E. DE STRENS.

STEAM BOILER.

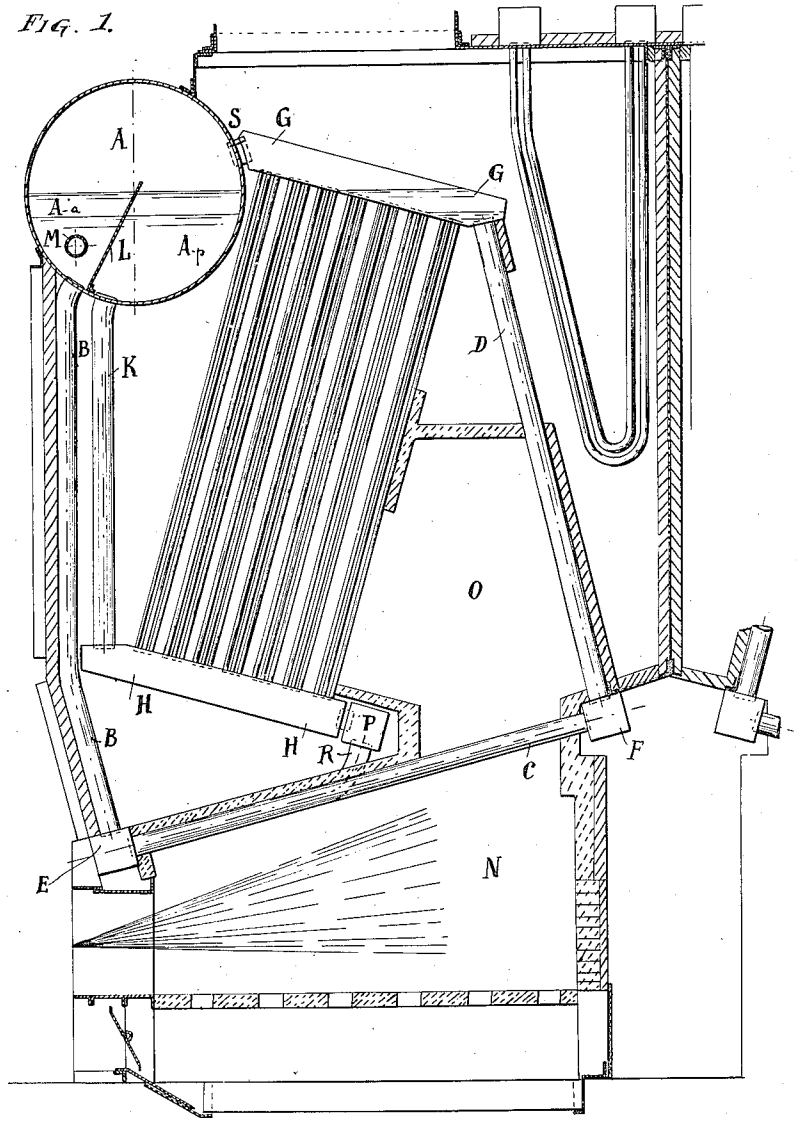
APPLICATION FILED MAR. 10, 1914.

1,268,549.

Patented June 4, 1918.

5 SHEETS—SHEET 1.

FIG. 1.



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5 SHEETS—SHEET 2.

