Feb. 17, 1953 J. VAN BRUNT 2,628,598

STEAM GENERATOR

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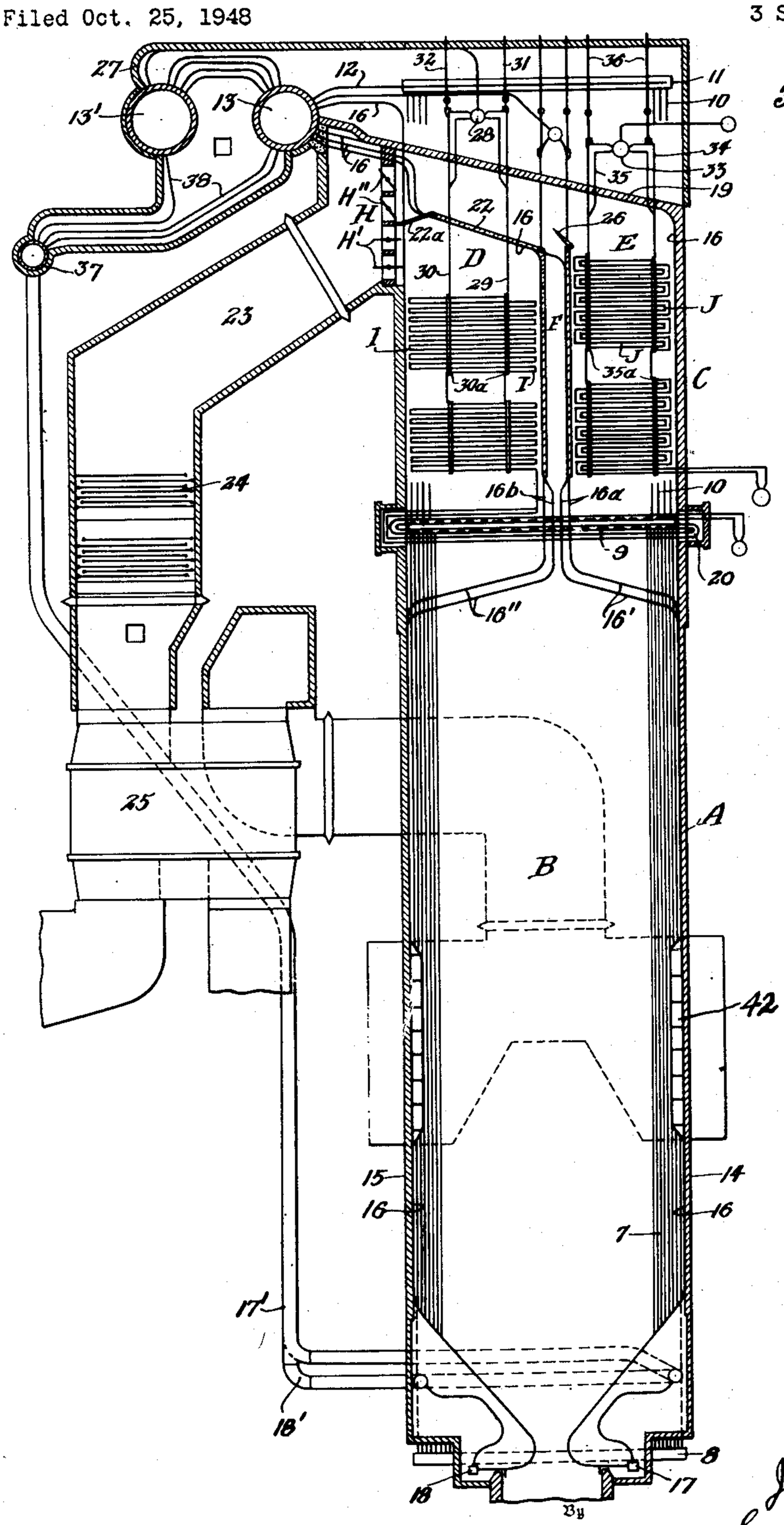
Fig. 1.



