

April 1, 1924.

1,488,531

H. CRUSE

STEAM GENERATOR

Filed May 23, 1921 2 Sheets-Sheet 1

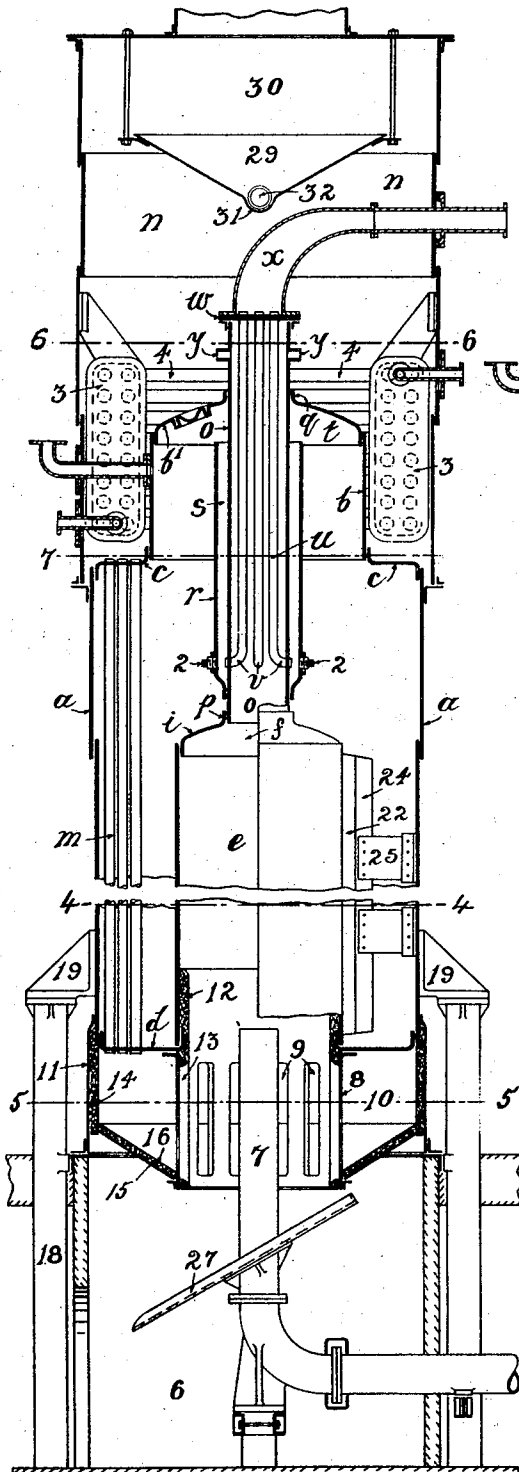


Fig. 2.

