No Model.)

3 Sheets—Sheet 1.

R. G. PACKARD.

STEAM GENERATOR.

No. 489,495. Patented Jan. 10, 1893.

Fig. 1.

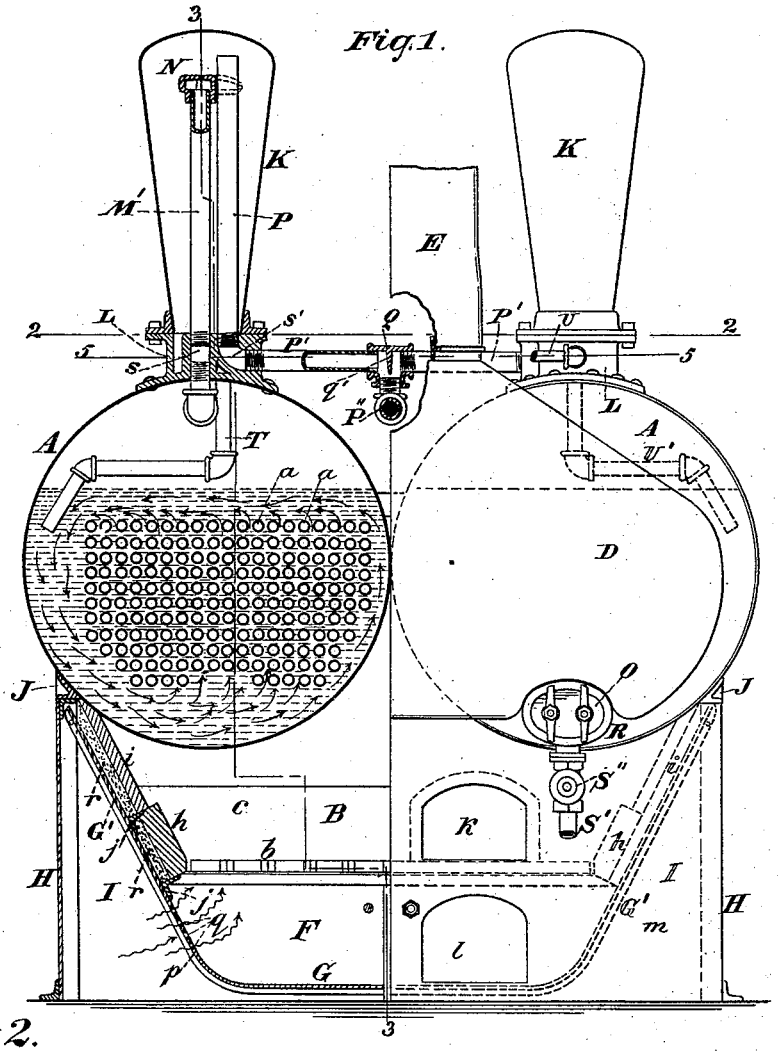
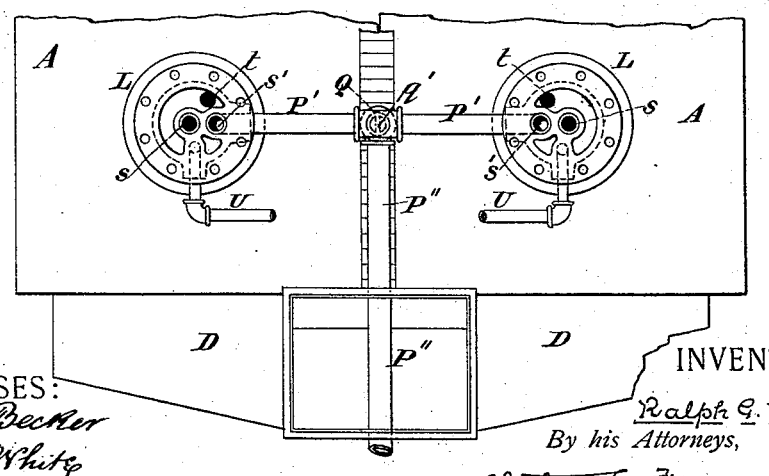


Fig. 2.