FIG. 10

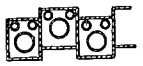
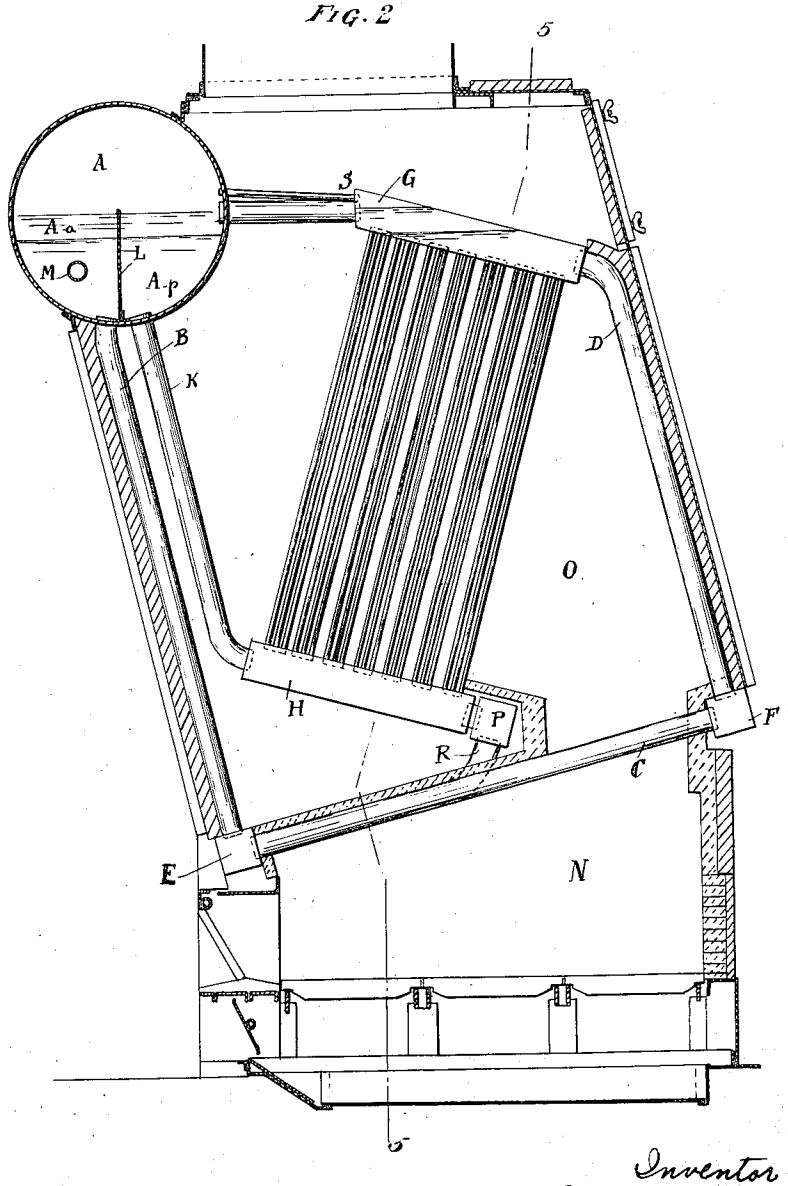


FIG. 2



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5 SHEETS—SHEET 3.