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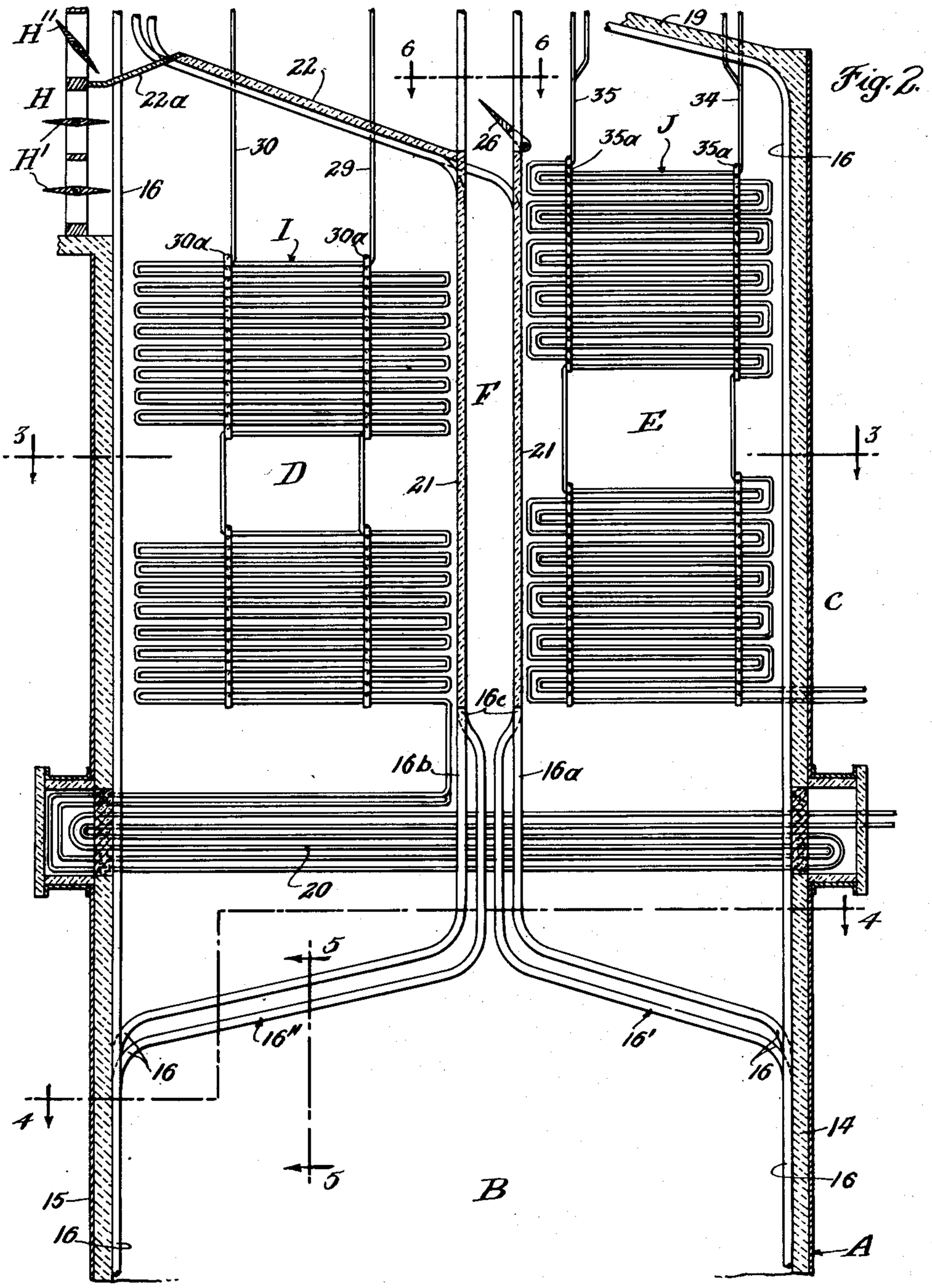

Fig. 2.

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Fig. 3.