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(No Model.) 3 Sheets—Sheet 2.

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STEAM GENERATOR.

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Fig. 4.

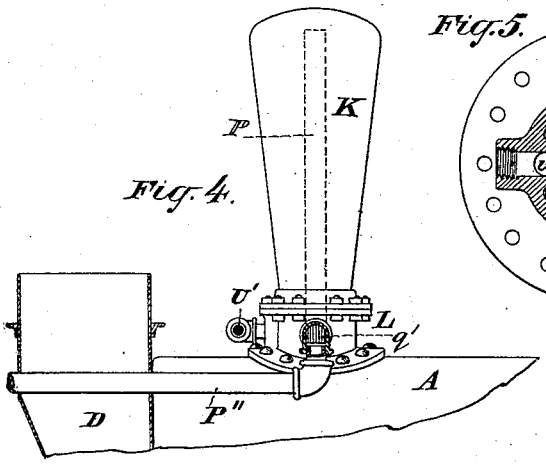

Fig. 5.

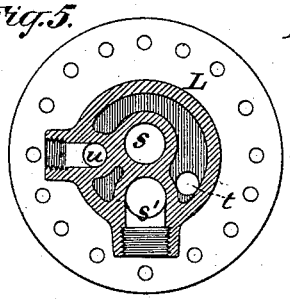

Fig. 6.

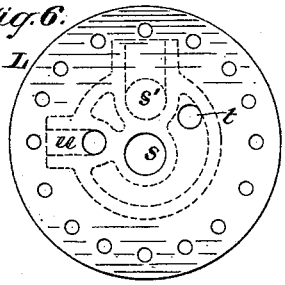

Fig. 7.

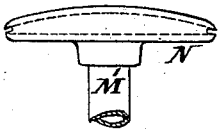

Fig. 8.

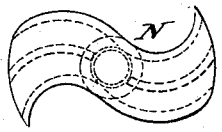

Fig. 9.

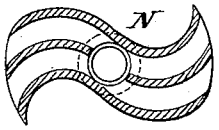

Fig. 3.

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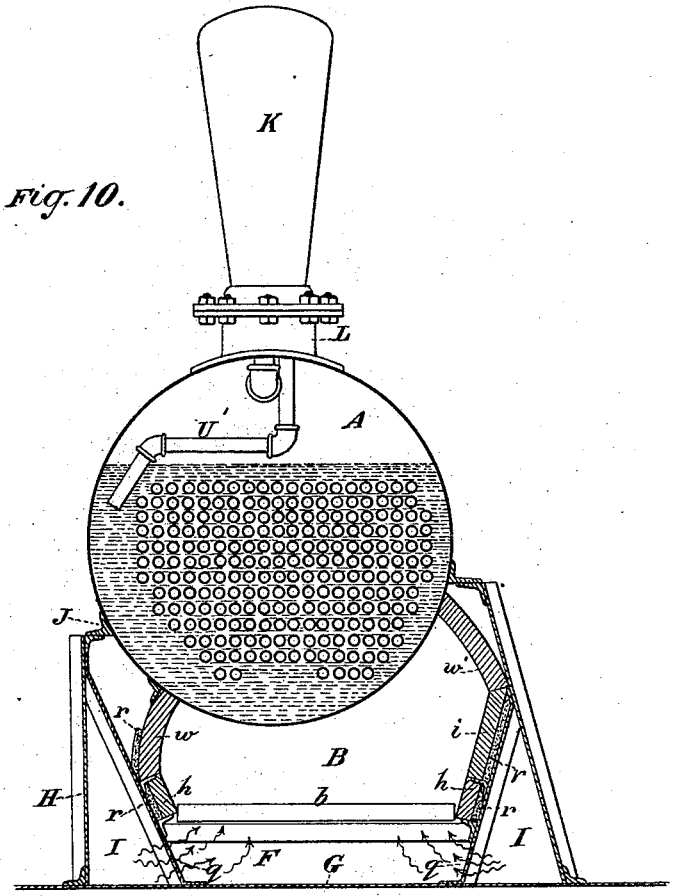
(No Model.) 3 Sheets—Sheet 3.

