C. S. DRUMMOND.

STEAM GENERATOR.

APPLICATION FILED JUNE 3, 1910.

1,008,797.

Patented Nov. 14, 1911.

2 SHEETS—SHEET 1.

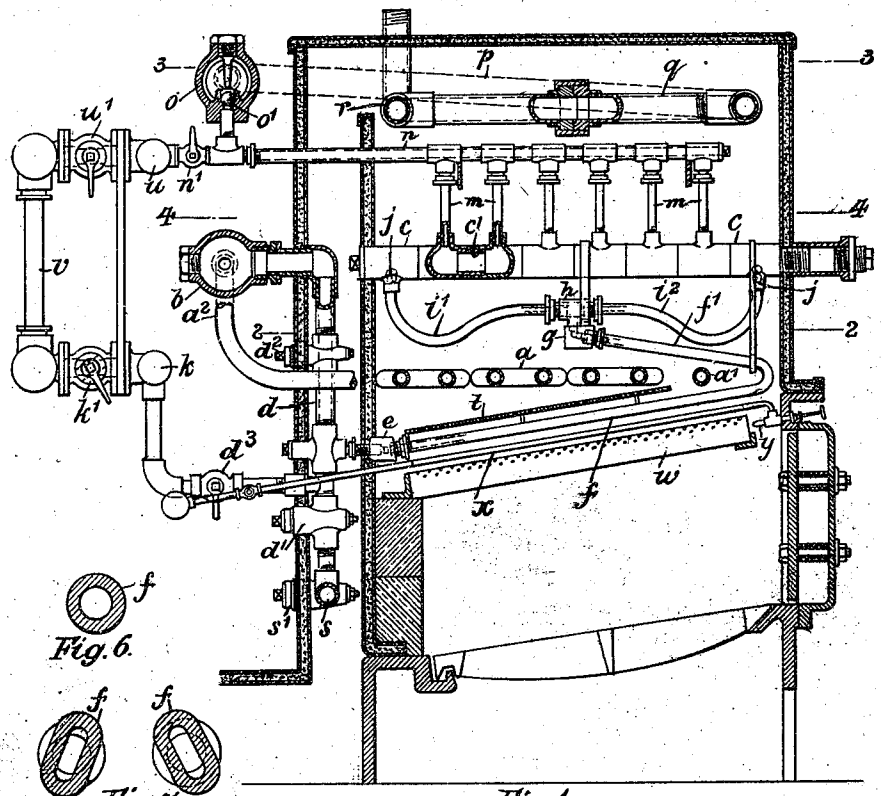

Fig. 1.

Fig. 6.

Fig. 7.

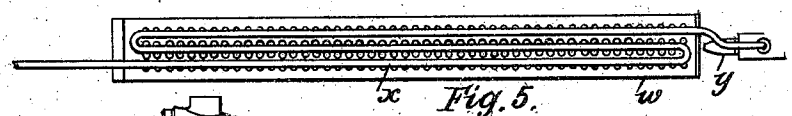

Fig. 5.

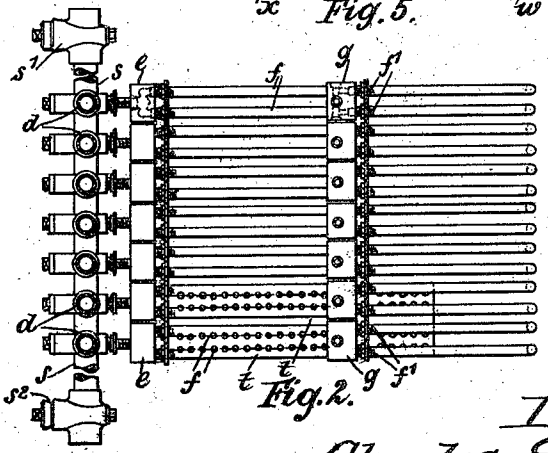

Fig. 2.

Attest.