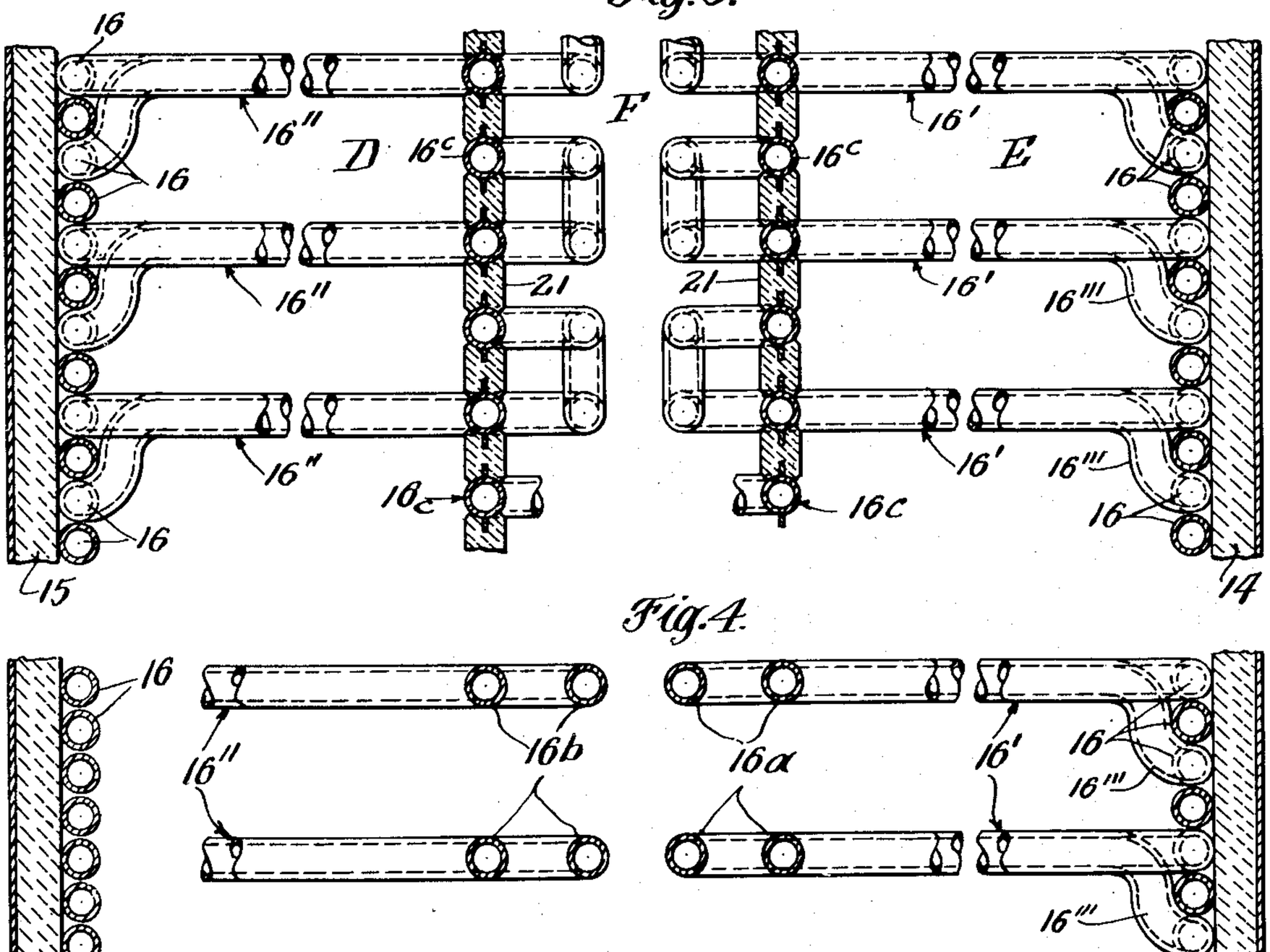


Fig. 4.

Fig. 5.

