

(No Model.)

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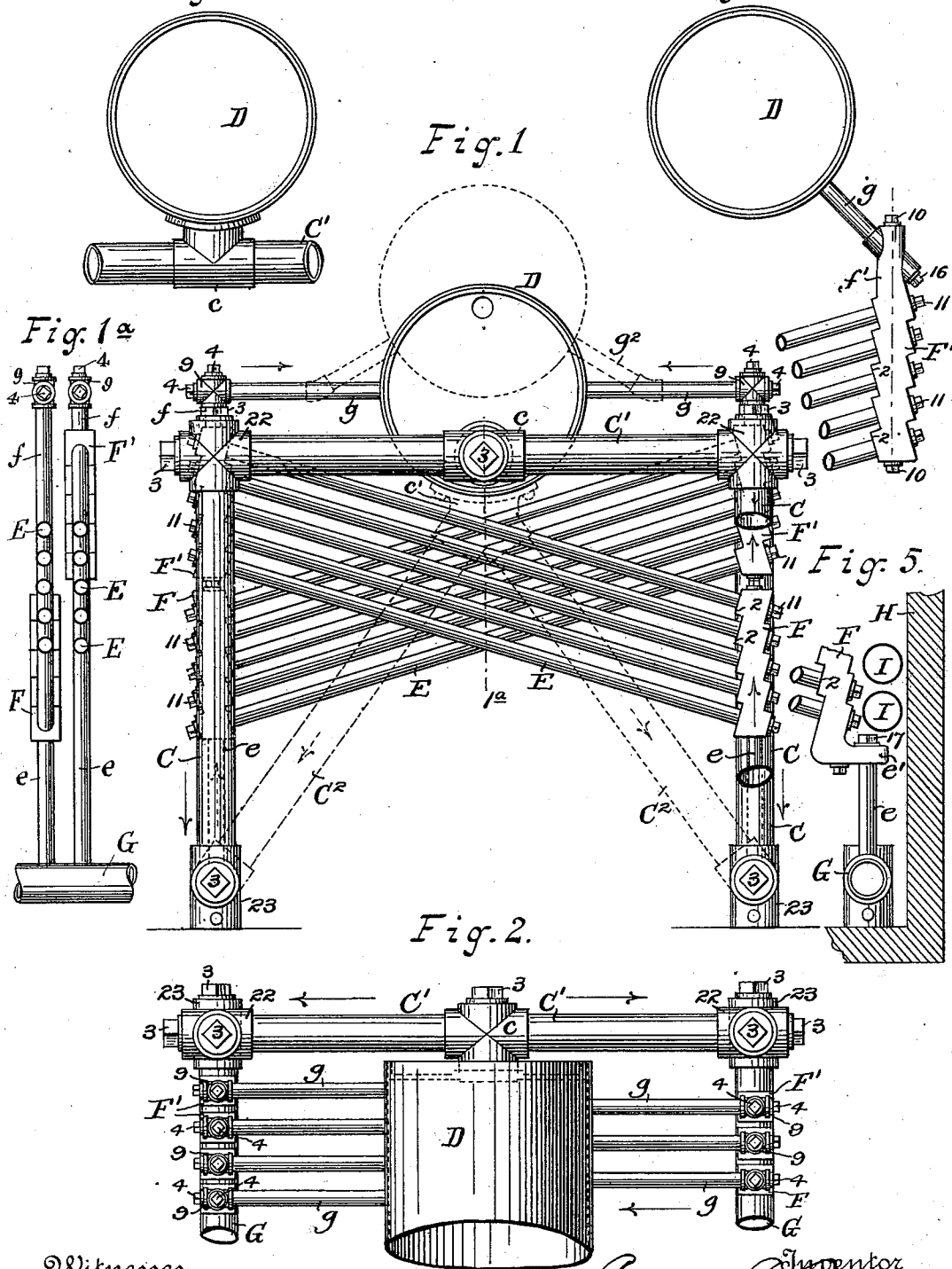
E. E. ROBERTS.  
STEAM GENERATOR.

No. 507,504.

Patented Oct. 24, 1893.

Fig. 4.

Fig. 3.



Witnesses  
Chas. Hanemann  
N. Marler.

Inventor  
Edward E. Roberts  
By his Attorney  
Chas. W. Forbes

(No Model.)

4 Sheets—Sheet 2.

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Fig. 6.