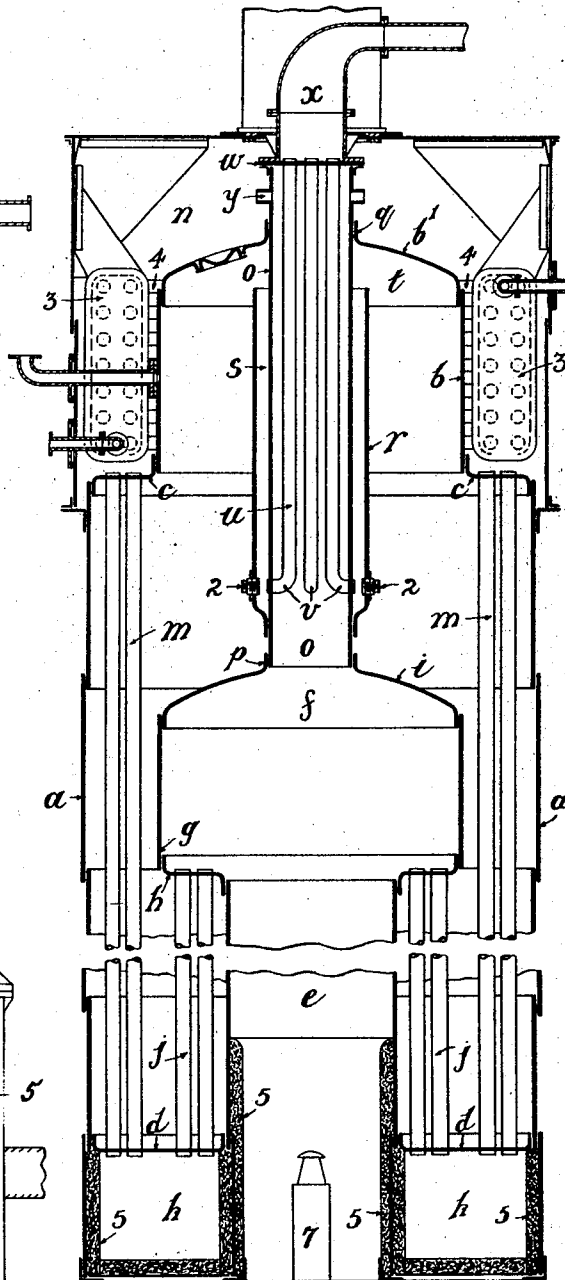


Fig. 1.

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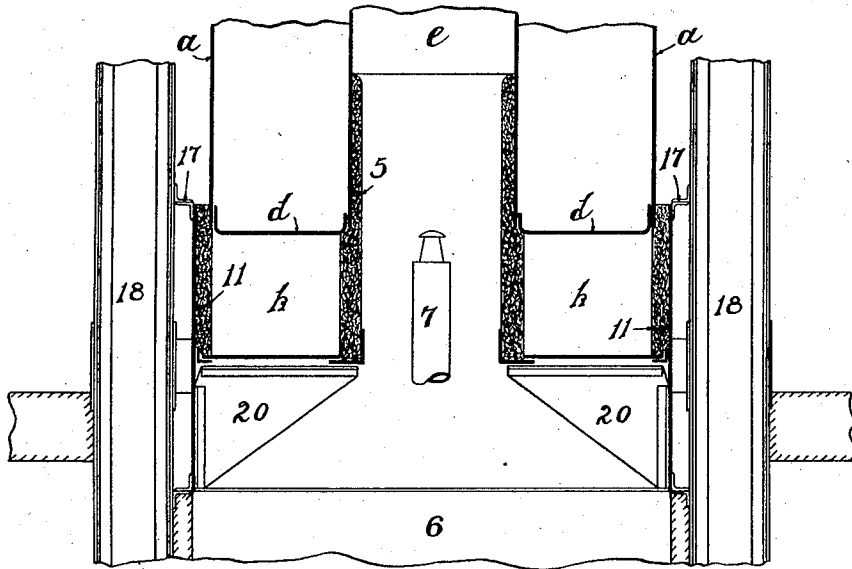
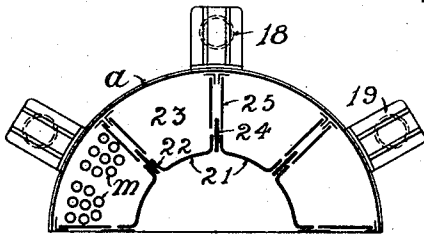
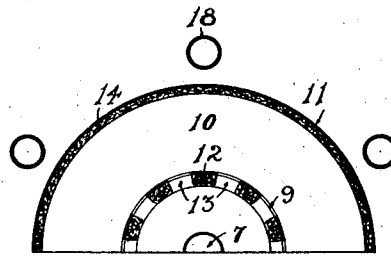
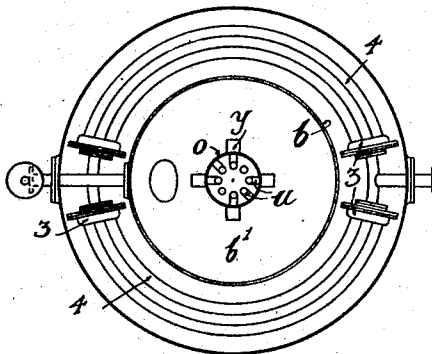
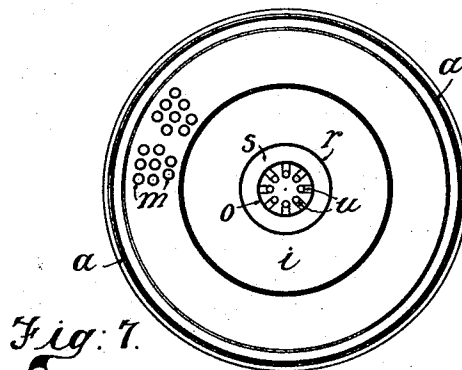
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STEAM GENERATOR