R. G. PACKARD.

STEAM GENERATOR.

No. 489,495. Patented Jan. 10, 1893.

Fig. 10.



WITNESSES:
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Fred Whitz.

INVENTOR:
Ralph G. Packard,
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UNITED STATES PATENT OFFICE.

RALPH G. PACKARD, OF MORRISTOWN, NEW JERSEY.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 489,495, dated January 10, 1893.

Application filed October 5, 1889. Serial No. 326,098. (No model.)

To all whom it may concern:

Be it known that I, RALPH G. PACKARD, a citizen of the United States, residing in Morristown, Morris county, New Jersey, have invented certain new and useful Improvements in Steam-Generators, of which the following is a specification.

My invention relates to steam boilers and furnaces therefor, being especially designed for stationary or marine steam generators.

The principal distinguishing feature of my invention is the relative arrangement of the boiler and furnace in such manner that the fire and heat are more or less cut off from one side of the boiler while the other side and bottom of the boiler are subjected to a greater extent to the full heat of the furnace, whereby the water on one side of the boiler is subjected to a more intense heat than the other and a circulation is produced in the boiler taking place generally in vertical transverse planes, the water flowing downwardly on the side of the boiler which is somewhat protected from heat, upwardly on the side to which the most intense heat is applied, and from the bottom, and laterally at the upper and lower portions of the mass of water. I provide a steam separating chamber above the boiler and conduct the steam from the boiler to the upper part of the chamber into which it is discharged through a nozzle in tangential direction, whereby a whirling motion is set up in the steam and the particles of water held in suspension are thrown centrifugally outward against the walls of the chamber, while the steam which is thus freed from water is drawn off from the top of the separating chamber through a suitable pipe. The separated water is drained from the bottom of the chamber back into the boiler through a pipe which discharges it into the downward current of water on the cooler side of the boiler. The boiler is constructed with only two openings into it, one at the top and the other at the bottom and preferably at the front end thereof. The upper opening is closed by a casting in the nature of a saddle piece which forms also a base for the dome or separator, and this casting is constructed with passages in connection with suitable pipes through which the feed-water is admitted into the boiler, the steam is conducted from the boiler to the separating chamber, the water drained from it is led back into the boiler, and also by preference the steam from the top of the separating chamber is conducted away from the boiler to the engine or other place where it is to be used.

My invention also comprehends in its preferred form the employment of twin boilers constructed in the form of cylinders arranged longitudinally side by side and with the furnace constructed beneath them and arranged with its middle portion beneath the adjacent sides of the two boilers, its fire bed extending in transverse direction approximately from beneath the middle of one boiler to beneath the middle of the other. Thus the hottest portion of the fire comes against the under sides of the boilers and their inner or adjacent sides, which are consequently heated to a higher degree than their outer or remote sides. The furnace walls are made inclined, flaring or curved and their upper sides terminate against the outer lower sides of the boilers, thereby confining the direct heat of the furnace to the bottoms and inner sides of the boilers. The furnace is constructed with a metal shell or casing which is suspended at both sides at or near its contacts with the boilers from the girders on which the boilers rest, so that it is free to expand and contract without straining the boilers or girders. The fire chamber of the furnace is lined with fire brick or tiles of refractory material and between these tiles and the metal shell or casing is placed a layer of non-conducting material in order to protect the metal casing from injury by over-heating. The side walls of the furnace are sloped outwardly at a sufficient inclination to hold the lining tiles in place by their own weight, and in the case of a marine boiler, to prevent their displacement by the rolling of the vessel. The lining tiles are supported on ledges attached to the metal shell so that they can be separately replaced, and the lower tiles which come against the fire-bed are made thicker than the upper ones in order to withstand wear. Air heating chambers are formed at both sides of the furnace and the air heated in them is admitted into the ash pit through perforations in the sides of the latter. In the case of twin boilers the steam pipes leading from them are united by means of a T union having an intercepting partition

to prevent the direct passage of steam from one boiler into the other.