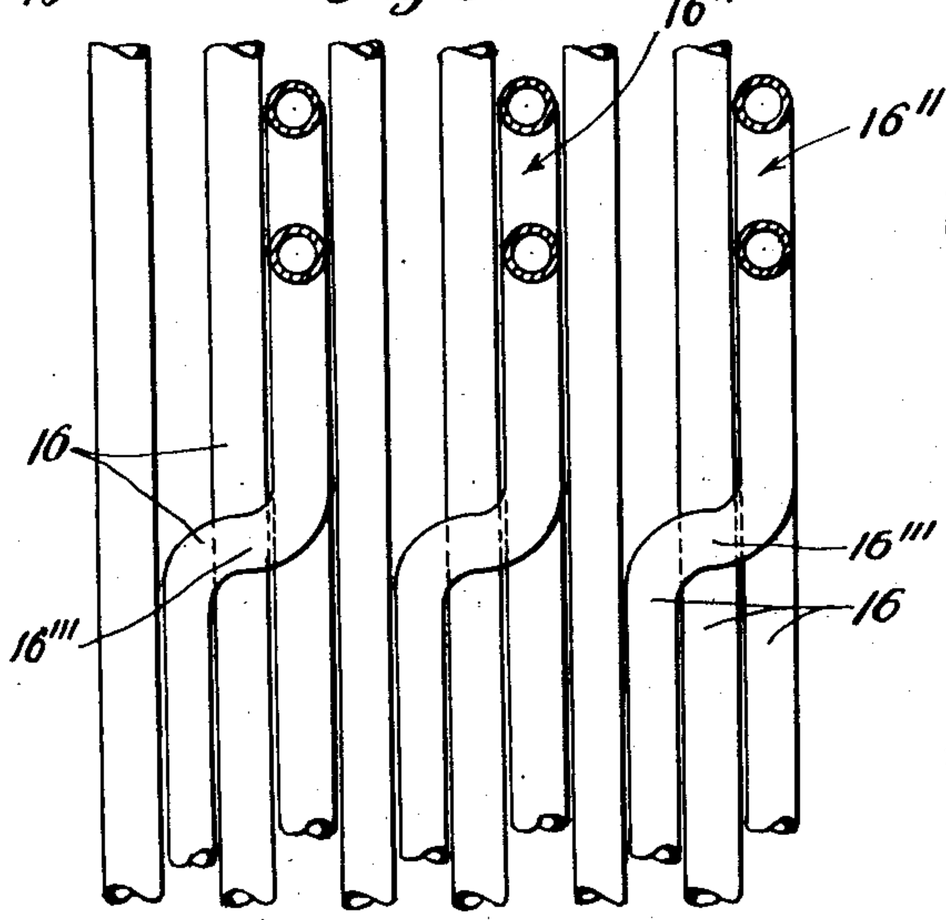
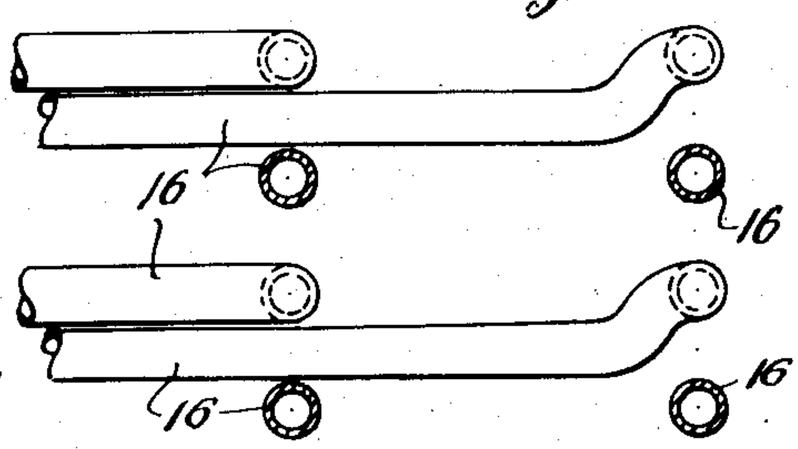


Fig. 7.

Fig. 6.



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UNITED STATES PATENT OFFICE

2,628,598

STEAM GENERATOR

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Application October 25, 1948, Serial No. 56,381

6 Claims. (Cl. 122—480)

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This invention relates to steam generators, and it is especially useful in that type of steam generator which includes steam superheater and reheater elements.