Filed May 23 . 1921 2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE.

HENRY CRUSE, OF MANCHESTER, ENGLAND.

STEAM GENERATOR.

Application filed May 23, 1921. Serial No. 471,941.

To all whom it may concern:

Be it known that I, HENRY CRUSE, subject of the King of Great Britain and Ireland, and resident of Manchester, in the county of Lancaster, England, have invented a new or Improved Steam Generator, of which the following is a specification.

This invention relates to a new or improved steam generator especially adapted to be fired by oil, gas, pulverized fuel and the like.

My invention comprises in its simplest elements a vertical outer cylindrical shell terminating in a dome at its upper end, tube plates or rings near the base of the shell and at the base of the dome, fire or gas tubes connecting the tube plates or rings, an inner cylindrical shell or combustion chamber concentric or eccentric to the outer shell of the boiler, the lower end of which is connected to the lower tube plate or ring whilst its upper end terminates in a dome of larger than, or of the same diameter as, the inner shell, such dome being located well below the normal water level of the boiler and suitably connected at the base with the top of the furnace flue or inner shell, fire or gas tubes connecting the combustion chamber dome to the lower tube plate or ring, and fire or gas tubes connecting the latter to the upper end of the generator, suitable flues for guiding the products of combustion in their passage from the combustion chamber through the fire and gas tubes of the boiler; improvements in the construction of the outer shell of the boiler; means to allow the heated gases—and particularly those resulting from the burning of pulverized or atomized fuel—to pass from the lower end of the combustion chamber into an annular flue and thence up the fire or gas tubes within the outer shell of the boiler to the smoke chamber of the latter; a vertical tuyère burner or atomizer for the fuel within the combustion chamber at its lower end or a tuyère or burner arranged in any other suitable way for efficiently controlling and directing the fuel to be burned; improvements in the arrangement of the lower end of the boiler shell and combustion chamber, respectively; means for receiving and discharging ash, dust or the like and slag or carbon from the combustion chamber; an improved form of combustion chamber including means for staying it to the outer shell of the boiler; an

ash and soot-catching device arranged at the upper end of the smoke chamber and the combination with the combustion chamber and steam and water space of the generator of an anti-priming device or steam dryer or superheater situate in the steam chamber, and, or in a portion of the water area of the boiler, whereby the steam is dried or superheated on its passage from the steam area of the boiler by means of a portion of the gases of combustion drawn from the combustion dome and travelling through and beyond the steam dome into the smoke chamber, or smoke stack.

My invention will be fully described with reference to the accompanying drawings in which—

Fig. 1, is a vertical section of a boiler arranged in accordance with my invention,

Fig. 2, vertical section of a boiler of modified construction, showing the fuel burner and means for collecting and conveying away the ash and soot from the smoke box.

Fig. 3, vertical section to an enlarged scale of the lower portion of the boiler showing another modification of the tuyère chamber and flue.

Fig. 4, half sectional plan of boiler on line 4—4 of Fig. 2.

Fig. 5, half sectional plan of boiler on line 5—5 of Fig. 2.

Fig. 6, sectional plan of feed water heater on line 6—6 of Fig. 2, and

Fig. 7, sectional plan of boiler on line 7—7 of Fig. 2.