The accompanying drawings show my invention in its preferred construction.

Figure 1 is a front elevation of my improved steam generator, the left half of the figure being in vertical mid-section in the plane of the line 1—1 in Fig. 3. Fig. 2 is a fragmentary plan of the front portion thereof, partly in horizontal section on the line 2—2 in Figs. 1 and 3. Fig. 3 is a vertical longitudinal section cut in the plane of the line 3—3 in Fig. 1. Fig. 4 is a fragmentary mid-section showing a portion of one of the twin boilers in elevation. Figs. 5 to 9 are drawn on double the scale of those just described, and illustrate details. Figs. 5 and 6 show the saddle or base casting of the steam-dome, the former being a horizontal section on the line 5—5 in Fig. 1, and the latter an underside plan. Figs. 7, 8 and 9 show the centrifugal nozzle within the steam dome, Fig. 7 being a side elevation, Fig. 8 a plan and Fig. 9 a horizontal section on the line 9—9 in Fig. 7. Fig. 10 is a transverse section of a single boiler and its furnace, embodying my invention.

Referring to Figs. 1 to 4, let A A designate the twin boilers, and B the furnace. The boilers A A are preferably horizontal cylindrical multi-tubular boilers and are placed close together side by side. The furnace B is arranged under the boilers, its fire space enveloping the bottoms of the boilers and their adjacent or inner sides, but not their outer sides, as shown in Fig. 1. The fire-bed *b*, which is constructed of grate-bars, or in any other known way, is preferably of a width equal to, or somewhat greater than, the distance from center to center of the two boilers, and it extends backward preferably for a distance equal to approximately two-thirds the length of the individual boilers. In rear of the fire-bed is a sloping bridge-wall *c* (Fig. 3) which extends up far enough to form a slightly contracted throat *d* adjacent to the boilers, behind which on a lower lever is a hearth *e* of fire brick. From the rear of this hearth a curved back-wall *f* of fire-brick extends upwardly, and from its top springs the usual brick arch *g*, which terminates against the rear ends of the boilers A A. There is thus formed a passage or flue C for leading the flames and products of combustion from the fire-bed of the furnace to the rear ends of the boilers and conducting them into the tubes *a a* of the boilers, through which they flow to the front ends thereof and enter the breach D whereby they are collected and conducted upwardly to the base of the stack E, as usual.

The side walls of the furnace B are made sloping, as shown in Fig. 1, being lined with fire bricks *h* and *i*. The fire-brick or tile *h*, which will ordinarily be in direct contact with the bed of coals, is made of considerable thickness in order to enable it to withstand the wear caused by the raking of the fire and by the adherence of clinkers. The upper tile *i* is made much thinner in order to reduce the weight. Both these tiles rest at their lower edges on brackets *j j* forming part of the framing or shell of the furnace, being thereby upheld so that when worn or broken either can be replaced without disturbing the other by simply lifting it out of its position and laying in a new tile of the same shape and size in its place. The lateral displacement of these tiles is prevented by the sloping of the shell or side walls of the furnace at such an angle that the tiles will remain in place by their own weight. For a marine boiler it is necessary that the angle shall be sufficient to prevent disturbance of the position of the tiles by the rolling of the vessel. The angle shown is a suitable one for a marine generator.

