H. C. HEATON.

STEAM GENERATOR.

APPLICATION FILED OCT. 7, 1910.

1,137,137.

Patented Apr. 27, 1915.

2 SHEETS—SHEET 1.

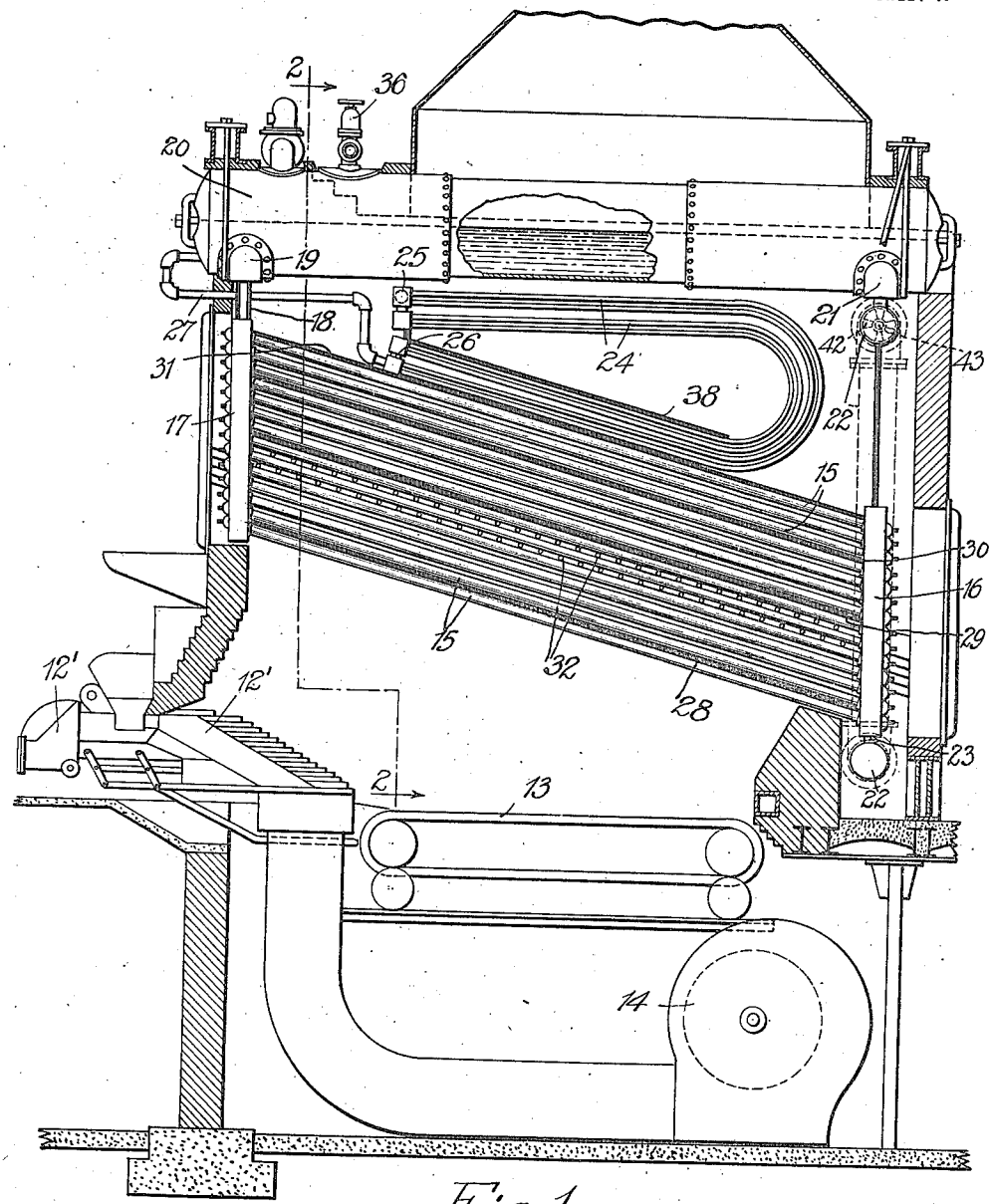


Fig. 1.