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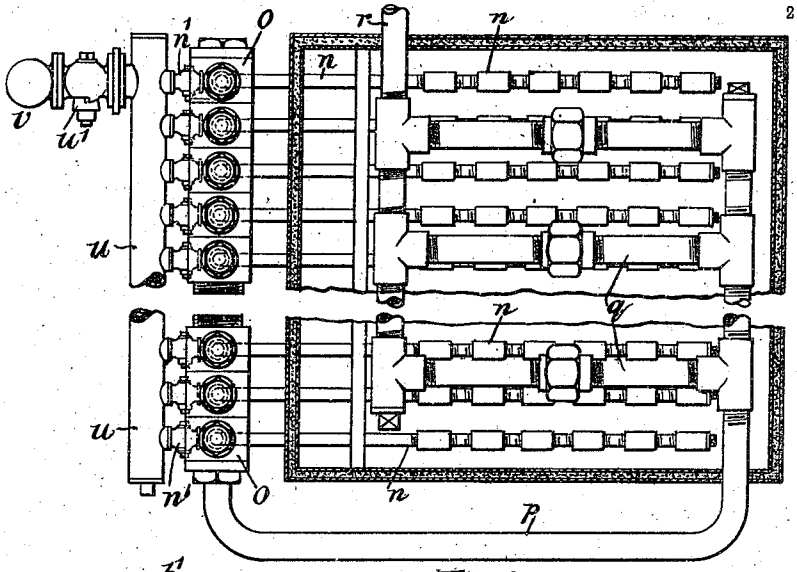

Fig. 3.

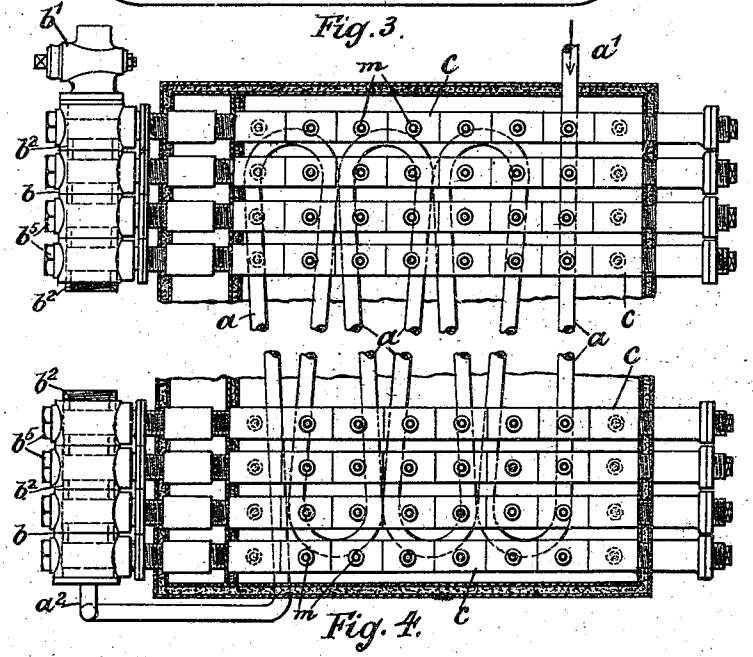

Fig. 4.

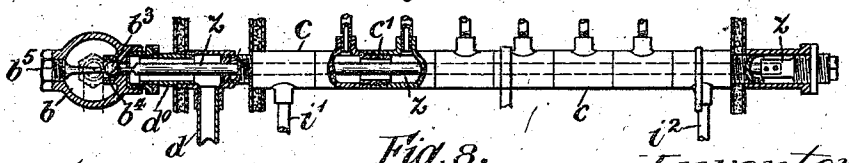

Fig. 8.

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UNITED STATES PATENT OFFICE.

CHARLES SINCLAIR DRUMMOND, OF LONDON, ENGLAND.

STEAM-GENERATOR.

1,008,797. Specification of Letters Patent. Patented Nov. 14, 1911.

Application filed June 3, 1910. Serial No. 564,779.

To all whom it may concern:

Be it known that I, CHARLES SINCLAIR DRUMMOND, subject of the King of Great Britain, residing at 87-89 Aldgate, London, England, have invented new and useful Improvements in Steam-Generators, of which the following is a specification.

This invention relates to a tubulous steam generator which embodies new features and new combinations of features whereby an extremely high rate of heat transmission to the water is obtained under conditions which provide great safety and durability.