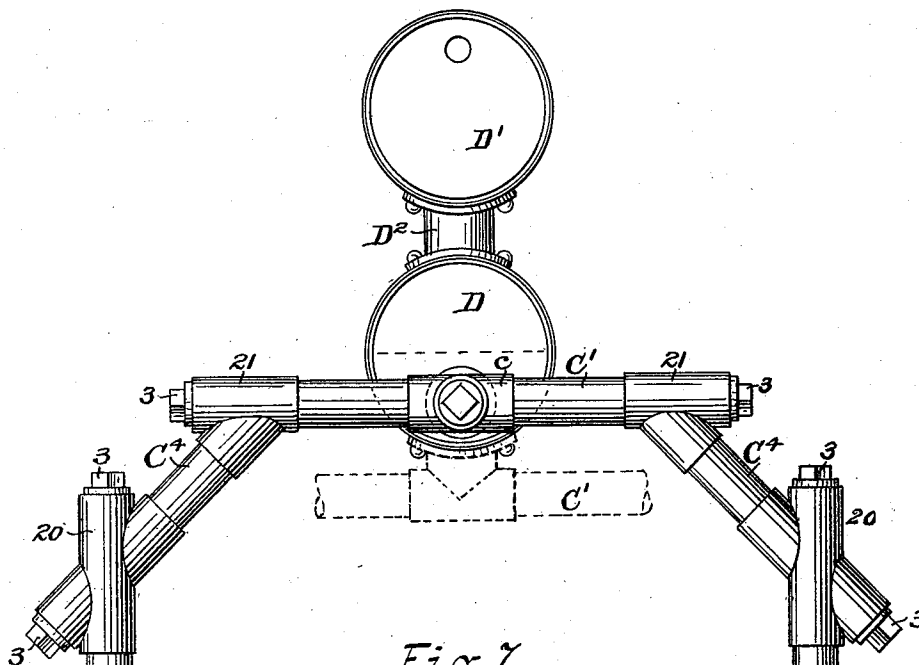
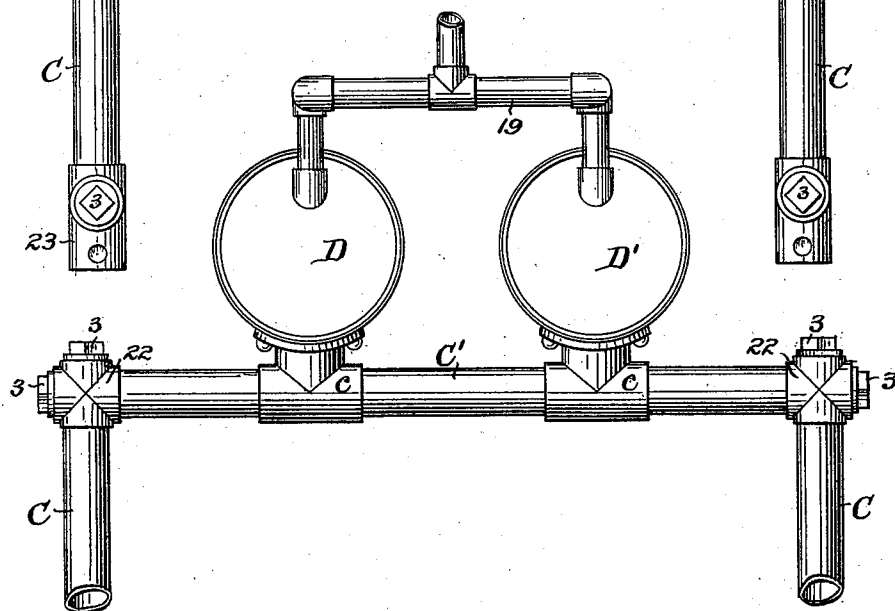


Fig. 7.