In all the foregoing figures like parts are indicated by the same reference characters.

In accordance with the form of my invention, shown in Fig. 1, I construct the boiler as follows:—

The shell *a* of the boiler is vertical and cylindrical. The boiler top is formed of a cylindrical steam dome *b* of suitable shape, connected at its base to the shell *a* by means of a pressed or wrought steel annular ring *c*, or rings, or tube plate or plates. The bottom of the boiler is formed of a pressed or wrought steel annular ring *d*, or rings, or a tube plate or plates, the outermost flange of the ring being connected to the outer shell *a* and the innermost flange being connected to the bottom end of the furnace or fire flue or combustion chamber *e*.

At the top the combustion chamber is crowned by a cylindrical dome or combus-

tion chamber *f* of suitable shape, the base *g* of which is attached to the combustion chamber *e* by a pressed or wrought steel annular ring or rings or a tube plate *h*, or plates. The crown *i* of the dome is well below the water level of the boiler. Fire or gas tubes *j* are suitably fitted at one end into the ring or rings or tube plate *h*, or plates, at the top of the furnace or fire flue, and at the other end into the inner ring or rings or tube plate *d* or plates, forming part of the bottom of the boiler, the tubes *j* connecting these top and bottom tube plates together, and also they connect the combustion chamber or dome *f* to the flue *k* beneath the boiler. Fire or gas tubes *m* are, in similar manner, fitted to connect together the outer annular top and bottom rings or tube plates *c* and *d*, and also the flue *k*, beneath the boiler to the smoke chamber *n* above the boiler.

An anti-priming and steam drying or superheating device is provided in the following manner:—

A fire tube *o* of sufficient diameter rises from the dome *f* of the combustion chamber *e* with which it is suitably connected at *p*,—to the steam dome *b*, to the crown *b*¹ of which latter it is conveniently attached at *q*. It is shrouded or encased by a tube *r* of larger diameter to form an annulus *s* for steam around it for a suitable portion of its length, the top of the encasing tube *r* being open to the steam space *t* of the boiler. Steam tubes *u* are placed inside the fire tube *o*, the inlet ends *v* of which are expanded into its shell, thus opening into the annulus. These steam tubes are expanded at the top into a tube plate *w* to which is secured the steam discharge pipe *x*. The gases from the fire tube *o* gain egress to the smoke chamber *n* through suitable openings *y* in the tube *o*.

Removable screwed plugs 2, are secured in the tube *r* opposite the inlet ends of the steam tubes *u*.

The smoke chamber *n* is arranged around and above the top of the boiler where the gases assemble and travel to the chimney above. In this smoke chamber are, or may be, arranged a suitable feed water heater 3 and (or) a superheater, either or both preferably formed of rings 4, or their equivalent of steel tubing.

The bottom shell ring of the boiler is prolonged for a suitable distance and lined with refractory material 5 to form a chamber or flue *k* for the passage of the downward gases from the combustion chamber through the inner ring or rings of tubes to the outer ring or rings of tubes, which lead to the smoke chamber *n* above the boiler.

Beneath the lower end of the boiler is a chamber 6 Figs. 2 and 3 in which is placed the means for supplying the fuel to the burner or tuyère 7.

In the boiler as described the fuel from the burner or tuyère 7 is projected upwards through the lower combustion chamber into the combustion dome, so heating them, the heated gases thence passing down the first series of fire tubes nearest the combustion chamber to the flue beneath the boiler and thence up the outer series of fire tubes to the smoke chamber above the boiler, thus heating the tubes and in conjunction with the heated shell of the combustion chamber and combustion dome imparting such heat to the water in the boiler and securing a high evaporative efficiency. Part of the furnace gases pass through the fire tube rising centrally from the combustion dome so imparting heat to the tube and to the steam tubes within it. The generated steam passes from the steam space of the boiler down the annulus between the fire tube and its encasing tube, and thence along the steam tubes or coils within the fire tube to the steam discharge pipe and in this way becomes dried and superheated. Again, the main furnace gases on their exit from the boiler impinge directly on the tubes of the feed water heater so heating the water circulating through them.