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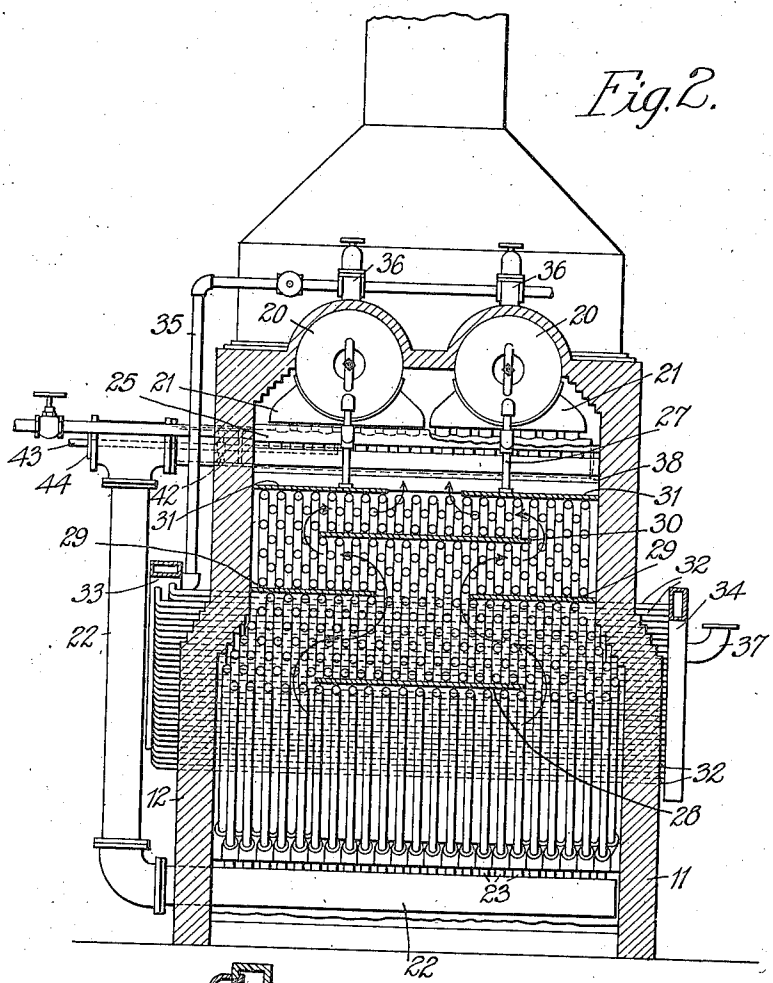
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2 SHEETS—SHEET 2.

Fig. 2.



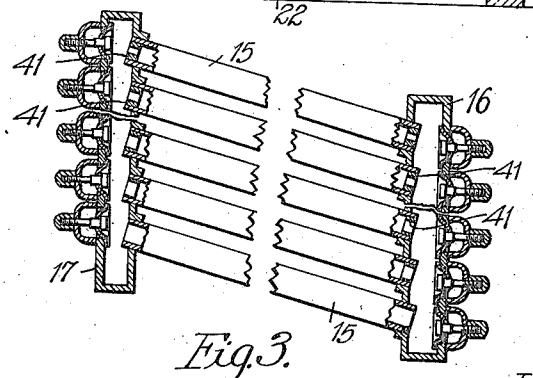


Fig. 3.

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UNITED STATES PATENT OFFICE.

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STEAM-GENERATOR.

1,137,137. Specification of Letters Patent. Patented Apr. 27, 1915.

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To all whom it may concern:

Be it known that I, HERMAN C. HEATON, a citizen of the United States, residing at Berwyn, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Steam-Generators, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to steam-generators and has for its object the provision of a construction which will generate steam with superior capacity and efficiency.

It provides the combination of an economizer, a water tube boiler, a superheater, and various features of improved arrangement and construction in these several parts.

One of the principal features of my invention is an improved method of baffling the tubes of the boiler proper. The boiler comprises a set of inclined water tubes connected with a header at either end, the front header being connected with one end of a drum or drums, to the other end of which the rear header is connected. As the water is heated in the water tubes it flows upwardly along the incline, thence through the front header to one end of the drum or drums—the circulation is then toward the other end of the drum or drums—and thence downwardly to the bottom of the rear header.

The economizer is of a novel construction and arranged to occupy the generally triangular space between the water tubes and the steam drums.

The superheater comprises a series of tubes which are run crosswise between certain of the water tubes of the boiler proper and the steam is led from the steam drums to these superheating tubes and thence across between the water tubes at a point where they will be subjected to the gases of combustion while still at a comparatively high temperature.