Witnesses  
Chas. Hanemann  
H. Mader

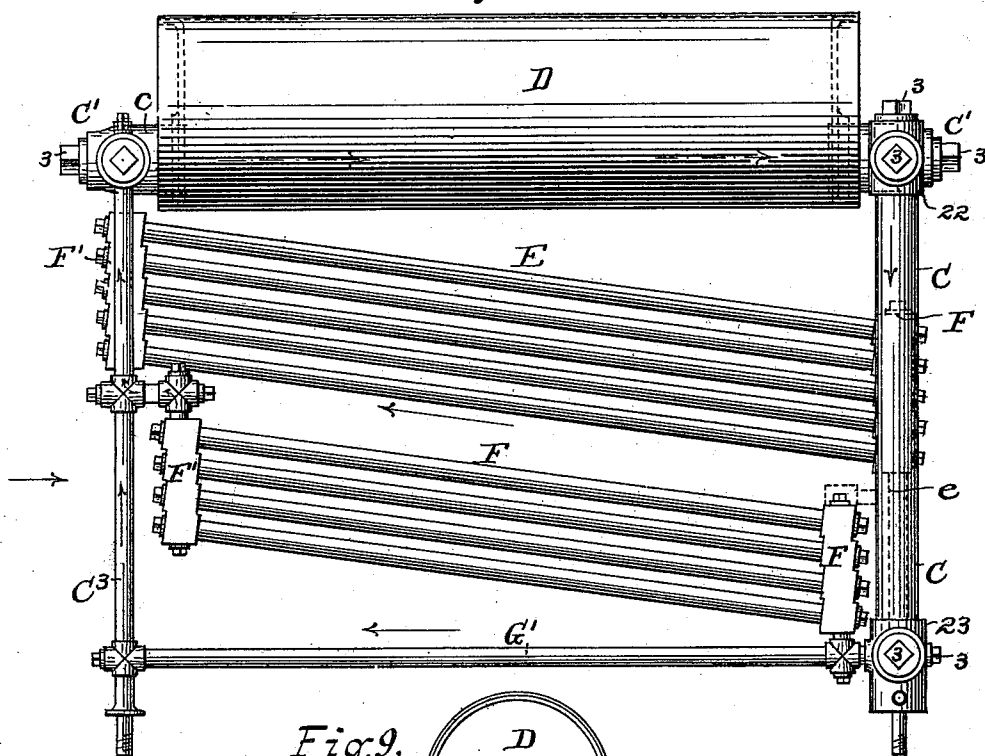
Inventor  
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By *Chas. W. Forbes* Attorney

4 Sheets—Sheet 3.

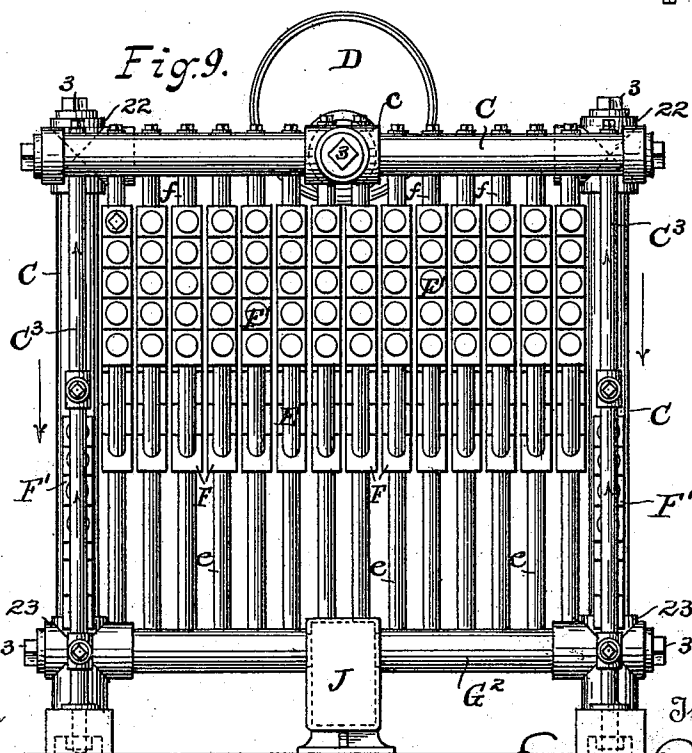
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*Fig. 8.*



*Fig. 9.*



Inventor

By his Attorney

Edward C. Roberts  
Attorney  
Chas. H. Forbes

(No Model.)