It has been known to provide boilers with passes for the gaseous products of combustion and to provide serially arranged superheater and reheater elements and to provide damper means for controlling distribution of the gas flow as between the passes, for the general purpose of temperature control.

The primary object of the present invention is to provide a simple and effective arrangement of steam generator in which, nevertheless, steam generating elements of the generator are used to provide passes for accommodating superheater and reheater elements in parallel and may be used to afford support for such superheater and reheater elements.

How the foregoing, together with such other objects and advantages as may hereinafter appear or are incident to the invention are realized is illustrated in the accompanying drawings, wherein—

Fig. 1 is a more or less diagrammatic vertical section through a steam generator unit embodying my improvements;

Fig. 2 is an enlarged fragmentary vertical section through the upper portion of the steam generator;

Fig. 3 is a still further enlarged fragmentary plan section taken on the line 3—3 of Fig. 2 with certain tubes broken out to condense the Figure;

Fig. 4 is a fragmentary plan section taken on the line 4—4 of Fig. 2 also with certain tubes broken out to condense the figure;

Fig. 5 is a fragmentary cross section taken on the line 5—5 of Fig. 2;

Fig. 6 is a fragmentary plan section taken on the line 6—6 of Fig. 2 with the baffling omitted; and

Fig. 7 is a fragmentary view illustrating a modification of the invention.

Referring now to Figure 1, the reference character A indicates the boiler setting which provides a tall, straight chamber, rectangular in cross-section. The lower portion B of the space defined by the setting constitutes a combustion chamber proper, and the upper portion C receives the gaseous products of combustion generated in the combustion chamber for ultimate delivery to the stack.

The side walls of the space defined by the setting are lined with closely spaced, steam generating tubes 7, which rise from the supply headers 8 of which there is one at each side of the setting. These tubes 7 extend to the delivery headers 9 and are subject to radiant and convection heat. Although only a portion of the side walls are shown as being lined with such tubes 7, it will be understood that the entire surface thereof is so lined and that the tubes constitute, in effect, a substantially continuous water wall.

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The side walls of the chambers C are also lined with tubes 10 which rise from the headers 9 to the delivery headers 11. These tubes are not as closely spaced as the tubes 7 for the reason that the walls of the chamber C do not need so extensive protection, since the temperature of the gases passing through the chamber C is relatively lower. Delivery tubes 12 discharge the mixture of steam and water from the headers 11 into the primary steam and water drum 13.

The front and rear walls 14 and 15 are also lined with tubes 16 which are closely spaced like the tubes 7. The respective sets of tubes 16 rise from the front and rear supply headers 17 and 18 located at the bottom portion of the combustion chamber B.

In the installation of the drawings, the tubes 7 and 16 are 3'' tubes set on 3⅛'' centers, as best seen in Figures 4 and 5.

Near the upper portion of the combustion chamber B alternate tubes 16 lining the front wall 14 are bent inwardly and upwardly toward the fore and aft center of the combustion chamber as indicated at 16', to provide the parallel arrangement of such tubes shown in Figures 3, 4 and 5, the parallel rows being on 12½'' centers.

Similarly, alternate tubes 16 of the rear wall 15 are bent inwardly and upwardly toward the center of the combustion chamber as shown at 16'', again providing a parallel arrangement.

It is to be noted that in order to obtain this parallel arrangement of the inclined portions 16' and 16'' of the tubes 16, one tube of each pair is bent to bring it in alignment with the other tube, for example, as indicated at 16''' in Figures 3, 4 and 5.

The tubes of the front and rear water walls which are not so bent continue their straight course upwardly along the front and rear walls of the chamber C.

At the top of chamber C the front wall tubes 16 bend inwardly and incline upwardly and extend to the drum 13, and serve as a support for the roof 19 of chamber C. Similarly, the rear wall tubes 16 which are not bent inwardly and upwardly toward the center of the combustion

chamber at the upper part thereof, pass upwardly along the rear wall of chamber C, pass through the roof 19, and discharge into drum 13.