The baffling between the water tubes is accomplished by baffle plates which, in the preferred construction, run lengthwise from front header to rear header. One baffle plate is made to extend across the central portion tube space only, and the next higher baffle plate covers the outside tubes only, there being a space in the center for the flow of the gases of combustion. The next higher baffle plate is centrally located again so that the gases of combustion must follow a zigzag course always transverse to the water tubes. As will appear, the baffling is so arranged that the successive passes diminish in cross section, thus taking care of the decrease in volume due to the cooling of the gases.

The construction of my invention provides for an effective natural circulation of the water and I provide auxiliary means which may be brought into play to increase the circulation. To regulate the circulation of the water through the several rows of tubes I provide means for restricting the openings into the tubes in such a way that the tubes which are in position to absorb the greatest amount of heat from the furnace will be supplied with a correspondingly large amount of water and vice versa.

These and the various other features of improvement which constitute my invention will be more clearly understood by reference to the accompanying drawings, in which—

Figure 1 is a side elevation of the steam-generator of my invention, the furnace walls being in part broken away to reveal more clearly the interior construction; Fig. 2 is a sectional view taken in the direction of the arrowheads on the broken line 2, 2 of Fig. 1; and Fig. 3 is a detail showing the restricting of the water tubes to regulate the circulation.

In all of the figures the same characters of reference are used to designate corresponding parts.

Although the furnace constitutes a part of the steam-generator of my invention, it may be of any old and well-known type and, except as it acts in conjunction with the other parts, the furnace forms no part of my present invention. I shall refer only briefly, therefore, to the furnace shown more or less in outline, the furnace walls which inclose the boiler construction being shown at 11, 12. The automatic stoker is indicated at 12′. The chain grate is shown at 13, and the fan for forced draft at 14. I contemplate firing the boiler by any and all kinds of fuel, such as coal, gas, oil, etc.

The water tubes 15, 15 of the boiler proper are set at a considerable angle of inclination and extend between the rear headers 16 and the front headers 17. The forward header is connected by the tubes 18 with the cross-box 19, which in turn is

riveted to the shell of the drum 20. The cross-box 21 at the rear of the drum is connected by a series of tubes with the downtake pipe 22 which leads in a U-shaped path from a point below the cross-box 21 to a position just below the headers 16. The lower arm of this downtake 22 is in turn connected by a series of smaller tubes 23 with the rear headers 16. It will be understood that while but a single drum is shown in Fig. 1, the boiler will comprise two or more of these drums and associated parts, as shown in Fig. 2. It might be desirable to have more water tubes where the heat is most intense, and I have therefore built out the walls, as shown in Fig. 2, to accommodate such additional tubes.

The economizer is made to occupy the generally triangular space between the upper water tubes 15 and the drum or drums 20. The economizer comprises a series of tubes 24, 24 bent into horseshoe shape and connected at their ends with the inlet and outlet headers or boxes 25 and 26. It will be understood that the cold water supplied to the steam-generator will enter the economizer at 25 and after flowing around the horseshoe bend to the headers 26, will flow through the pipe 27 to the drum 20. The economizer may be divided into sections, one for each drum, if desired, and these sections may conveniently be connected to supply feed-water in parallel to the several drums. Provision may also be made for bypassing a part or all of the water around the economizer and directly to the drums, if so desired.

The arrangement of the baffle plates is best illustrated in Fig. 2, which it will be remembered is a sectional view taken on line 2, 2 of Fig. 1. The lowermost baffle plate is shown at 28 and extends across the boiler between the first and second tiers of water tubes. This baffle does not, however, extend to the sides of the furnace, but only across the more centrally located tubes. This lower baffle may, if desired, be made of a form of tile which completely incloses the tube, with a view of diminishing the tendency of the boiler to make smoke. The next layer of baffling is placed several tiers higher, but this in turn extends from the furnace walls on either side toward the center a greater or less distance, as the special conditions of an installation may dictate. This second baffle plate is shown at 29, 29 in Fig. 2. A third baffle plate much like the first is shown at 30, this being centrally located. Again, at the top, a fourth baffle 31 may be placed. The number of these baffle plates may vary, the important feature being, however, that each baffle plate extends from one end of the water tubes to the other,—that is, it runs all the way from the forward header to the rear header. The flow of the gases of combustion is not, therefore, longitudinal of the tubes, but rather perpendicular to each tube and in a generally zigzag path from the lower tubes to the uppermost. The flow of flue gases, in a general way, is indicated by the arrowheads in Fig. 2. It will be noted that the passes for the gases decrease in cross section successively upwardly, this, as before stated, providing for the gradual decrease in the volume of the gases as they cool. It has not been attempted with these arrowheads to avoid intersecting the tubes, because the lines of flow can at best be indicated only in a diagrammatic fashion.