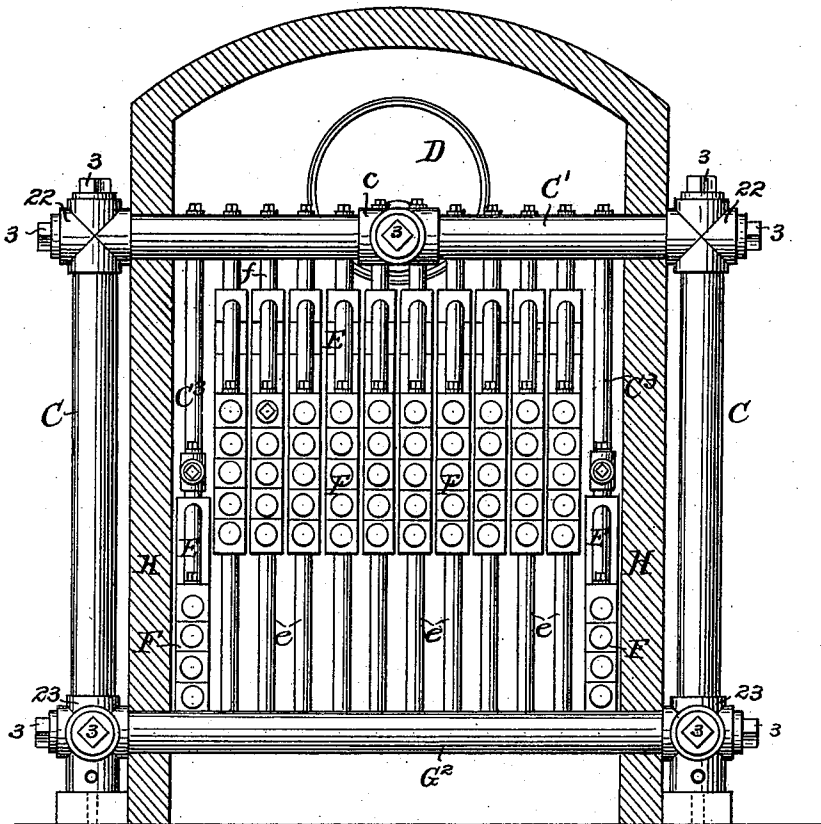
4 Sheets—Sheet 4.

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*Fig. 10.*



Witnesses  
Chas. Hanemann  
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Inventor  
Edward E. Roberts  
By his Attorney  
Chas. W. Forbes

# UNITED STATES PATENT OFFICE.

EDWARD E. ROBERTS, OF RED BANK, NEW JERSEY, ASSIGNOR TO THE  
ROBERTS SAFETY WATER TUBE BOILER COMPANY, OF SAME PLACE.

## STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 507,504, dated October 24, 1893.

Application filed June 12, 1891. Renewed May 27, 1893. Serial No. 475,796. (No model.)

*To all whom it may concern:*

Be it known that I, EDWARD E. ROBERTS, a citizen of the United States, residing at Red Bank, in the county of Monmouth and State of New Jersey, have invented certain new and useful Improvements in Steam-Generators, of which the following is a description.

The present invention relates generally to steam generators and more particularly to that class of such generators of which Letters Patent No. 371,710, granted to me October 18, 1887, is a type.

The object of the present invention, among other things, is to provide a generator which will rapidly generate steam due in a large measure to the rapid and effective circulation, and also to afford provision for a thorough cleansing of all the parts of the boiler, and to provide a structure that may be readily and inexpensively renewed in each of its parts without necessarily wholly dismantling the structure.

To this end the improved generator consists of a structure constructed in the main of pipes or tubes in connection with a steam and water drum with which the pipes communicate. Instead of arranging the tubes in the form of coils which may form the sides of the fire box as in my said patent, the tubes are arranged in gangs, the opposite ends of which are connected with headers, through which headers and the pipes the water circulates back to the steam and water drum, by which arrangement, while the water is subjected to as great an area of heating surface, the danger of a too great frictional resistance in the pipes is prevented which would tend to prevent adequate circulation.

The invention also consists in a header for the pipes adapted to an inclined arrangement thereof but which may, in itself, extend vertically in line with the natural vertical wall of the generator so that the size of the grate is not unduly restricted; and it furthermore consists in certain details of construction and combinations of parts hereinafter fully set forth.

The accompanying drawings illustrate a practical embodiment of the invention both in its preferred form and in various modifications thereof.

