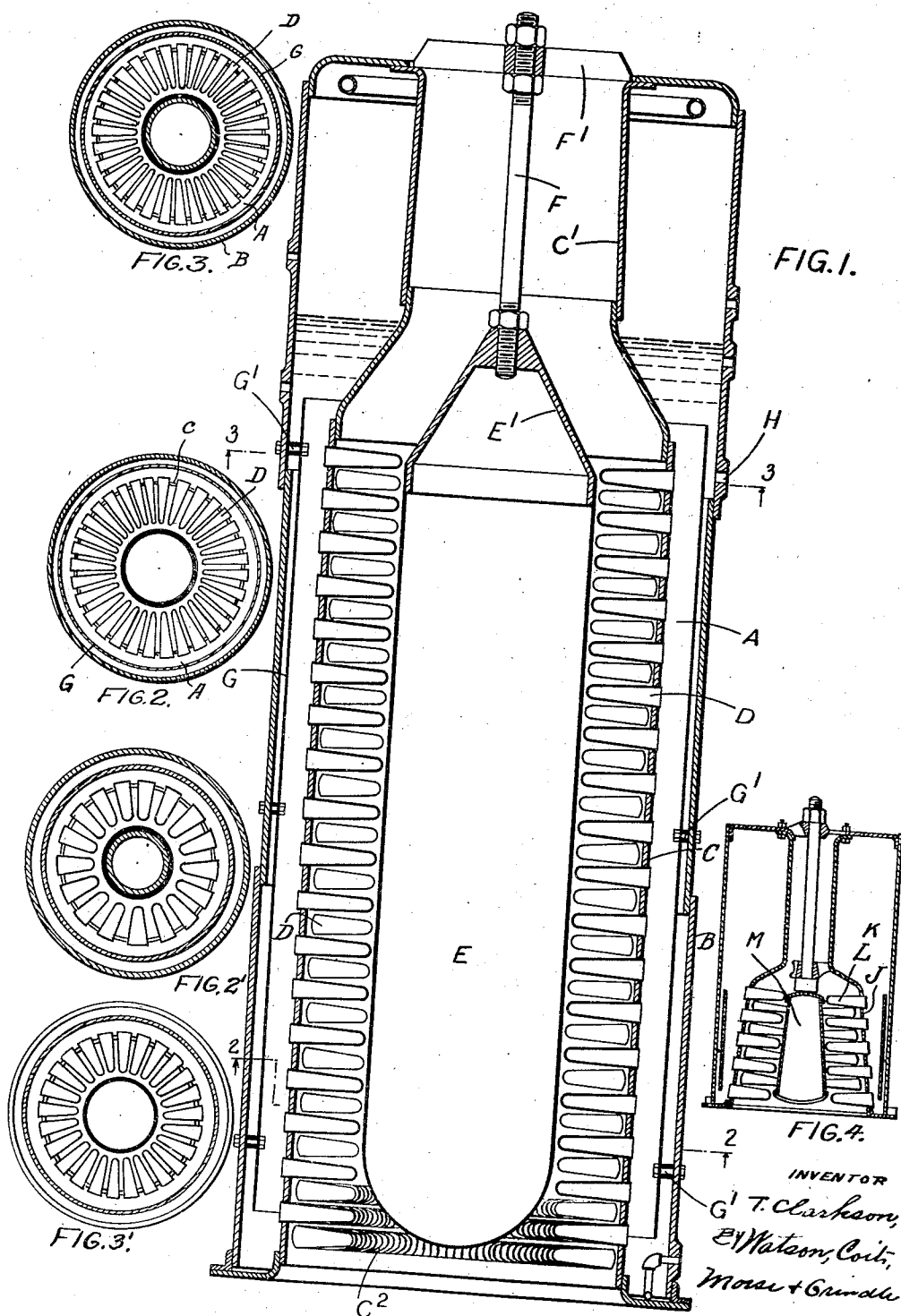


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STEAM GENERATOR

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STEAM GENERATOR.

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This invention relates to water heaters or steam generators of the kind in which hot gases flow over and between a series of closed-ended water-containing thimbles which radiate inwards from an annular steam and water chamber into a heating space provided with a central plug or baffle.

The invention is particularly applicable to heaters of the above kind employing waste or exhaust gases, for example, from an internal combustion engine although it may also be employed in connection with generators heated by the combustion of fuel directly beneath them.