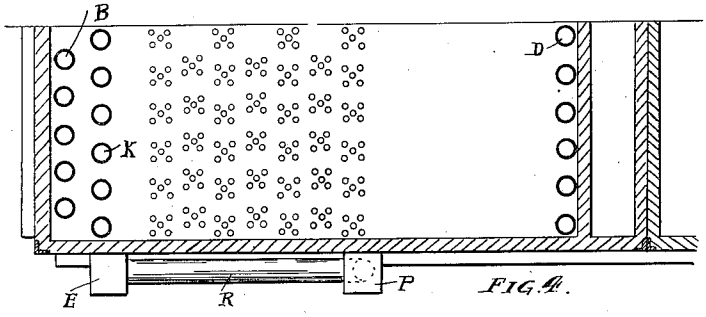
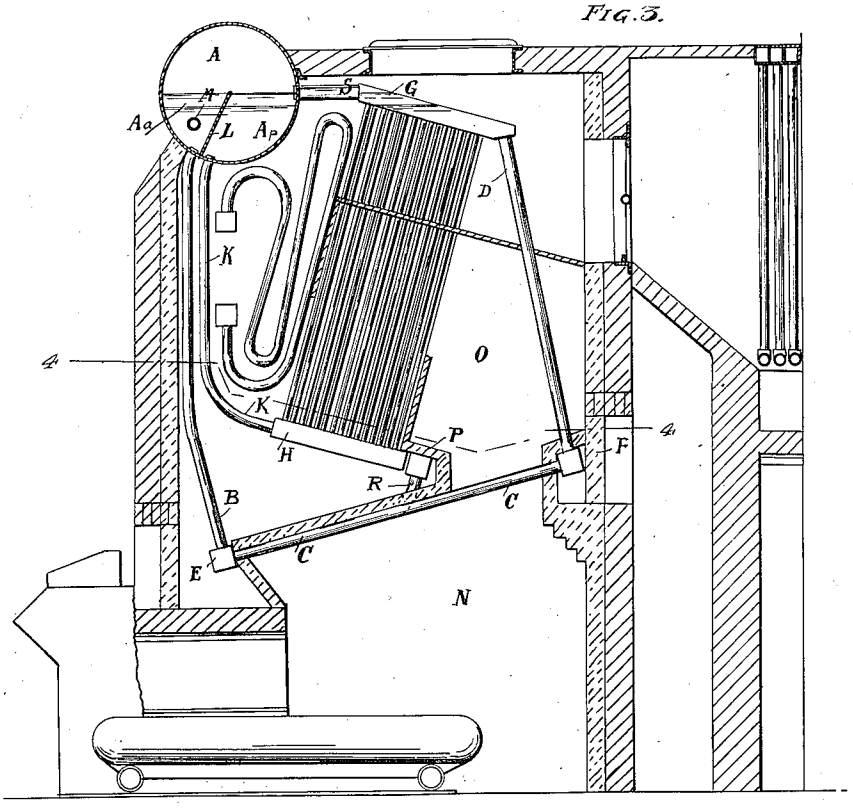


FIG. 4.

FIG. 3.



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5 SHEETS—SHEET 4.

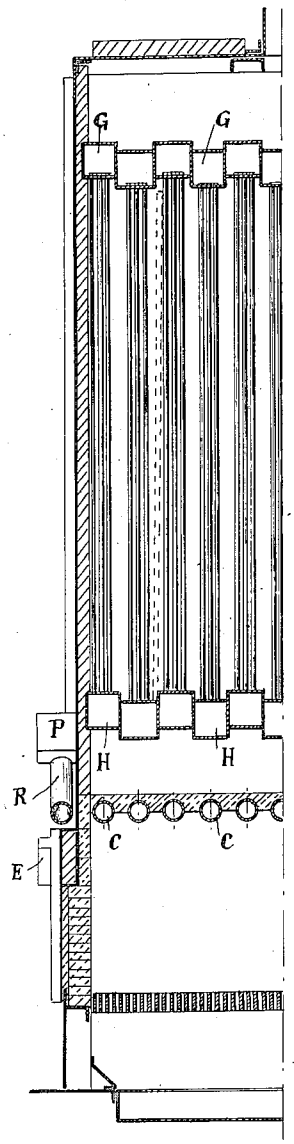

FIG. 5

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5 SHEETS—SHEET 5.

FIG. 8.

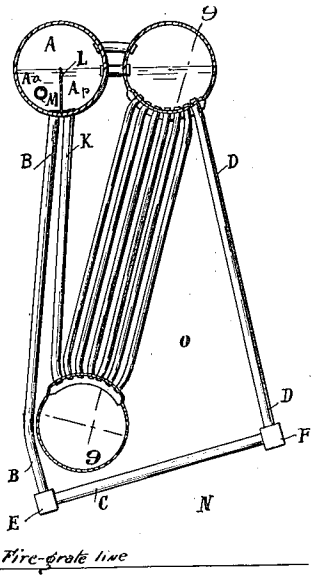
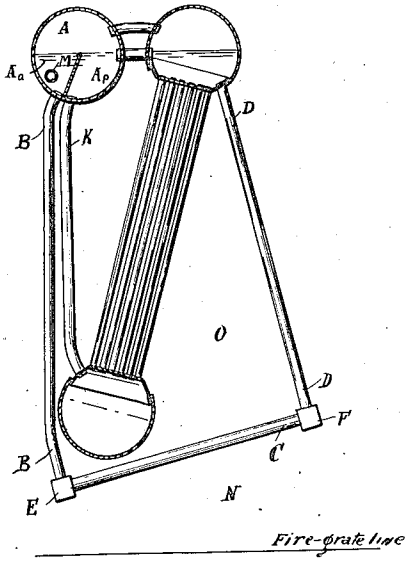