In said drawings:—Figure 1 is an end elevation of the improved generator, the front right-hand side down-flow pipe being broken away to disclose underlying parts; and Fig. 1<sup>a</sup>, is a detail vertical section on the line 1<sup>a</sup>, of Fig. 1. Fig. 2 is a plan view of a portion of the same. Fig. 3 is an end view of a portion of the apparatus showing a modified connection of the header with the steam and water drum. Fig. 4 is an end view of a part of the generator showing particularly a changed position of the cross pipes. Fig. 5 is a detailed sectional elevation of a slightly modified form of the header making provision for the coils of a super-heater without increasing the exterior dimensions of the generator. Fig. 6 is an end elevation of a generator showing a modified form of the cross and down-flow pipes and illustrating the steam and water drum in duplex form, one over the other. Fig. 7 is a similar view of another modification of the same parts with the duplex steam and water drum lying in the same horizontal plane. Fig. 8 is a side elevation of a modification of the structure shown in Fig. 1, the gangs of steam pipes extending longitudinally of the structure instead of crosswise. Fig. 9 is an end elevation thereof. Fig. 10 is a similar view of Fig. 9 showing the down-flow pipes arranged outside of the generator walls.

Referring to said drawings it will be understood that the generator is supported in the usual manner, upon a suitable base or foundation; and in the main it consists of four vertically arranged pipes C, located substantially at the four corners of the generator, which pipes rise from the base of the generator and connect at their upper ends at the front and rear with a cross pipe C' which in turn is connected by a T c, with its steam and water drum D. Thus the vertical pipes C at each end of the generator are connected together by a cross pipe and thence with the steam and water drum. The connection of the cross pipe C' may be made through the end of the steam and water drum as indicated in Figs. 1, 2, 6, 8, 9 and 10, or the connection may be made through the shell of the drum from its under side as indicated in Figs. 4 and 7 by dotted lines in Fig. 6; and in some cases where such a structure would not interfere

with the fire door, or where a single fire door is arranged centrally of the structure, the cross pipe  $C'$  may be entirely omitted and the vertical pipes  $C$  arranged diagonally with respect to the vertical line of the generator (see dotted lines  $C^2$  Fig. 1), and meeting in a single union  $c'$  and thereby connected with the steam and water drum. The generator also embraces a plurality of gangs of tubes  $E$ , the opposite ends of which are connected with and open into headers  $F F'$ , one of the headers being in communication from its bottom, by a lower vertical tube  $e$ , with a longitudinal pipe  $G$  extending at the side of the generator between a pair of vertical pipes  $C$ ; and the other header is in communication from its top, by an upper tube  $f$ , to a return tube  $g$ , entering the steam and water drum  $D$ , which return tube may lead straight to the drum or as shown by dotted lines may connect by an elbow with an inclined tube  $g^2$ , and in either case the return tubes will connect with the drum on a radial line with its central axis.

In the structure shown in Fig. 1, the gangs of tubes  $E$  are arranged at an incline to the horizontal plane of the generator while the headers are arranged substantially vertical, and the alternate gangs of tubes are oppositely inclined so that the header of one gang is in communication by a lower tube  $e$  with the horizontal pipe  $G$  at one side of the generator, while the header of the next gang is in communication by a similar tube with the horizontal pipe  $G$  on the other side of the generator; and the headers  $F'$  are likewise in communication at opposite sides of the generator by the upper tubes  $f$ , and return tubes  $g$ , with the opposite sides of the steam and water drum.

Owing to the inclination of the gangs of tubes  $E$ , with respect to the headers, their connection with the headers will be at an angle, and in order to obtain the proper connection between the gangs of tubes and the headers, and to permit the headers to stand vertically, each header is stepped as shown in Figs. 1, 3, 5 and 8, so as to present seats 2 for the tubes at right angles to the longitudinal axes of the latter, which seats are angularly disposed to the vertical axes of the headers and thus make up the stepped or offset formation of the header. This formation of the header also affords provision for the proper cleansing of each of the tubes of the gang and also of the header and connecting tube.

The connection between the respective headers  $F F'$  may be somewhat modified from that heretofore described. Thus in Fig. 3 the header  $F'$  is provided with a vertical hollow extension  $f'$  with which the return tube  $g$  is directly connected, the said tube being angularly disposed with respect to the header and connected with the steam and water drum  $D$  on a line radial to its central axis; the said extension being provided as in the other form with an opening closed by a plug 10 for clean-

ing the header and with an opening closed by a plug 16 for cleaning the tube  $g$ . In Fig. 5, the lower portion of the header  $F$  is provided with a hollow horizontal off-set  $e'$  which has direct communication with the tube  $e$ , the said off-set having an opening closed by a plug 17 for cleaning the off-set and tube  $e$ . This form of header also provides a space between the vertical side of the header and the wall or casing  $H$  of the generator for the coils of a super-heater  $I$  without unduly enlarging the generator or its exterior dimensions.