In water heaters of the above kind the rate of flow of the hot gases through the annular space into which the thimbles radiate tends to decrease as these gases give up their heat to the water, owing to the diminution in the volume of the gases, and the object of the present invention is to obviate this loss in the rate of flow of these gases and thus to maintain efficient transference of heat, which largely depends upon the velocity of gases in relation to the heat absorbing surfaces.

To this end the heater is so constructed that the average cross-sectional area of the annular space through which the hot gases flow over and between the thimbles is less towards the outflow than towards the inflow end of this space, so that the velocity of these gases, when cooled by and after passing over the thimbles, remains substantially constant throughout its passage through the heater. The average cross-sectional area of the annular space may differ at successive points in the length of the generator and this result may be secured by increasing the number of thimbles in successive rows or groups of rows from the inlet towards the outlet end of the hot gases, the size of these thimbles being constant throughout. Alternatively, the size of the thimbles in the rows or groups of rows may be increased towards the end through which the hot gases escape, the actual number of thimbles in each row being constant throughout. Yet again, the inner or outer walls which enclose the annular space into which the thimbles project may be tapered, so that the radial dimension of this gas space will be less at or towards the gas outflow end of the heater than the corresponding dimension of this annular space at or towards the inflow end.

Three alternative constructions of heater or generator for carrying the invention into effect are illustrated somewhat diagrammatically by way of example in the accompanying drawings, in which

Figure 1 is a sectional side elevation of a heater having a greater number of water tubes in the upper zone than in the lower zone,

Figure 2 is a section on the line 2—2 of Figure 1, and

Figure 3 is a section on the line 3—3 of Figure 1.

Figures 2' and 3' are sections similar to Figures 2 and 3 showing in an exaggerated form the manner in which the variation in the number of tubes causes a reduction in the cross-sectional area of the gas passage, and Figure 4 is a sectional elevation of an alternative form of generator in which the walls of the gas passage are tapered for the purpose of reducing its cross-sectional area at the outlet end.

In the construction illustrated the generator comprises an annular steam and water space A bounded by cylindrical walls B, C, the inner one C of which carries projecting radially inwards therefrom a series of thimbles D. These thimbles are preferably tapered as shown with their smaller ends directed inwardly, but their axes lie conveniently truly radially with respect to the axis of the generator. The thimbles D are disposed in annular rows, each row lying in a plane normal to the axis of the generator while the length of the thimbles is such as to leave a central cylindrical space extending throughout the main part of the generator. Within this central space is disposed a cylindrical core or plug E which may be either formed of refractory material or of steel or other tubing as shown. Alternatively the core may be formed partly of metal tubing and partly of refractory material. The core E is conveniently suspended from the upper or outflow end of the generator as shown by means of a rod F engaging at one end a suitably screwthreaded bore in a cap member E' for the plug E and at the other end connected to the centre of a bridge piece F' extending diametrically across the gas outlet passage C' of the gen-

erator. As will be seen, this structure provides an annular space between the central core or plug E and the inner wall C of the steam and water space A. Hot gases enter this annular space through the inlet opening C² and after flowing over and between the thimbles D, escape through the outlet passage C¹. The thimbles are formed of uniform dimensions but the number of thimbles in each of the annular rows which lie in transverse sections taken through the generator is increased, preferably by stages, from the inflow end towards the outflow end. Thus, for example, in the construction illustrated while a certain number, say 10, of the annular rows of thimbles adjacent to the inflow end each contain a similar number of thimbles, for example 34, as shown in Figure 2, a certain number, say 13, of the annular rows of thimbles adjacent to the outflow end C¹ are each provided with a larger number of thimbles, for example 37, as shown in Figure 3. The remaining number of annular rows of thimbles which lie between the top and bottom stages, comprising say 14 rows, may have some intermediate number of thimbles, for example 36 thimbles per row.

The arrangement described above is suitable for a generator having approximately an external diameter of 5 feet and a total overall length of about 15 feet.

As will be seen from the drawings, the thimbles in adjacent rows are staggered while their inner closed ends lie near to the outer wall of the central core or plug E. It will be understood that instead of the gases flowing in the upward direction, as in the particular example illustrated, they may flow downward through the heater, in which case the number of thimbles in the uppermost row or group of rows will be less than those in the intermediate and lowest group of rows.

Within the steam and water space A is disposed a cylindrical baffle member G which is carried by the outer wall B of the generator on short studs G¹ and extends conveniently from adjacent to the lower end of the steam and water space to a short distance above the last of the annular rows of thimbles. This cylindrical baffle plate G serves to assist the water circulation, an upward current tending to take place within the baffle plate and a downward current flowing outside it. The feed water is introduced through the outer wall of the generator at some point where this water will strike against the baffle plate G, for example a few inches below the top edge of the baffle as indicated at H.