According to this invention, the tubes exposed to the direct heat of the fire are of small bore and formed with thick walls, the section of the metal of the tubes being for example about three times that of the bore. These tubes are fed with water at their lower ends, and at their upper ends constricted passages are provided for the escape of the heated fluid to the steam space of the boiler, the resistance to escape being such that the water in the thick tubes, directly exposed to the fire, is under considerable super-pressure and attains a corresponding super-heat, the formation of steam being suppressed until the water escapes through the constricted passages. The very high rate of heat transmission which results from the employment of such an arrangement and proportions is partly due to the nature and arrangement of the heat supply which consists of highly superheated vapor. The high temperature of the source of heat in conjunction with the exceptionally high temperature of the exterior surface of the metal of the tubes is such as to preclude dissociation of the vapor and deposition of carbon or solid compounds thereof on the outside of the tubes, permitting the tubes to be completely immersed in the flames of superheated vapor without interfering with its complete combustion. The heat thus received at a very rapid rate is conducted partly in a radial direction and partly along the wall of the tube to the inner surface thereof, causing the upper portion of the inner surface to be as well supplied with heat as the lower portion. This, coupled with the suppression of steam generation within the tube, will enable the water flowing therein to absorb heat at an unprecedented rate.

The use of thick-walled tubes in so-called flash boilers, is well known, but in such boilers the function of the thick wall is to serve as a reservoir of heat, as a substitute for a reservoir of steam and a reservoir of heat of a mass of boiling water which is provided in other boilers.

The function of the thick wall in the tubes of the boiler of the present invention is to enable a tube of relatively small external diameter to absorb a quantity of heat which is greatly in excess of that which has hitherto been possible, the heat being conducted through the body of the wall equally to all portions of the internal surface of the tube.

When the highly superheated water escapes through the constricted passages into the steam space under the influence of the considerable super-pressure, steam is generated at the expense of the superheat as the pressure becomes relaxed and the energy of expansion due to the fall from the super-pressure, breaks up the stream of unevaporated water and causes it to attain a very high velocity and become pulverized to a very fine state of division, the particles being suspended in an atmosphere of steam. The very fine spray will impinge with considerable velocity on the higher situated tubular heating surfaces, and by maintaining them in a wet condition, raise the rate of heat transmission much above that which is normally attainable. So much energy will be available from the descent from the super-pressure that the agitation will continue after the evaporation has been completed, and thus the superheating of the steam will be promoted.

The invention above described may be embodied in a tubulous boiler constructed as will be described with reference to the accompanying drawings, in which:—

Figure 1 is a side sectional elevation. Fig. 2 is a part sectional plan, taken along the line 2—2, the feed heating coils being omitted. Fig. 3 is a part sectional plan, taken along the line 3—3 of Fig. 1. Fig. 4 is a part sectional plan, taken along the line 4—4 of Fig. 1. Fig. 5 is a plan on an enlarged scale of one of a plurality of burners of gaseous fuel, and Figs. 6 and 7 show representative sections of the thick walled tubes which are exposed to the direct heat of the fire. Fig. 8 shows a modification of the water feed.

In these figures, *a* is a feed-heating coil

formed with a plurality of loops. To this coil the water is admitted at a^1 and after a series of excursions across the furnace, the partially heated water is delivered at a^2 to a tube b of relatively large diameter, outside the furnace, wherein any precipitate which may have been formed by the heating of the water will have an opportunity of becoming deposited, such deposit being at intervals evacuated through the blow-off cock b^1. The tube b is shown built up of a number of short sections united by nipple tubes b^2 but it may be formed integrally. From the tube b, which is common to a plurality of like sections of which the boiler is composed, a downtake pipe d leads to a junction-piece e so formed as to receive, in a fluid-tight manner, the ends of two bent thick-walled tubes f the ends of the upper branches of which are secured to a junction-piece g. To this is secured a T shaped connection h from which tubes i^1 i^2 curved to allow for expansion lead in opposite directions to the ends of a tube c which is built up of sections connected by nipples c^1 according to the method of construction of the tube b previously described. The exit of the fluid from the tubes i^1 i^2 into c is commanded by non-return valves j j. From c the fluid, which will consist of atomized water suspended in an atmosphere of steam, will flow upward through short tubes m to a composite horizontal tube n during which the suspended atomized water will be converted into steam and flow past a non-return valve o^1 into a tube o which is common to all the sections of the boiler. The tube o is also shown as built up of sections though, being outside the furnace, it may be integrally made. From the tube o the steam, assembled from all the sections of the boiler, is led through the pipe p to flow in parallel through the tubes q q of the super-heating portion of the steam generator to the pipe r whereby it is conducted away for useful service. The several down-take pipes d, each being provided with a blow-off cock d^1, are, beyond the blow-off cocks, interconnected by a pipe s, having at one end a blow-off cock s^1 and at the other end a cock s^2 through which, under special circumstance of emergency, feed water can be admitted from the feed-pump. Perforated baffle-plates t, as shown in Figs. 1 and 2 may be fitted to hinder the upward flow of the products of combustion and distribute them among the heat receiving tubes.