The baffle plate 38 may be located between the bends of the economizer in order to concentrate to some degree the heat to which the lower turns of the economizer tubes are subjected. The pipes 18 may also, if desired, be protected, as shown, from the direct action of the gases of combustion.

The superheater comprises essentially a series of small tubes 32, 32 which are run across the boiler between the water tubes. As shown in the drawings, these superheating tubes are connected at their ends with the inlet and outlet headers or boxes 33 and 34, it being desirable that the superheating tubes make a right-angle bend at one end or the other to take care of unequal expansion which may occur among the several tubes of the superheater. Means may be provided, if desirable, for flooding the superheater with water through suitable pipe connections. The inlet header 33 is connected by a pipe 35 with the steam nozzles 36, 36 upon the drums 20. Steam is taken from the boiler by means of the nozzle 37 connected with the outlet header 34 of the superheater. Capped openings may be provided in the superheater headers for cleaning, repairing, and renewing the tubes.

Before alluding to certain other features of improvement, I shall describe in a general way the operation of those parts already set forth.

There is a considerable combustion chamber above the grate in order that the fuel may be pretty thoroughly burned before the gases are cooled by contact with the water tubes. The gases of combustion having attained a very high temperature within this combustion chamber, are brought into contact with the lowermost tier of water tubes, thereby subjecting these tubes to a very high degree of heat, which will have the effect naturally of generating a large amount of steam and of causing a very violent circulation or flow of water from the rear header 16 to the front header 17. The water entering at the lower and rearward end of the tube and the water and entrained steam being discharged from the forward or upper end, it will be noted that the downtake for

the return from the steam drums of the unevaporated water is directly to the lower end of the rear header. The water is thus brought most directly to those water tubes which will handle the largest supply,—that is, to those lowermost tubes in which the circulation is most violent. The gases of combustion will pass in a zigzag path, as indicated, between the various tiers of tubes, the gases losing something of their heat in this passage between the water tubes, and the water in turn absorbing this heat and being transformed into steam. Since the gases lose their heat as they travel upwardly between the tubes, the uppermost tubes will not be able to absorb so much heat as those nearer the bottom of the bank. Consequently, the circulation will not be so active in the upper tubes and these upper tubes will not make so large a demand upon the header 16 for a supply of water. The circulation of the water in the generator of my invention conforms with this difference in demand, the water being supplied to the bank of tubes at the bottom where the demand is greatest and flowing in part upwardly through the header 16 to supply the lesser demand of the upper tubes. This regulating of the supply of water to and among the tubes can be further regulated by means of the graduated restriction of openings as described in a previous paragraph. The above-mentioned arrangement provides the maximum head of water to supply the force necessary to cause circulation. So much having been said, it will be apparent that the circulation of water is through all of the tubes from the rearward header 16 to the forward header 17 and thence upwardly through the tubes 18 to the cross-box or boxes 19, thence to the steam drums, where, in the usual manner, a deflector plate may be located to throw the water and entrained steam toward the rear of the drums 20 in order that an excess of water may not be carried off through the nozzles 36, 36 to the superheater. There is a large area of water surface in the drums 20, which is of advantage in the liberation of the entrained steam and in maintaining the general water level notwithstanding fluctuations in the feed-water supply. The gases of combustion having spent most of their heat in their passage between the water tubes, encounter the lower arms of the economizer tubes 24 and after passing the baffle plate 38, in case such baffle be employed, they encounter the upper turns of the economizer into which the cold feed-water flows from the header 25. The circulation of the feed-water through the economizer is aided by the inclination of the lower arms of the economizer tubes, these lower tubes through which the heated water passes being subjected to the flue gases when at a higher temperature than later when they encounter the upper arms of the tubes into which the cold water flows. The arrangement is therefore one which utilizes the heat remaining in the flue gases to advantage and one which acts naturally to aid in the flow of the feed-water in its passage from the header 25 to the steam drums 20 through the pipes 27.