The furnace is constructed with an ash-pan F beneath the grate, and with the usual front doors *k* above the grate for stoking, and ash-doors *l* beneath the grate opening into the ash-pit. These doors are formed in a front plate *m* constituting part of the shell of the furnace. A rear plate *n*, Fig. 3, forms the rear of the ash-pit, and its upper edge constitutes the ledge for the support of the bridge tile *c*. The sides and bottom of the furnace are inclosed by a shell G of boiler-plate or other material, shown best in Fig. 1, which is stiffened by ribs *p p* of angle iron. At each side of the furnace is an outer wall or shell H which may be arranged vertically, as shown in Fig. 1. The side walls G′ of the shell G being sloping, as shown in Fig. 1, two triangular air-spaces I I are formed between these walls and the outer walls H H. These air-spaces communicate with the ash-pit F by means of perforations *q q* formed in the side walls G′.

The air which supplies the furnace is passed through the air chambers I I, wherein it is heated, and enters by means of the perforations *q q* into the ash-pit F. By the heating of the air in the air chambers I I the heat which is conducted through the tiles *h* and *i* and radiates therefrom is saved, and the shell H is kept cool. When a forced draft is employed the air chambers I I are made tight and an air conduit leading from a blower communicates with them and conducts the air forced by the blower to the chambers I I, wherein it is heated and whence it finds its way into the ash-pit.

In order to prevent undue loss of heat by its conduction through the several fire bricks or tiles *h*, *i*, *c* and *f*, (and also any other tiles that may be in or about the furnace) I employ linings *r r* of non-conducting material, which linings are placed behind the respective tiles and between the latter and their supporting shelves or plates. Any suitable non-conducting material that can be molded into a plate or slab, and that is sufficiently refractory to withstand the heat employed, may be used as the materials for these linings *r r*.

It is to be observed that the furnace shell G, which is in the form of a U-shaped apron, or trough, is suspended at its upper edges from the girders J J or other support upon which the boilers rest. This construction enables the shell to expand and contract without disturbing the girders or boilers. This shell G sustains the weight of the tiles *h i* and their non-conducting backing, and part of the weight of the grate-bars and fire-beds, the remaining weight of the latter being sustained by the front and rear plates *m* and *n*.

The direction of the furnace relatively to the twin boilers and the consequent concentration of its heat to one side of the centers of the boilers, that is to say on the sides thereof adjoining one another, results in an unequal transmission of heat to the water in the boilers, that on the inner side of each boiler, or the side toward the middle of the furnace being more rapidly heated, than that on the outer side thereof, which is exterior to the furnace, and protected from its heat. There is thus a circulation instituted in the water of the boiler, this circulation being upward where the water is most rapidly heated and downward where transmission of heat is less rapid, as clearly shown by the arrows in Fig. 1. This circulation occurs approximately in vertical transverse planes. As the water is heated not only by the portion of the boiler shell which comes within the furnace, but also by the tubes or flues passing through the boiler, the upward circulation takes place not only adjacent to the inner side of the boiler shell, but also through the spaces between the tubes. In order to provide a clear and unobstructed space for the downward current the tubes are omitted for some distance from the outer side of the boiler shell, as clearly shown at the left hand in Fig. 1. Thus an active circulation is maintained while the boiler is in use, the water flowing rapidly down the cooler side and flowing up between the tubes and against the shell on the hotter side of the boiler and returning across the top, as clearly indicated by the arrows in Fig. 1. The circulation thus caused renders the boiler very efficient, increasing the evaporation and facilitating the disengagement of the particles of water from the steam, thereby reducing priming.

