the drum I and the tubes J and pipes K. The entire boiler may be inclosed at its front, rear and sides by any suitable casing. When a number of such boilers are arranged in a row as they would be in a steamship no casing is necessary outside of the side wall tubes H H except at the ends of the row.

The flame and heated gaseous products of combustion from the fire chamber E circulate between the fire chamber and smoke connection R as indicated by the arrows 6, 6, in Fig. 2, that is to say, first upward among and between the tapered larger lower portions of the tubes D D and through the holes *o'* in the calorimeter plate N into the space between said plate and the plate P, thence rearward across and between the tubes D D to the rear smoke connection O, thence forward across and between the uppermost portions of the tubes D D and around the upper water tubes C C and front water chamber B and through the horizontal passages *m m* in the connection *l* and into the front smoke connection R and thence to the smoke stack.

The water admitted to the boiler by the feed pipe connection *f* is all received within the box *d* which is inclosed within the chamber B, whence the greater portion of it passes into the inner horizontal tubes *c c* which keep the rear chamber B' supplied, while a portion also passes into the tube *k*. (See Fig. 2.) The direct circulation of the water is indicated by arrows 7, 7, and the return circulation by arrows 8, 8, the direct circulation from the tubes *c c* being downward through the several tubes *e* to the bottoms of the tubes D and H and that from the pipe *k* being into the tube *h* and thence downward through the tubes *j* to the bottoms of the tubes F. The return circulation is upward through the tubes D and H into the horizontal tubes C and thence into the water chamber B. The return circulation from the tubes *j* is upward through the front wall tubes F into the lower front drum I and thence through the tubes J, and the upper parts of the front tubes D into the front water chamber B. The same arrows 8, 8, which indicate the direction of the return circulation of the water also indicate the direction of the steam which is generated in the several tubes D F J H K and C, also in the water chambers B B'. The water level will be a little above the tubes C C, and above this level in the chambers B B' the steam is all collected to pass thence to the drums M M'.

It will be obvious that the greatest area of heating surface in this boiler is constituted by the tubes D, the form of which is very important. In the first place, the lower portions of the said tubes being tapered and presenting inclined surfaces against which the flame and gaseous products of combustion impinge in their upward course from the fire chamber constitute a much more effective heating surface than if the said portions of the tubes were cylindrical and the flame and products of combustion merely ran along them, and in the second place the upper portions of the said tubes being of a reduced size as compared with the lower portions and having a circulation of the flame and heated products of combustion running across them are still more effective in proportion to their area.

In order to insure the most active return circulation from the inner tubes *e* and *j* through the drop tubes D, H and F, I provide each of said tubes *e* and *j* at its lower end with the circulator *g* hereinbefore mentioned which is shown in Figs. 3 and 5. This circulator consists of a collar secured in any suitable manner, as by driving it on tightly to the lower end of the inner tube *e* or *j*, the said collar projecting laterally all around the tube and having its sides and lower face rounded to conform to the rounded bottom of the drop tube D, H or F and having projecting wings or lugs *g'* which fit and rest within the interior of the rounded bottom of the drop tube and which serve both to center and support the lower end of the inner tube within the drop tube, the support being so far above the bottom of the drop tube that there is an unobstructed space, as shown in Fig. 3, between the bottom of the inner tube and the bottom of the drop tube for the free circulation of water which on issuing from the inner tube passes outward and upward between the lugs *g'* of the circulator *g* into the drop tube. The circulator thus constructed and applied compels a strong current of steam and water to so continuously sweep the inner surfaces of the bottoms of the tubes D F H as to prevent deposit therein.

Within and parallel with the steam drums M M' there are respectively arranged separating drums T T' of about three quarters the diameter of the steam drums and extending the whole length thereof. These separating drums have respectively on one side a longitudinal opening *s t* the outer edge *s* of which overlaps the inner edge *t*, which latter edge is also lapped inside by a lip *q* projecting from the inside of the said drum, the edges of the said opening therefore having a double lap so that steam entering the said drum from its steam drum will be to such extent baffled that water contained in it will be thrown back into the lower parts both of the separating drum and steam drum.