FIG. 7.



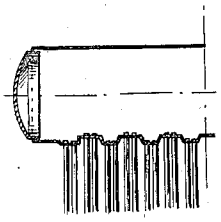


FIG. 9.

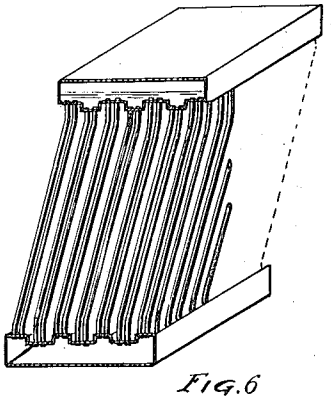


FIG. 6

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UNITED STATES PATENT OFFICE.

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STEAM-BOILER.

1,268,549. Specification of Letters Patent. Patented June 4, 1918.

Application filed March 10, 1914. Serial No. 823,747.

To all whom it may concern:

Be it known that I, EMILIO DE STRENS, mechanical engineer, subject of the King of Belgium, resident of Gazzada, Province of Como, in the Kingdom of Italy, have invented new and useful Improvements in Steam-Boilers, of which the following is a specification.

The new steam boiler forming the object of the present patent application is the embodiment of a new fundamental idea by means of various arrangements which severally and jointly are forming the object of the present invention.

The fundamental idea is to distinctly separate in the boiler the function of heating the water up to the temperature of the saturated steam and the function of the evaporation proper or change of state from water into steam. The object aimed at by the separation of these two functions is to obtain a material increase in the heat-transmission-coefficient for both functions. The present invention therefore has for its fundamental object:

(1) A tube-system specially provided to effect through it the water heating alone, this tube-system being arranged in the hottest portion of the furnace, in order that the maximum temperature-difference be available for heating the water first.

(2) A further, separate tube-system arranged at a greater distance from the fire than the foregoing one, to take up the evaporating process, this second tube-system being fed with water supplied to it by the former system at a temperature near that of the change of state in such a manner as to obtain therein a sudden evaporation of the water in contact with the tube walls. This sudden evaporation is due to the fact that a water molecule with the temperature of the change of state cannot receive any further increase of heat without being instantaneously converted into steam, whereby it will absorb at once from its surroundings all the necessary calories corresponding to the latent heat. There will therefore be a considerable heat absorption from the surroundings by the said molecules and consequently a most important increase of the heat-transmission coefficient of the tube walls with which the said molecules are in contact. For the better utilization of the heat, tubes of relatively small diameter are provided for the evaporating system, so as to increase the specific contact surface in respect of the water mass.

The respective surfaces of the two separate circuits are so proportioned that the water passes from the first to the second one only after it has reached the critical temperature or a temperature very near this.

As an example of this splitting of the boiler into two distanct circuits the arrangement shown in the drawing has been adopted, but the arrangement can obviously receive many different solutions and be applied to boilers of any type.

The annexed drawings show by way of example several constructions according to the present invention.