On top of each of the twin boilers A A is mounted a steam dome K, which is connected with the boiler through a base-casting or saddle-piece L. A round hole is cut in the top of the boiler and this saddle-piece is fastened over it, the dome being fastened on top of the saddle-piece. The saddle-piece entirely closes the hole in the boiler and cuts off communication between the interior of the dome and the boiler except by means of certain passages formed through the saddle for the reception of pipes screwed into them. Thus the dome is made a closed chamber or steam-separator, into which steam is admitted from the boiler and in which whatever water may be carried with the steam is separated from it before the steam is conducted to the engine. The steam is taken from the boiler A through a horizontal pipe M arranged longitudinally close to the top of the boiler, and perforated on its under side, as shown in Fig. 3. This pipe extends to the middle of the saddle-piece L and joins by an elbow a steam passage *s* (Figs. 2, 5 and 6) formed approximately through the center of the saddle-piece. A pipe M′ is screwed into the upper end of this passage *s* and projects up vertically within the dome K, terminating a short distance below the top thereof. Its upper end is fitted with a nozzle N, shown separately in Figs. 7, 8 and 9. This nozzle is so constructed that the steam which passes from the pipe M up through the pipe M′ in escaping from the latter will be deflected tangentially in one or more jets or streams, so that a centrifugal or whirling motion shall be imparted to the steam within the steam dome or separating chamber. This whirling motion acts to throw the particles of water suspended in the steam centrifugally outward by reason of their greater weight, so that the water is brought against the inner surface of the walls of the chamber, down which it flows to the bottom thereof. This chamber or dome is an inverted cone and because of its shape the water discharged from the nozzles adheres to its surface as it goes spirally downward thus leaving the center of the chamber for dry steam. The nozzle N is formed with lateral passages for the steam, which are curved tangentially as they extend outwardly from the center, and are somewhat restricted at their outlet in order to cause the steam to issue forcibly and in rapid streams or currents, so that it shall be effective in maintaining the whirling movement within the dome. Any suitable construction of nozzle which will accomplish this result may be used.

The particular construction shown in Figs. 7, 8 and 9 consists of a casting shaped in plan somewhat like a two-bladed screw propeller, and formed with two steam channels in each of its opposite wings, these channels being contracted in vertical direction at their outlet openings, as shown in Fig. 7.

The steam in the dome or separator after having by its whirling motion thrown off the particles of water, rises to the top of the dome above the nozzle N and descends through a pipe P which stands vertically within the dome, as shown in Fig. 1 and in dotted lines in Fig. 4, which is screwed at its lower end into an elbow-shaped passage *s′* cored out in the saddle-piece or casting L. These passages *s′* in the two saddle-pieces L L are turned toward each other, and are connected by the two pipes P′ P′, the outer ends of which are screwed into the passages *s′*, and the inner ends of which are jointed by a T-union Q, to the lower leg of which a downwardly-extending branch-pipe is connected, to which is joined by an elbow the main steam-pipe P″ leading from the boiler to the place

where the steam is to be used. This pipe P″ passes through the breech D, as shown in Fig. 4, whereby it is heated by the products of combustion on their way to the stack, and thereby the steam passing through the pipe is to some degree superheated. The T-union Q is constructed with a partition q' projecting from the side opposite its outlet and extending toward the outlet a distance equal preferably to the diameter of the pipes P′, so that this partition serves to intercept direct communication from one of the two pipes across to the other, and acts as a deflector to turn the current of steam entering from the pipes P′ P′ on either side downward, and directly into the pipe P″. It has been found that without this deflecting partition q' there is a liability in case one boiler becomes hotter than the other that the water from that boiler shall prime over into the other boiler, this result being due, as is believed, to the current of steam flowing from one boiler and through the pipe P′ thereof directly across into the other pipe P′ and thence into the other boiler. This deflecting partition entirely overcomes this difficulty.

The water which is disengaged from the steam in the dome or chamber K and flows down the walls of the latter, is drained from the bottom thereof back into the boiler by passing out through a passage t (Figs. 2, 5 and 6) in the saddle-piece L, and thence through a pipe T within the boiler, being finally discharged into the water therein beneath the water-level. The upper end of the pipe T is screwed into the passage t, and the pipe is provided with elbows so that it is carried to the outer side of the boiler where its discharge end turns downwardly (Fig. 1) in order to discharge the disengaged water into the water in the boiler on the side to which the least heat is applied, and where the downward current is found, whereby the advantage of a suction is gained tending to draw back into the boiler the water from the dome K. The boilers are fed with water from any suitable source through pipes U U (Fig. 2) the ends of which are screwed into bosses on the front of the saddle-pieces L L and communicate with passages u u in the latter, which passages extend backwardly and then downwardly, as shown in Fig. 3. Within the boiler is a pipe U′ provided with bends or elbows of the same shape as the pipe T, the upper end of which is screwed into the passage u and the lower end of which discharges beneath the water line on the outer side of the boiler, as shown in dotted lines on the right hand boiler in Fig. 1. The feed-water is thus directed into the downward current on the side of the boiler to which the least heat is applied.