Across the space between each separating drum T or T' and its respective steam drum M or M' on one side of the connection *l* or *l'* which forms the steam inlet to said drum from its respective chamber B or B', there is a partition plate *r* which runs the whole length of the drums. The steam entering the steam

drum is deflected by the partition plate *r* and caused to circulate as indicated by the arrows 9, 9, in Fig. 2, around the space between the steam drum and its separating drum until it passes the outer edge *s* of the opening in the latter where it finds an outlet between the said outer edge and the inner edge *t* and between the said edge *t* and the overlapping lip *q* and into the separating drum whence the outlet is in the upper part as at *u* in T and *u'* in T'. The steam in its circulation deposits any water that may have been in it within the lower part of the separating drum and within the lower part of the steam drum as shown by arrows 10, 10. Some of this water returns through the connections *l l'* to the water chambers B B', while some of it collects in the lower part of the steam drum on the other side of the partition *r* and some in the lower part of the separating drum. That collected in the lower parts of the drums passes out through the openings *v w* and pipes *w** into a drip pipe *x* which runs down to a lower drum L at the rear of the fire chamber while the dried steam passes out from the separating drums through the outlets *u u'* in their upper parts. The partially dried steam passing from the separating drum T' passes first into the steam drum M outside of its separating drum T by a pipe U and afterward passes along with the steam from the latter drum into the separating drum T in which the drying is completed and whence it passes from the outlet *u* where the main steam pipe *u** (Fig. 1) is connected.

The water chambers B B' serve also as sediment collectors and have near their bottoms openings *y* (see Figs. 2) at which are cocks or valves (not shown) for the discharge of the sediment. The rear chamber B' has a pipe *z* leading from its lower part into the drip pipe *x* which provides for the constant circulation of water downward from the chamber B' to the lower drum L whence the return circulation is through the rear wall tubes G to the said chamber B'. The drum L serves as a sediment collector and the blow-out pipe is connected with this drum at 15. (See Fig. 2.)

The front chamber B is provided with a bonnet B* which extends its whole length and which is removable for the purpose of obtaining access to the interior of the said chamber. The rear chamber B' is also provided with a bonnet B'* for a similar purpose. On the front of the water box *d* at the sides of the feed pipe connection *f*, there is provided a longitudinal opening 11 (see Fig. 1) to which is fitted the swinging valve 12 which is arranged within the chamber B and the spindle 13 of which passes through one end of the said chamber B and is connected with a rod 14. (See Fig. 2.) In the chamber B' there is a similar valve 12 which is adapted to close the rear ends of the tubes *c c*, the spindle 13 of this latter valve running through one end of the chamber B' and being connected with the same rod 14 which is connected with the first mentioned valve spindle 13. The connection of the rod 14 is such that both valves will close together and both will open together. When the boiler is in operation these valves are both left open. They are only closed for the purpose of blowing out or emptying the boiler. When these valves are closed, the water to be blown out passes up from the inner tubes *e* and *j*, thence through the pipes *c c* and *k* into the box *d* and out through the feed pipe connection *f*. This connection *f* is intended to be furnished with a valve which may be opened in one direction or the other for the purpose of admitting the water to feed the boiler or of providing for the exit of the water in discharging from the boiler, the said connection in the latter case serving as the outlet.

I have represented in Fig. 4 the manner in which I connect the ends of the tubes C with their respective tube sheets A A'. The ends of the said tubes are flanged outwardly as shown at 16 in said figure and are screw-threaded internally. The flanges 16 abut against the tube sheets. The screw-threaded ends of the said tubes have screwed into them from outside the tube sheet, flanged sockets or thimbles V which pass through the holes provided in the tube sheet for the connections of the tubes and the flanges of which abut against the outer face of the tube sheet. The faces of the tube flanges 16 of the tube and of the flanges 17 of the sockets being coated with red lead paint, the screwing up of the said sockets causes the flanges 16 and 17 to be pressed closely to the tube-sheet and a tight joint to be made without applying to the screw-threads any paint which would prevent the unscrewing of the socket, the joint being made between the faces of the tube-sheet and the faces of the flanges of the tube and socket respectively. The screw-threads might be coated with a graphite lubricating composition to allow the socket to be easily unscrewed and taken out. The taking out of the socket leaves the tube free to be easily removed for renewal or repair. Fig. 4 also shows how the ends of the inner tube *c* may be supported and centered in the outer tubes C, viz: by a simple projection 18 in the bottom of the tube *c* resting in the lower part of the socket or thimble V.