In Figure 1 the boiler shown is of sectional type, that is to say, the boiler consists of several identical sections, the tubes of each section being expanded into separate rectangular headers,—

Fig. 2 shows a boiler of sectional type generally arranged as in Fig. 1 but with a different method of connection between the downtake tube and the bottom header as well as between the uptake tube and top header,—

Fig. 3 represents a sectional boiler as per Figs. 1 and 2, fitted with superheater and economizer, baffles being provided for guiding the hot gases,—

Fig. 4 is a horizontal section on IV—IV in Fig. 3,—

Fig. 5 is a cross section on V—V in Fig. 2 and shows how the headers are staggered in order to enable the removal and replacement of the tubes, as hereinafter explained,—

Fig. 6 shows a modified construction of the boiler tube headers shown in Fig. 1,—

Fig. 7 represents a modified construction of the boiler shown in Fig. 1,—

Fig. 8 represents a further modified construction of the boiler shown in Fig. 1,—

Fig. 9 is a partial cross-section on IX—IX through the top drum of the boiler represented in Figs. 7 and 8, and

Fig. 10 shows the front ends of the top headers in Figs. 1, 2 and 3.

The arrangement shown in the drawing, Figs. 1, 5, 4 and 10 comprises a drum A and a set of longitudinal, subhorizontal top headers G fitted near one another and arranged a little above the water level, so that a free water surface is formed in the headers in addition to that in the steam and

water drum. The headers are connected to the drum in their top portion by means of suitable nipples, Fig. 10, arranged some above and some below water level, the former ones discharging the steam and the latter the water into the drum.

The drum A and headers G are common to both tube-systems, viz., to the water-heating-system and to the evaporating system; both are placed in parallel on the common portion, and in respect of the combustion products they are arranged in the manner said, viz., first the heater and then the vaporizer, unlike the ordinary arrangement of boilers fitted with the so-called economizer, in which the economizer is placed after the boiler in respect of the combustion products.

The two tube-systems can be made up of several identical elements placed side by side and connected with one another by the portion which is common to all of them.

With reference to an elementary section of the boiler in longitudinal direction, the heating-tube-system consists, for each longitudinal element, of a downtake-tube B starting from the drum and connected to an inclined subhorizontal tube C arranged direct over fire: tube C in its turn is connected to the uptake-tube D, which is directly exposed to the heat reverberated by the combustion chamber and is connected to the subhorizontal header G and through the latter to the drum, a closed circuit A—B—C—D—G—A being thus formed. The connections between B and C and C and D are obtained by means of horizontal cross collectors E and F. The feed water enters the drum in the portion superincumbent to the downtake tube B, and a partition L fitted inside the drum divides the latter into two portions A*a* and A*p*, A*a* being the portion destined to receive the feed water which enters at M. The feed water descends from A*a* through B into collector E, is heated direct by the furnace heat in tube C, rises through F and D where it is further heated by contact with the flames in the combustion chamber O. There are two combustion chambers, one (N) immediately over the furnace, and the other (O) which is obtained in the space between the evaporating tube bundle spoken of farther on and tubes C and D thanks to the different inclination of these parts. Tubes D, as already mentioned, are connected to the return headers G and the heated water pours itself from the latter into the compartment A*p* of the drum.

The tube-system destined to the evaporation, beside the portion A*p* of the drum and beside the headers G, mainly consists of downtake tube K starting from A*p* and of a tube bundle formed by a complex of small diameter tubes arranged subvertically and expanded into the mentioned headers G and into as many bottom headers or longitudinal subhorizontal collectors H, to which the bottom end of tube K is connected.

Accordingly in the evaporting circuit the heated water delivered by the heating bundle flows from G into A*p*, descends through K to feed the evaporating bundle, and the steam produced in the subvertical tubes of the latter disengages itself in collector G.

In order to equalize the pressure and the water level in the two distinct systems having in common the drum and the top headers, a collector is fitted connecting the bottom headers H of the bundle with one another at their lower ends, and from this collector an equalizing pipe is led to the bottom collector E, which also serves as blow-off pipe for the evaporating bundle. The headers H have a common muddrum-like collector P, which by an equalizing pipe R is connected to the bottom cross-collector E.