It will be observed that there is only one hole or opening in the upper part of each boiler, viz, the one which is covered by the saddle-piece L, and that through this one opening the feed-water is introduced into the boiler, the steam is withdrawn from the boiler and the water separated from the steam is conducted back into the boiler. This result is due to the construction of the saddle-piece L with the four openings or passages s s' t and u formed through it.

In the front of each boiler and close to the bottom thereof is formed a man-hole or hand-hole, shown at the right hand in Fig. 1, and lettered O. An opening is cut in the front of the boiler shell of the proper size, and to the front of the boiler over this opening is fastened a man-hole box R, which may be of cast iron, and which has holes in its front and back coinciding, or approximately so, with the opening in the boiler shell. The hand-hole cover is arranged to close the opening in the front of this box so that the interior of the box is in communication with the interior of the boiler shell. Within the boiler is placed a blow-off pipe S which extends longitudinally along the bottom of the boiler and is open on its under side and preferably near the rear end of the boiler. Its front end is screwed into an elbow fastened within the box R, which communicates downwardly through the bottom of the box with a pipe S′ continuing the pipe S, a cock S″ intervening in order to control the blow-off. By this construction the blow-off pipe passes through the man-hole opening in the boiler shell, thereby avoiding the necessity of cutting a separate hole for the blow-off pipe and hence avoiding the weakening of the boiler and liability to leakage incidental to such additional hole.

It is an important advantage of my improved steam generator that each boiler has only two openings into it, one at the top closed by the saddle L and the other at the bottom closed by the box R and its hand-hole cover. All the communication that is necessary to be made with the interior of the boiler is effected through these two openings.

Fig. 10 shows my invention as applied to a single boiler. The furnace is constructed with its fire-bed b to one side, and with its side walls w and w' meeting the shell of the boiler at different distances from the center, so that the direct heat of the furnace is caused to act upon the boiler for a considerable distance on one side, while it is almost entirely cut off therefrom on the other. Thus the water on the latter side is subjected to less heat than on the former, and consequently circulates downwardly, while on the hotter side and between the boiler tubes it is circulating upwardly. The walls w w' are arched in this construction, the wall w extending from the top of the tile h on one side, and taking the place of the tile i in Fig. 1, and the wall w' extending from the top of the tile i on the other side, and terminating at the boiler at a point much higher or farther from the center than the wall w.

I claim as my invention the following defined improvements in steam generators, substantially as hereinafter specified, namely:—

1. The combination with a multi-tubular boiler having its tubes arranged apart from its shell on one side, thereby leaving an unobstructed space for the passage of a downward current of water between the tubes and shell, of a furnace constructed with its fire chamber in communication with the bottom and with more or less of the opposite side of the boiler, and with the side of the boiler which is constructed with said space for downward circulation cut off to greater extent from direct communication with the fire chamber.

2. The combination to form a steam generator of two horizontal boilers arranged side by side and a furnace constructed beneath them with its fire chamber in communication with more or less of the inner or adjacent sides of the boilers but to greater extent cut off from communication with their outer sides, with the fire bed of the furnace of less width than the two boilers, and sloping walls for the sides of the fire chamber extending upwardly and outwardly from the sides of the fire bed and joining the shells of the boilers.

3. The combination to form a steam generator of two horizontal boilers arranged side by side and a furnace beneath them having a fire bed of a width approximately equal to the distance from center to center of the boilers, and with its fire chamber constructed with its side walls sloping upwardly and outwardly from the sides of the fire bed and joining the boilers at the lower outer sides thereof, whereby the direct heat of the fire chamber is in communication with the bottoms and inner sides of the boilers but is cut off from the outer sides thereof.