The method of connecting the drop-tubes with the horizontal water tubes C is also important and is illustrated in Fig. 3. The tubes C are provided with sockets *c'* one for each tube D, the said sockets being flanged as shown at c^2 and the tubes D being furnished each with a flange c^3 at a short distance from its upper end. The said flange is represented as formed of a collar tightly screwed on to the tube. The upper face of the flange c^3 and the lower face of the flange c^2 are faced and the interior of the sockets *c'* and the exterior of the terminal portion of the tube are screw-threaded. To make a

tight joint it is only necessary to apply a coating of red lead paint between the opposite faces of the flanges c^2 and c^3 and screw up the tube D into the socket. There being no print on the screw-threads which may be coated with a graphite composition for lubrication, the drop-tube may be unscrewed with comparative facility when necessary for repair and yet a tight joint is preserved between the face of the flanges c^2 and c^3.

What I claim as my invention is—

1. In a steam boiler, the combination of a fire-chamber having openings in its crown plate, a second plate arranged above said crown plate with an outlet at one end from the space between the two said plates, and drop-tubes extending through said space into the fire-chamber and having those parts within the fire-chamber tapered downward and those parts within the said space of smaller diameter than the parts below the crown plate, substantially as herein set forth.

2. In a steam boiler, the combination of a series of drop-tubes having abrupt enlargements at some distance from their upper ends and tapered downward from said enlargements and means of supplying said tubes with water from above, a horizontal plate supported above the enlargement of the said tubes and having openings in it between said tubes, an upper horizontal plate arranged at a distance above the first mentioned plate and closing the spaces between said tubes, a bulk-head at the front end of said plates, a smoke connection at the opposite end between the spaces below and above said upper plate, and a smoke outlet above said bulk-head, substantially as herein set forth.

3. In a steam boiler, the combination with two parallel tube-sheets and supports upon which said tube-sheets are set up edgewise, of a boiler structure comprising two water chambers one outside of one and the other outside of the other of said tube-sheets, horizontal water tubes communicating at their opposite ends respectively through said tube-sheets with said chambers, and drop-tubes dependent from said horizontal water tubes, the whole of said structure being supported by said tube-sheets, all substantially as herein set forth.

4. The combination in a steam boiler, of two water chambers, a series of outer water tubes arranged in a horizontal tier and communicating at their opposite ends respectively with said chambers, drop-tubes dependent from said outer water tubes, a water box within one of said chambers, a series of inner horizontal water tubes running through said outer water tubes and communicating at one end with said water box and at the other end with the other of said water chambers, and a series of inner water tubes arranged within the drop-tubes and open at their lower ends to the latter tubes and at their upper ends to the inner horizontal water tubes, substantially as herein set forth.

5. The combination of a horizontal tier of outer water tubes, two water chambers one at each end of said tubes, drop-tubes dependent from said horizontal tubes, a water box within one of said water chambers having an opening to said chamber and a discharge outlet, inner horizontal water tubes running through said outer water tubes and communicating at one end with said water box and at the other end with the opposite water chamber, tubes within said drop-tubes and open at their upper ends to the said inner horizontal tubes and at their lower ends to the drop-tubes, a valve for closing the opening of the water box to its respective water chamber and a valve for closing communication between the said outer water tubes and the opposite water chamber, all substantially as and for the purpose herein set forth.

6. The combination with a drop-tube having its lower part of inverted conical form and its upper part contracted, a horizontal water tube in communication with the upper end of said drop-tube, a second horizontal water tube within the first mentioned horizontal water tube, a vertical water tube within the drop tube in communication with said second horizontal water tube, and a circulator consisting of a winged collar fitted to the bottom of said vertical water tube and supporting said tube on the bottom of the drop tube, substantially as herein set forth.

7. The combination of a steam drum having a steam inlet in its bottom, a separating drum inside of said steam drum, and a partition arranged between said drums lengthwise thereof on one side of and adjacent to said steam inlet, the said separating drum having a longitudinal opening with double overlapped edges for the admission of steam thereinto from the outer drum and having an outlet for the dried steam; substantially as herein set forth.

8. The combination with the tube-sheet A or A′, of the horizontal water tubes C having their ends internally screw-threaded and outwardly flanged to abut against said tube-sheet, and the outwardly flanged sockets or thimbles screwed into the said tubes and clamping the tube-sheet between their own flanges and the flanges on the tubes and forming joints between said flanges and the two faces of the tube-sheet, substantially as herein set forth.

9. The combination of the horizontal water tubes C provided with flanged internally screw-threaded sockets c', and the drop-tubes provided with flanges c^3 and screwed into the said sockets with their flanges abutting against and forming a joint against the flanges of the said sockets, substantially as herein set forth.

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