The rate of feed to the several sections of the steam generator is controlled by means of turn-cocks d^2 and, by the aid of a single glass-gage, means are provided for ascertaining the level of the water in each of the several sections of the boiler. For this purpose, in each section of the boiler, a pipe leads from the down-take pipe d past a stop-cock d^3 to a tube k common to all the sections of the boiler. Correspondingly, in each section of the boiler the tube n is continued past a stop-cock n^1 to a tube u common to all the sections of the boiler. The tubes k and u are, near one end, connected by a glass-gage v, cocks k^1 and u^1 respectively being interposed in order to control the fluid. By such means, if the stop-cocks d^3 and n^1 of any section are opened and those of the other sections closed, the level of the water in the open section will be indicated by the water level in the glass-gage, and by appropriate adjustment of the feed cocks d^2, the water in all the sections of the boiler can be regulated to a uniform level.

The junction-piece g, to which two tubes f^1 are connected, has only one branch of small section in the stem of the T piece h whereby the superheated fluid can flow to the tubes i^1 i^2. From this constricted section the fluid escapes in equal quantities in opposite directions, and after passing the non-return valves j j the streams are reversed in direction and meet one another with a violent eddying motion within the tube c. The non-return valves j j will serve to prevent the back flow of steam into the tubes i^1 i^2 f^1 in the event of excess pressure in any one of the sections.

Fig. 6 shows a section of a cylindrical thick-walled tube of small bore of which the proportions are such that the character and rate of heat transmission will be that above described. A tube with a bore of one-quarter of an inch diameter and a wall one eighth of an inch thick for example, will effect the desired purpose.

Fig. 7 shows a tube of modified section in which the thickness of the wall is the same as in Fig. 6, and also the sectional area of the bore, moreover the dimension, in plan, of the tube is equal to that of the round tube in Fig. 6, thereby leaving the like width of air spaces between the tubes. The tube of Fig. 7 will be derived by taking a round tube of larger bore and flattening it as shown, the ends of the tubes where connection with the junction pieces is effected being left round.

The burner w is fed with combustible fluid as follows:—Liquid fuel, under a considerable air pressure, is supplied to an upward sloping pipe x of small bore situated above the flames of the burner, the pipe is continued downward and again upward, requiring the fluid to undergo a triple excursion exposed to the heat of the flames of the burner. It then escapes at a very high velocity through the adjustable nozzle y into the interior of the burner w entraining therewith a quantity of air. The upward slope of the pipe x permits of a relatively large surface of liquid from which evaporation takes place with a minimum degree of disturbance of the liquid. Thus little or no

suspended liquid will be conveyed with the vapor through the other branches of the pipe with the result that the fluid will escape through the nozzle y as highly superheated vapor and the temperature of the products of combustion which issue through the apertures of the burner coupled with the relatively high temperature of the outer surfaces of the thick walls of the tubes f will prevent the deposition of soot on the tubes. Instead of there being three excursions of the combustible fluid through the flames of the burner, the number may be more or less, to correspond with the less or greater volatility of the liquid fuel which is supplied.