The location of the superheater tubes will be governed by the conditions of a particular installation, such, for example, as the type of the furnace and the duty of furnace and boiler, as these factors will, to an extent, determine the exact position of the superheater tubes. If placed too low, they will be subjected to the flue gases while at an unduly high temperature, and this would likely cause trouble when large quantities of steam are not passing through the superheater. On the other hand, the tubes must not be placed too high, because the flue gases when they leave the water tubes are not likely to have a temperature sufficiently high to give the steam a superheat such as is likely to be required. It will be noted that I have placed the superheater tubes just below an intermediate baffle plate and the combination works with decided advantage in distributing the heat of the gases of combustion with a high degree of equality as between the tubes in any one tier and from end to end of the superheater tubes. It might be here stated that in the construction shown the "counter current" principle of operation is embodied; that is, the flow of water and steam are, in a measure, traveling in opposite directions. This utilizes the heat of combustion in the most efficient manner.

In Fig. 3 I have shown the stopper plate 40 within the header 16, in which holes of various sizes are drilled to regulate the flow of water through the central tubes. Instead of a single plate in which holes are thus formed, individual stoppers, one for each tube, as shown at 41, may be employed, the latter arrangement having some advantages as to removal for cleaning the inside of the water tubes and also if it becomes necessary or desirable to change the sizes of stoppers for some or all of the tubes. The amount of heat absorbed by the water in each tube will, of course, determine the amount of steam generated within the tube and thus to a large extent the rapidity of the flow through that particular tube, the circulation corresponding roughly to the amount of steam generated. The stoppers, however, form a useful auxiliary to regulate the circulation and compel, if necessary, the larger part of the circulation to be by way of the lowermost water tubes of the bank.

To aid in circulation, particularly when it is necessary to force the boiler, I provide a small pump in the cross-drum of the down-

take 22. This pump is shown more or less diagrammatically in the form of a propeller wheel 42 which is driven by power supplied through the axle 43. The propeller wheel and axle are slidably mounted within the stuffing gland 44 so that the propeller wheel may be withdrawn from the cross-drum and into the T shown in the drawings when it is not in use to force circulation. This part of the invention is not, however, confined to the particular form of circulating device shown, and another device of equal or greater advantage may be used.

I have endeavored in my description of this improved steam-generator to confine myself to essentials and have not therefore, gone into elaborate detail with respect to many features which are of course not necessary in a modern boiler but which are understood by those skilled in this art. Thus, for example, the lowermost leg of the downtake will serve as a mud drum and means should be supplied for blowing out the mud as also hand holes for cleaning. So also the various headers must be supplied with means of ingress for cleaning the various parts. Other parts must be lagged with an insulating covering to conserve heat. Such details may, however, be arranged in various ways all within the well-known practice of the art, and I have deemed it unnecessary to confuse my description and illustration of essential features by too much elaboration of detail.

It will, I think, be apparent that I have provided a steam-generator in which the heat of the gases of combustion is transferred to the water or steam in an efficient manner, one in which there will be a naturally vigorous circulation, one in which the supply of water to steam generating-surfaces may be made to correspond closely with the evaporating power of the several surfaces, and one which has all the requisites of safety and easy access for cleaning.

Having described my invention, I claim:

1. In a boiler, a furnace, a plurality of horizontal tiers of inclined water tubes, said furnace having walls on the sides of said water tubes, baffle plates arranged parallel with said tubes, said baffle plates defining a path of decreasing area for the products of combustion, said baffles including a pair of baffles each extending from a point adjacent the side walls and a baffle above the space between said pair of baffles and relatively remote from said side walls.

2. In a boiler, a furnace having side walls, a plurality of horizontal tiers of inclined water tubes, baffle plates arranged between said horizontal tiers and parallel with said tubes, said baffle plates extending from end to end of said tubes and defining a path of decreasing area for the products of combustion, said baffles including a pair of baffles each extending from a point adjacent the side walls and a baffle above the space between said pair of baffles and relatively remote from said side walls.

In witness whereof, I hereunto subscribe my name this 3rd day of October A. D. 1910.

HERMAN C. HEATON.

Witnesses:
W. M. SALISBURY,
CHAS. H. COX.