Figures 2' and 3' are cross-sections similar to Figures 2 and 3 of a generator in which the number of tubes towards the outlet end of the generator is considerably

greater than the number of similar tubes towards the inlet end of the generator. Such a construction would not be used in practice but is given for the sake of clearness to show in an exaggerated manner how the reduction in the cross-sectional area of the gas passage is produced. Figure 4 shows an alternative construction of generator according to this invention in which the inner wall J of the water and steam space K which carries the thimble tubes L is tapered, while the central plug or baffle M is also tapered so that it lies adjacent to the inner ends of the tubes L at all points in its length. In this construction the number of thimble tubes in each circumferential row would normally be the same, and it will be seen that the cross-sectional area of the gas passage will be less at the outlet end of the heating space than at the inlet end.

The improved generator according to this invention may be supplied with hot gases in various ways. For example where the generator is employed for utilization of waste heat it may be in some cases conveniently arranged for the hot gases to enter at the lower end whence they pass upwards through the annular gas space over the thimbles into the outlet passage in the upper end of the generator. A chamber may be provided at the lower end of the generator into which the hot gases enter, this chamber being arranged with a helical passage into which the gases are led so that they will tend to flow spirally up through the gas space around the central core. This chamber may be provided with a second opening into which the flame from a liquid fuel burner may be directed so as to apply heat to the generator when the hot gases are not available. Means may be provided either external to the generator or internally for controlling the flow of the hot gases over the thimbles, i. e. the central core may be formed tubular and arranged to be movable in the direction of its axis so that, when lowered on to a suitable end cap, the gases only flow through the annular space, while, when raised, the tube will tend to close to a greater or less extent the upper end of the annular gas space and will cause the gases to flow then wholly or partially through the central tube.

It is to be understood that the constructional details of the apparatus may be varied within wide limits without departing from the invention.

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

1. A water heater of the class described comprising in combination an annular water chamber surrounding a heating space through which hot gases can flow, closed-ended water-containing thimbles extending radially into the heating space from the water

chamber, an inlet for the hot gases at one end of the chamber, an outlet therefor near the other end and a baffle of circular cross-section disposed centrally within the heating space, the cross-sectional area of the heating space between and around the thimbles being smaller towards the outlet than towards the inlet for the heating gases for the purpose specified.

2. A water heater of the class described comprising in combination an annular water chamber surrounding a heating space through which hot gases can flow, closed-ended water-containing thimbles extending radially into the heating space from the water chamber, an inlet for the hot gases at one end of the chamber, an outlet therefor near the other end and a baffle of circular cross-section disposed centrally within the heating space, the average cross-sectional area of the heating space between and around the thimbles being reduced in stages from the inlet for the heating gases towards the outlet so that the rate at which these hot gases flow over the thimbles is substantially constant.

3. A water heater of the class described comprising in combination an annular chamber surrounding a heating space through which hot gases can flow, closed-ended water-containing thimbles extending radially into the heating space from the water chamber in a plurality of superimposed rows, an inlet for the hot gases at one end of the chamber, an outlet therefor at the opposite end thereof and a baffle of circular cross-section disposed centrally within the heating space, the number of thimbles in each row towards the gas outlet end being

greater than the number of similar thimbles in the rows towards the gas inlet end for the purpose specified.

4. A water heater of the class described comprising in combination an annular water chamber surrounding a heating space through which hot gases can flow, a plurality of closed-ended water-containing thimbles of similar dimensions extending radially into the heating space from the water chamber in a series of superimposed rows, an inlet for the heating gases at one end of the chamber, an outlet therefor at the other end and a baffle of circular cross-section disposed centrally within the heating space, the number of thimbles in each stage of rows being successively increased from the gas inflow end towards the outflow end as and for the purpose specified.

5. A water heater of the class described comprising in combination an annular water chamber surrounding a heating space through which hot gases can flow, a plurality of closed-ended water-containing thimbles of similar dimensions extending radially into the heating space from the water chamber in a series of rows arranged in staggered relationship with one another, an inlet for the heating gases at one end of the chamber, an outlet therefor at the other end and a baffle of circular cross-section disposed centrally within the heating space, the number of thimbles in each stage of rows being successively increased from the gas inflow end towards the outflow end as and for the purpose specified.

In testimony whereof I have signed my name to this specification.

THOMAS CLARKSON.