In Fig. 8 is shown an automatic regulator of the feed-water which may be employed as an alternative to the hand-regulation method of distributing the feed-water among the several sections of the boiler or as an addition thereto. This operates by means of a thermostat which consists of a rod z extending along the axis of the tube c and composed of a metal which has a higher co-efficient of expansion than that of the metal of the tube c. This rod extends from the tube c nearly to the tube b being thereat inclosed within a branch d^o of the down-take pipe d. The passage between b and d^o is commanded by a ball-valve of which b^3 is the seating and b^4 the valve, the water-pressure of the feed-pump tending to close the valve and the rod z, when sufficiently elongated by heat, forcing the valve to open and admit water to the said section. The valve is confined by the extremity of the stem of a removable plug b^5. The axis of the tube c and contained rod z is situated at about the normal level of the water in the boiler when quiescent. One end of the rod z is secured to a socket z^1 at the front of the boiler whereby the action of the thermostat can be adjusted.

I claim:

1. In a tubulous steam generator, means for suppressing the generation of steam in the tubes exposed to the radiant heat of the fire and for superheating the water flowing therein, comprising a constricted sectional area of escape from the said tubes at the upper ends thereof.

2. In a tubulous steam generator, means for suppressing the generation of steam in the tubes exposed to the radiant heat of the fire and for superheating the water flowing therein, comprising a constricted sectional area of escape from the said tubes at the upper ends thereof, the said tubes having such a transverse section that, that of the wall exceeds that of the water space thereof.

3. A steam generator consisting of a plurality of sections of which each comprises a tube of small bore having a relatively thick wall which is exposed to the direct heat of the fire, a tube of larger bore situated away from the direct heat of the fire and a constricted passage connecting the said tubes, combined with means for supplying water to the lower end of the thick-walled tube at such a rate that the generation of steam within that tube is suppressed by the super-elevation of pressure therein.

4. A steam generator consisting of a plurality of sections of which each comprises a tube of small bore having a relatively thick wall which is exposed to the direct heat of the fire, and a tube of larger bore situated away from the direct heat of the fire, a constricted passage connecting the said tubes and a non-return valve situated beyond the constriction, combined with means for supplying water to the lower end of the thick-walled tube at such a rate that the generation of steam within that tube is suppressed by the super-elevation of pressure therein.

5. A steam generator consisting of a plurality of sections of which each comprises a tube of small bore having a relatively thick wall which is exposed to the direct heat of the fire, a tube of larger bore situated away from the direct heat of the fire, and a constricted passage connecting the said tubes, combined with means for supplying water to the lower end of the thick-walled tube at such a rate that the generation of steam within that tube is suppressed by the super-elevation of pressure therein, and with means for individually regulating the supply to each section of the boiler.

6. A steam generator consisting of a plurality of sections of which each comprises a tube of small bore having a relatively thick wall which is exposed to the direct heat of the fire, a tube of larger bore situated away from the direct heat of the fire and a constricted passage connecting the said tubes, combined with means for supplying water to the lower end of the thick-walled tube at such a rate that the generation of steam within that tube is suppressed by the super-elevation of pressure therein, means for individually regulating the supply to each section and with means for observing the water level in each section of the boiler.

7. A steam generator consisting of a plurality of sections of which each comprises a tube of small bore having a relatively thick wall which is exposed to the direct heat of the fire, a tube of larger bore situated away from the direct heat of the fire, and a constricted passage connecting the said tubes, combined with means for supplying water to the lower end of the thick-walled tube at such a rate that the generation of steam within that tube is suppressed by the super-elevation of pressure therein, means for individually regulating the sup-

ply to each section and a gage-glass common to all the sections of the boiler for observing the water-level in any one section.

8. A steam generator comprising a feed-pipe which traverses the furnace a plurality of times, a tubular chamber outside the furnace to which the pre-heated water is conducted, and a plurality of tubular sections each connected with the said chamber by a passage of controllable section through which the fluid flows in parallel without intermixing until it reaches the condition of steam, said tubular sections consisting, in the portion exposed to the direct heat of the fire, of tubes of small bore and thick walls and having such constrictions at the upper ends of such portions as to suppress the generation of steam by a super-elevation of pressure.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CHARLES SINCLAIR DRUMMOND.

Witnesses:
H. W. WAGHORN,
H. D. JAMESON.