Instead of connecting the pipes  $C$  direct with the cross pipes  $C'$  as in Fig. 1, the connection may be varied as is shown in Fig. 6, wherein each of the pipes  $C$  is connected by a union 20 with an angularly arranged pipe  $C^4$ , and the latter by a union 21 with the cross pipe  $C'$ . In this construction the cross pipe is connected either by a  $T$  to the end of the steam and water drum  $D$  or to the shell of the drum at its under side, as indicated by dotted lines. In this case the drum  $D$  is supplemented by a steam drum  $D'$  arranged vertically above the drum  $D$  and connected therewith by one or more connections  $D^2$ .

In Fig. 7, the arrangement of the pipes  $C$  and  $C'$  is similar to that of Fig. 1; the steam and water drum is in duplex form  $D D'$ , both connected with the cross pipe  $C'$  and both connected by a steam pipe 19 of the usual form.

In Figs. 8, 9 and 10, the gangs of tubes  $E$ , instead of being arranged across the fire space as in Fig. 1, are arranged longitudinally with respect thereto. In this modification shown in Figs. 8 and 9, the steam and water drum  $D$  is in communication at its rear end by the cross pipes  $C'$  with vertical down-flow pipes  $C$  and at its opposite or front end with a similar cross pipe  $C'$ . And in order to support the front cross pipe, small up-flow pipes  $C^3$  connect with the opposite ends thereof and by horizontal pipes  $G'$  with the pipes  $C$  at the rear of the generator. The pipes  $C^3$  might be replaced by any other suitable support for the front cross pipe, but when pipes are used it is necessary that the water should circulate through them. The gangs of tubes  $E$  are arranged with one exception, longitudinally above the grate and, as before, are connected with headers  $F F'$ , the headers  $F$  being in communication by vertical tubes  $e$  with a horizontal cross pipe  $G^2$  connecting the down-flow pipes  $C$ , while the headers  $F'$  are in communication by tubes  $f$  with the cross pipe  $C'$  at the front of the generator; the inclination of the gangs of tubes being upwardly from the rear so that the highest part of the gangs of tubes will be at the front of the generator. The two gangs of tubes  $E$  at the extreme outside of the generator, one at each side, are interposed in the same vertical plane with the axis of the down-flow pipes  $C$  and the up-flow pipes  $C^3$ , and their respective headers  $F$  are connected with the horizontal pipe  $G'$ , or with the down-flow pipes  $C$ , as indicated by dotted

lines in Fig. 8, and the headers  $F'$  are in communication with the up-flow pipes  $C^3$ . This construction presents gangs of tubes at the sides of the furnace as well as over the top of the same. If the pipes  $C^3$  and  $G'$  are omitted, the upper end of the headers  $F'$  of the side gangs of tubes  $E$  will be connected by a tube at the front cross pipe as the others are, and in this respect the upper portion of the pipes  $C^3$  is to be considered the equivalent of the tubes  $f$ .

Sediment pockets may be provided as usual in the corners of the generator at the base of each of the pipes  $C$ , but, I have found it advantageous to place one in connection with each of the longitudinal pipes  $G$ , preferably centrally between the pairs of vertical pipes  $C$ . In Fig. 1<sup>a</sup> such a pocket is represented at  $J$ , so that in the circulation of the water the impurities will be swept from opposite directions into the sediment pocket and thus collected therein, from which they may be discharged by a blow-off (not shown) as is usual. As shown in the modification Fig. 9, the sediment pocket is placed in the lower horizontal cross pipe  $G^2$  which connects the two rear pipes  $C$  together, giving the same results as in the arrangement shown in Fig. 1<sup>a</sup>, so that in the circulation of the water the impurities will be swept from opposite directions into the sediment pocket and thus collected therein, from which they may be discharged by a blow-off cock (not shown) as is usual. This centrally arranged sediment pocket may be provided in the longitudinal pipes  $G$ , if preferred.