In the construction of boiler already described the main furnace gases pass from the combustion dome downwardly through fire tubes in the water space of the boiler outside the lower combustion or furnace chamber, thence into an annular flue and up another series of fire tubes to the smoke chamber. In Fig. 2 and Figs. 4 to 7 I have shown a boiler more particularly designed for using pulverized or atomized fuel in which the heated gases due to its combustion are projected upward and centrally of the furnace or combustion chamber and thence in an enveloping stream downwardly to the lower end of the chamber into an annular flue at the base of the boiler and finally in an upward direction through fire tubes within the boiler shell to the smoke box as before, part of the gases also passing through a central fire tube forming part of the superheater as before.

In this modified construction the combustion chamber *e* is made cylindrical for the whole of its length and is fitted at its upper end with a dome *f* of substantially the same diameter. The lower end of the shell *e* of the combustion chamber may likewise be extended below the tube plate *d* or plates, or preferably by an attached extension 8 located between itself and the outer shell *a* of the boiler, such extension being provided with a number of passages 9 through which the heated gases on their downward return flow can pass into an annular flue 10 located between such extension and a downward and preferably attached extension 11 of the outer shell *a* of the boiler to correspond

therewith, so that the gases may pass upwardly through the fire tubes *m* within the boiler shell *a* as previously described. The lower part of the combustion chamber is lined internally with refractory material 12 which extends from the lower end of the chamber upwardly for a suitable distance above the level of the tube plate *d*. This refractory lining is conveniently supported and is likewise provided with passages 13 for the heated gases corresponding to passages 9 in the extended lower portion 8 of the combustion chamber *e*. The inner surface of the boiler shell, or its attached extension 11, below the tube plate *d* to its extreme lower end is likewise lined with refractory material 14. In addition, the base 15 of the outer extension 11 may be made conical and in fixed or removable sections in order that ash, slag or carbon may easily flow or fall down towards the axial centre of the lower end of the combustion chamber *e*. This conical portion is also lined with refractory material 16. I prefer to make the two extensions 8 and 11 detachable from their respective shells *a* and *e* so as to enable them to be replaced when required without interfering with the lower end of the boiler shell and the lower end of the combustion chamber. The arrangement also enables the extensions to be made from plates of thinner material. Both extensions may be suitably connected to each other and be independently supported without being connected to the boiler and combustion chamber shells. Such an independently supported arrangement is shown in Fig. 3, wherein the outer extension 11 is supported by angle rings 17 fixed to standards 18 by which the whole boiler structure is supported from brackets 19 studded to the shell *a*. The base of the annular flue and likewise the inner extension 8 is carried by brackets 20 from the outer extension 11.

In Fig. 2 and Figs. 4 to 7 the detail construction of the combustion chamber is of novel form, consisting in constructing it of vertical segmental plates 21 each flanged outwardly at 22 within the annulus 23 between the combustion chamber *e* and the boiler shell *a*, caulking strips 24 being located between the flanges so as to constitute vertical Adamson flanges. The caulking strips 24 are sufficiently wide to extend beyond the outer edges of the flanges 22 of the segmental plates 21 to allow such strips to form part of the means for staying the boiler and combustion chamber shells *a* and *e* radially together. This is done by securing to the strips 24 the inner ends of stays 25, the outer ends of which are, in turn, suitably attached to the inner surface of the boiler shell *a*.

The bottom tube plate of the combustion chamber may be made in segments secured

together instead of being a complete single unit. Also the segmental plates 21 may be plain as shown or be vertically-corrugated and in either case be formed with T-pieces to which the stays 25 are connected.