Another feature of the present invention concerns the means of securing the easy replacement of the tubes of the evaporating bundle, then the replacement of the tubes of the water-heating system does not present any difficulties owing to its simplicity and accessibility.

In a construction in which there is a series of parallel bundles, the ends of the tubes of each bundle being expanded into headers, and in which there is insufficient head room above the top headers, some means should be provided for replacing individual tubes other than the obvious method of threading the tubes in through handholes in the headers.

Means should therefore be provided for getting the tubes out and in between the headers. Now the length of the tubes is greater than the distance available between the top and bottom headers by the amount corresponding to the thickness of the expanding seat plus the length that the tube must project inside for bellmouthing, the total excess being about 2″. As mentioned, the tubes of the evaporating bundle should be of small diameter, Fig. 4. This enables them to be introduced through the clearance left between two adjacent longitudinal sections or through the clearance left between adjacent tubes crosswise. As long as the tube thus introduced is distant from the seat it has to occupy, it can be held inclined and so it can be got in notwithstanding its length being greater than the distance between the top and bottom headers; when, however, one of the tube ends has reached its seat, the tube must be righted and its axis must be made to take its definitive position. In order to make this possible, a new arrangement has been resorted to, this arrangement forming a further essential feature of the present invention.

Looking at the boiler from the front so that the several elementary identical sec-

tions are seen side by side, Fig. 5, the said sections have been alternately set one higher and the next lower, the difference just corresponding to the clearance requisite for righting the tube. When the tube has been brought near its seat, it should be pushed aside, lowered and made to rest on the next lower bottom header (or reversely it should be lifted and made to butt against the next raised top header). In this position (see tube shown in dotted lines) the tube can be righted and threaded into the hole of the header opposite the rest adopted. Since, owing to other constructive requirements, there always is a slight clearance left between the hole diameter and the outside diameter of the tube, this is sufficient to permit of the small inclinations requisite to thread in the tube. Once the tube is threaded into the header hole at one end, it can be slid therein upward (or downward) as much as may be required to place it in its exact definitive position below (or at the top) in the corresponding seat of the opposite header.

With the said arrangement another important feature is realized concerning the furnace and consisting in the obtaining of a second ample combustion chamber in a vertical direction, right above the first usual combustion chamber which is the one superincumbent to the grate in the case of coal firing or to the first flame jet in the case of oil firing and which is utilized directly for the water-heating alone.

These two chambers are separated by the subhorizontal tube-bundle of the water-heating system, in crossing which the flame gases are suitably mingled.

The additional chamber is very efficient toward the free development of the flames and enables a more favorable ratio: "fuel per hour to aggregate volume of combustion chambers", the available floor area remaining the same, and therewith permits of very high rates of combustion, the conditions yet being favorable to the combustion efficiency.

The constructions shown in the accompanying drawings are intended as illustrations only. It is obvious that many constructions other than those shown are contemplated by the spirit of the invention.

So for instance the boiler, instead of being made up of several identical sections placed near one another transversely, Fig. 5, and consequently with separate headers could have in lieu of the headers one or more flat boxes, Fig. 6, or semi-cylindrical drums with flat bottom, Fig. 7, or fully cylindrical drums with tubes suitably bent in order to insert them into the drum shell radially, Fig. 8. All this in a manner similar to that of other well known boiler types, yet so that the evaporating tube-system is separate from the special water-heating tube-system, the latter being in parallel with the said boxes, semicylindrical or cylindrical drums and being made up in a manner similar to the first tube-system described above and supplying the evaporating-tube-system with water that has already been raised to boiling temperature direct by the furnace: further the tube plates for the evaporating tubes being fitted with alternately projecting and recessed zones and both adjacent zones being expanding seats.