In Fig. 10 a construction similar to Figs. 8 and 9 is shown, so far as the arrangement of the gangs of tubes and pipes  $C$ ,  $C'$  and  $G^2$  are concerned. In this example, however, of the invention the pipes  $C$  are arranged outside of the generator case  $H$  so as to remove these pipes from the influence of the heat within the generator case, and thus aid in effecting a more thorough circulation of the water through them and prevent any evaporation of the water passing through them. The cross pipes  $C'$  at the front and rear of the generator may both be supported by the walls—in this case of masonry—of the casing  $H$ , and the front cross pipe  $C'$  will terminate at the casing or the outside, the pipes  $C$  and lower cross pipe  $G^2$  not being present. In the structure shown in Fig. 8, the cross pipes  $C'$  may be similarly extended into or through the masonry forming the side walls of the casing and thus support the generator at those ends enabling the dispensing of the pipes  $C^3$  and  $G'$ .

In addition to the provision for cleaning the gangs of tubes  $E$  and their headers and connecting tubes, the other tubes and pipes of the structure may also be readily cleaned. Thus the elbows 22 uniting the cross pipes  $C'$  with the vertical pipes  $C$ , each have horizontal and vertical openings closed by plugs 3 affording the cleaning of each of the pipes;

and for a like purpose the  $T^c$ , has an opening closed by a similar plug 3. Likewise the union 23 at the base of each of the pipes  $C$  connecting them with the longitudinal pipe  $G$  has an opening closed by a similar plug 3. The unions 20 and 21 of Fig. 6 also have openings closed by similar plugs 3 for cleaning the pipes  $C$ ,  $C'$  and  $C^4$ . The unions 9 connecting the tubes  $f$  and  $g$  also have openings closed by plugs 4 affording access to each of those tubes.

The pipe or tube connections throughout the boiler may be by screw threaded joints or by expanded joints as is obvious.

No detailed description of the operation of the generator is deemed necessary as this class of generators is now well known. It may, however, be stated that the circulation of the water is from the steam and water drum into the front and rear cross pipes  $C'$  in opposite directions through those pipes to the pipes  $C$ , down those pipes and thence longitudinally through the lower pipes  $G$ . From the latter pipes the water passes upward through the lower tubes  $e$ , into the headers  $F$  through the gangs of tubes  $E$  across the fire space to the opposite headers  $F'$ , thence upward through the tubes  $f$  and by the return tubes  $g$  back into the steam and water drum  $D$ . In the longitudinal arrangement of the gangs of tubes  $E$ , Figs. 8 to 10, the circulation is from the rear of the drum  $D$  into the rear cross pipe  $C'$ , thence in opposite directions through said pipe and down the vertical pipes  $C$  into the lower cross pipe  $G^2$ , thence by the lower vertical tubes  $e$ , into the headers  $F$ , through the gangs of tubes  $E$  longitudinally over the fire space, into the opposite headers  $F'$  and by vertical tubes  $f$  into the front cross pipe  $C'$  to the front of the steam and water drum.

What is claimed is—

1. In a steam generator, the combination with the steam and water drum, of the down-flow pipe, the inclined gangs of tubes united at each end in substantially vertical headers, the two upper cross pipes  $C'$  in connection with said drum, and four vertical pipes  $C$  connecting with the ends of said cross pipes extending to the base of the generator, as set forth.

2. In a steam generator, the combination with a plurality of incline gangs of tubes  $E$ , crossing each other within the fire chamber, headers  $F$ ,  $F'$ , for each gang of tubes, two longitudinal pipes  $G$ , connecting pairs of pipes  $C$  at front and rear, vertical pipes  $e$ , leading downward from one header of each gang of tubes to connection with said longitudinal pipes, vertical pipes  $f$ , leading upward from the opposite headers, and return tubes  $g$ , leading from said pipes  $f$ , to the steam and water drum, all substantially as and for the purpose described.

3. In a steam generator, the combination with the steam and water drum, and circulating pipes, of the gang of tubes united at their

opposite ends in headers and interposed between the drum and circulating pipes, one of the headers having a horizontal off-set providing a space above it and between the headers and the generator casing for the superheater coils, substantially as described.

In witness whereof I have hereunto set my

name, in the presence of two witnesses, this 22d day of May, A. D. 1891.

EDWARD E. ROBERTS.

Witnesses:

GEO. H. GRAHAM,  
N. MARLER.