Located within the lower end of the combustion chamber *e* is a vertical tuyère burner or atomizer 7 for directing the flow of the fuel to be burned in a central vertical stream, though I would have it understood that any other suitable arrangement of tuyère or equivalent device may be employed to direct the fuel as required. In any case the arrangement of the tuyère, combustion chamber and annular flue is such that the heated or burning products of combustion rise up the centre of the combustion chamber, towards or against the under surface of the dome at the top of the latter and thence flow downward enveloping the central upward stream and along the shell of the combustion chamber through the perforations near the base of the latter into the annular flue and then upwardly through the outer series of fire tubes within the outer shell of the boiler into the smoke chamber. There is thus obtained most efficient combustion and distribution of the heat without any possibility of short-circuiting the heated gases at the upper or lower ends of the combustion chamber.

The means for receiving and discharging ash, dust or the like, carbon and slag are shown in Fig. 2 and consist in the employment of an inclined tray 27 located below the aforesaid extension from the boiler and combustion chamber shells. Such tray may be supported from the tuyère or burner 7 as shown or may be otherwise supported within the tuyère chamber 6 below the extensions.

The ash and soot catching device is shown in Fig. 2, and comprises a suitably shaped tray 29 located within the upper end of the smoke chamber *n* and suitably supported therefrom. This tray is conveniently arranged in the smoke chamber in such shape and position that the gases from the boiler will expand in the space 30 above the tray and thus release the solid matters in suspension which then fall into the tray. The shape of the tray is such that the ash and soot falls towards its lowest point 31 which is provided with a convenient form of conveyor 32 or equivalent device by which the deposited material may be continuously or intermittently removed.

The form of superheater device hereinbefore described may be constructed in accordance with the modifications described in my application for patent filed on May 23, 1921, Serial Number 471,940.

The boilers hereinbefore described are erected on suitable foundations in which are arranged the gas flues, flues for the appara-

tus supplying the fuel, a furnace chamber, and also flues for the examination of the boiler and for cleaning and other purposes. They are also provided with all necessary manholes and doors, gauges, valves and other fittings.

What I claim as my invention and desire to secure by Letters Patent is:—

1. In a steam generator, a boiler shell, a combustion chamber arranged in the lower part of the shell, an annular fire flue arranged below the boiler shell, a smoke chamber arranged above the boiler shell, a vertical fire tube having its lower end secured to the top of the combustion chamber and its upper end portion projecting above the top of the boiler shell and provided with an outlet for a portion of the products of combustion which communicates with the said smoke chamber, a fuel supply pipe projecting centrally of the combustion chamber, means for conducting a portion of the products of combustion from the combustion chamber into the said annular fire flue, and smoke outlet tubes which connect the said annular fire flue with the said smoke chamber.

2. The combination, with a steam generator as set forth in claim 1, of a steam dome secured to the boiler shell and forming an annular space in the said smoke chamber directly over the said smoke outlet tubes, and a feed water heater arranged in the said annular space.

3. In a steam generator, a boiler shell, a combustion chamber arranged in the lower

part of the shell, an annular fire flue arranged below the boiler shell and provided with passages which connect it directly with the lower part of the combustion chamber, a vertical fire tube having its lower end secured to the top of the combustion chamber and its upper end portion projecting above the top of the boiler shell and provided with an outlet for a portion of the products of combustion, a fuel supply pipe projecting centrally of the combustion chamber, and smoke outlet tubes secured between the said annular fire flue and the top of the boiler shell.

4. The combination, with a steam generator as set forth in claim 3, of means for supporting the boiler shell secured directly to the boiler shell, and separate means for supporting the annular fire flue independently of its attachment to the boiler shell.

5. The combination, with a steam generator as set forth in claim 3, of an inclined tray for receiving the ashes secured to the said fuel supply pipe and arranged below the said combustion chamber.

6. A steam generator as set forth in claim 3, in which the main portion of the said combustion chamber is formed of a series of vertical segmental plates secured together by outwardly projecting flanges, and stays secured between the said flanges and the boiler shell.

In testimony whereof I have hereunto set my hand.

HENRY CRUSE.