Similarly, the headers H and G can be quite horizontal and the tubes of the evaporating-tube-system, instead of straight, can have suitably bent or curved ends. Again, the tubes K, instead of being fitted in the collectors as indicated, could have their lower end curved and fitted into the ends of headers H and G, as per Fig. 2.

Similarly, the tubes D—instead of being fitted into the underside of headers G—can have their top end curved and fitted into the ends of the said headers, see Fig. 2.

Finally the downtake tubes B and K as well as the uptake tubes C and D—instead of being single—can be more than one for each kind according to the total heating surface which it is intended to obtain and to the total passage area which it is intended to offer to the water.

The above described arrangement can be combined with a superheater, for instance as shown in Fig. 1 or 5, and nothing prevents the boiler being fitted with an economizer of the usual type arranged, as usual, in series and utilizing the products of combustion after they have left the boiler.

Having now described my invention and how the same is to be carried out, what I claim as my invention, is:

1. In a steam generating system, the combination of a furnace, a main steam and water drum, a tube system adapted to take water from the said drum and return it to the said drum at approximately the critical temperature, and a second tube system connected to the said drum in parallel with the first tube system and adapted to take from the drum water at approximately the critical temperature and deliver it to the said drum as steam, a partition fitted inside the drum and dividing same into two portions, respectively connected to one of said tube systems, the first tube system being situated nearer the furnace than the second tube system.

2. In a steam generating system, the combination of a furnace, a main steam and water drum, a tube system adapted to take water from the said drum and return it to the said drum at approximately the critical temperature, and a second tube system connected to the said drum in parallel with the first tube system and adapted to take from the drum water at approximately the criti-

cal temperature and deliver it to the said drum as steam; a partition fitted inside the drum and dividing same into two portions, respectively connected to one of said tube systems, the said second tube system being surrounded by the first tube system whereby the hot gases from the furnace come in contact with the first tube system before reaching the second tube system.

3. In a steam generating system, the combination of a furnace, a main steam and water drum, a tube system adapted to take water from the said drum and return it to the said drum at approximately the critical temperature, and a second tube system connected to the said drum in parallel with the first tube system and adapted to take from the drum water at approximately the critical temperature and deliver it to the said drum as steam; a partition fitted inside the drum and dividing same into two portions, respectively connected to one of said tube systems, the said second tube system being surrounded by the first tube system whereby the hot gases from the furnace come in contact with the first tube system before reaching the second tube system; the tubes of the second tube system being disposed at an angle to the tubes of the first tube system, whereby a combustion chamber is formed between the said tubes of the first and second tube systems.

4. In a steam generating system, the combination of a furnace, a main steam and water drum, two distinct tube systems connected in parallel to the said drum, a partition fitted inside the drum and dividing same into two portions, respectively connected to one of said tube systems, one of the said tube systems being surrounded by the other, the inner tube system comprising a series of parallel bundles of tubes of equal lengths; the tubes of each bundle terminating at both ends in common tube plates, the tube plates of the entire series of bundles being arranged in staggered relation to one another with respect to their longitudinal axes, each header having free spaces to temporarily accommodate the ends of the tubes of the adjacent bundles, whereby the individual tubes may be replaced transversely from the side instead of longitudinally through the tube plates.

5. In a steam generating system, the combination of a furnace, a main steam and water drum, two distinct tube systems connected in parallel to the said drum, a partition fitted inside the drum and dividing same into two portions, respectively connected to one of said tube systems, one of the said tube systems being surrounded by the other, the inner tube system comprising a series of parallel bundles of tubes of equal lengths; the corresponding ends of the tubes of each bundle being connected by common headers, the said headers being arranged in staggered relation to one another with respect to their longitudinal axes, each header having free spaces to temporarily accommodate the ends of the tubes of the adjacent bundles, whereby individual tubes may be replaced transversely from the side instead of longitudinally through the headers.

In testimony whereof I hereunto affix my signature in the presence of two witnesses.

EMILIO DE STRENS.

Witnesses:
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