4. A boiler furnace constructed with sloping side walls and with supporting ledges attached thereto at different levels, and tiles of refractory material resting on said ledges, whereby the lower tiles may be replaced without disturbing the upper ones.

5. A boiler furnace constructed with sloping side walls and with supporting ledges attached thereto and lined with tiles of refractory material resting on said ledges, the lower tiles which come into direct contact with the bed of coals being made of greater thickness than the upper tiles in order to withstand the wear due to the fire tools and clinkers.

6. A boiler furnace constructed with a trough-shaped metal shell supported at its upper edges, whereby its expansion and contraction do not affect its supporting member.

7. The combination with a boiler or boilers and the support thereof, of a boiler furnace constructed with a trough-shaped metal shell hung at its upper edges from said supports, whereby its expansion and contraction do not affect the boiler or its supports.

8. The combination with a steam boiler of a steam dome or separating chamber having invertedly conical sides, a steam pipe for conducting steam from the boiler into the upper part of said separating chamber, a nozzle at the outlet of said pipe, constructed with steam passages discharging tangentially, adapted to impart a centrifugal motion to the steam in said chamber and thereby to throw the particles of water off against the sides of the chamber, whereby they adhere to the latter and flow down to the bottom of the chamber, and a steam outlet pipe taking steam from the upper part of said chamber above said nozzle.

9. The combination with a steam boiler of a steam dome or separating chamber, a steam pipe for conducting steam from the boiler into the separating chamber, a nozzle N fitted to the outlet of said pipe and constructed with steam passages discharging tangentially and downwardly, and a steam outlet pipe P leading from the upper part of said chamber above said nozzle.

10. The combination with a steam boiler having an opening in its top and a steam dome mounted above said opening of a saddle piece fastened over said opening and forming the base to which the dome is secured, constructed with passages through it for establishing communication between the exterior and the interior of the boiler and dome, and pipes joined to said passages.

11. The combination with a steam boiler having an opening in its top, of a saddle piece fastened over said opening and constructed with steam passages through it, and the steam pipe leading from the boiler connected to the steam passage in said saddle-piece.

12. The combination with a steam boiler having an opening in its top of a saddle-piece fastened over said opening and constructed with steam and water passages through it, and the feed water pipe connected to the water-passage in said saddle-piece.

13. The combination with a steam boiler having an opening in its top, and a steam dome arranged above said opening, of a saddle-piece fastened over said opening and forming the base to which the dome is secured, constructed with steam passages s and s', the former opening into the boiler and having a steam pipe connected to it and projecting upward in the dome, and the latter opening into the dome and laterally to the exterior of the saddle piece, and having a steam pipe leading from the top of the dome and connected to its upper side and an external steam pipe connected to its lateral branch.

14. The combination with a steam boiler having an opening in its top, and a steam dome arranged above said opening, of a saddle piece fastened over said opening and forming the base to which the dome is secured, constructed with a water passage u opening downwardly into the boiler and laterally to the exterior of the saddle piece, with a feed pipe U connected to the exterior opening of said passage and a pipe U′ within the boiler connected at its upper end to the downward branch of said passage and having its lower end immersed in the water in the boiler.

15. The combination with a boiler and its

furnace constructed to impart more heat to one portion of the boiler shell than to another and thereby to create a downward current of water at the side receiving the least heat, of a feed pipe entering the boiler and terminating beneath the water level at the portion of the boiler in which said downward current exists, whereby it is adapted to discharge the feed water into the downward current.

16. A boiler-shell constructed with an opening at or near its bottom, a man-hole box constructed with front and rear openings coinciding with said opening and fastened to the boiler shell over said opening, a man-hole cover fastened into the front opening in said box, and a blow-off pipe leading from the interior of the shell and passing out through said opening and through the side of said box.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

RALPH G. PACKARD.

Witnesses:
WM. P. BARSTOW,
JOHN F. CLARKE.