Referring now again to the front and rear tubes 16 which are bent inwardly and upwardly toward the center of the combustion chamber, as shown at 16′ and 16″, it will be seen that they are again bent to extend vertically upward in parallel rows as indicated at 16*a* and 16*b*, as shown in Figure 4, by which arrangement it is possible to pass the return bend primary superheater tubes 20 between such rows.

The primary superheater tubes extend across the chamber B, from front to rear and back, at a point just above the inwardly and upwardly inclined portion 16′ and 16″ of the front and rear wall tubes, so as to be subject to all of the gaseous products of combustion flowing past the tube portions 16′ and 16″.

Because the radiant heat tubes lining the front, rear and side walls of the combustion chamber reduce the temperature of the rising gaseous products by absorption, and because the tube portions 16′ and 16″ also tend to reduce temperature of the rising gaseous products of combustion, the primary superheater tubes 20 are not subjected to excessive temperatures.

Just above the primary superheater tubes the two portions 16*a* are brought into alignment to form a single row of vertically extending tubes 16*c*, and similarly with the two portions 16*b*, as shown in Figure 3. These rows extend from side wall to side wall of chamber C.

These single rows of tubes are utilized to provide the gas passes D and E, for which purpose the tubes are desirably but not necessarily finned as shown, and the spaces between the tubes are closed with refractory blocks 21, to provide baffles, also as indicated in Figure 3.

Thus, the gas pass D is constituted by the rear wall and the side walls of the chamber and one of the two baffles, and the other pass E is formed by the front and side walls of the chamber C and the other of the two baffles.

The two rows of baffle tubes, being spaced from one another, a third and narrower pass F is provided between the gas passes D and E which may be used as a by-pass on starting up or in the case of quick shut down or to protect against excessive temperature, and to provide access. At the upper ends of the gas pass F the alternate tubes of said baffle tubes bend inwardly and upwardly toward the rear, as shown in Figs. 2 and 6, for eventual delivery into the drum 13 appearing in Figure 1. The others of such tubes serve as hangers, for which purpose they may be overhead supported.

The top of gas pass D is roofed over by a roof 22 carried by those portions of the tubes which incline rearwardly and upwardly.

The gas outlet from chamber C is shown at H. The gaseous products of combustion leaving the upper end of pass D, discharge through the portion of the gas outlet H below the roof baffle 22, and the gaseous products leaving from passes E and F, discharge through the portion of the gas outlet H above roof baffle 22, there being a supplemental baffle at 22*a* serving with the roof baffle to so divide the outlet.

The duct 23 conducts the waste gases to the stack not shown. Heat is recovered from the waste gases as by means of the economizer tubes 24 and the air preheater 25.

The relative flow of gas through passes D and E may be regulated by the set of controlled dampers H′ and H″ provided at the gas outlet H, coupled for joint or independent operation as desired, and by means of the damper 26 controlling pass F.

A sectional secondary superheater indicated as a whole by the reference character I is located in pass D and a sectionalized steam reheater indicated as a whole by the reference character J is located in pass E.

It will be seen that the several gas passes are in parallel and that the secondary superheater and the reheater are therefore also in parallel. The arrangement is one which is highly advantageous in that it is possible to maintain the temperature of superheat (in both the primary and secondary superheater), and the temperature of reheat, constant over a wide range of load as contrasted with the customary serial arrangement of superheater and reheater elements. Thus, for example, with a temperature of 1000° F. superheat and reheat, the temperature can be maintained constant from full load down to about 40%–50% of full load, whereas in the conventional serial arrangement that temperature could be maintained constant only to about 75%–80% of full load. At lower steam temperatures, the range of load during which constant temperatures can be maintained, increases substantially. Thus, for example, at approximately 950° F., steam temperature for both superheat and reheat, it is possible to maintain that temperature constant down to about 30% of full load. In the customary series arrangement, this temperature could only be maintained constant down to about 65% of full load.

A second steam and water drum 13′ may be employed. From this drum, tubes 27 deliver steam to the header 28. From this header lead two sets of tubes 29 and 30, which are utilized to supply the two sections or groups of return bend tubes of the secondary superheater. The return bend tubes constituting each group are arranged in parallel rows and the tubes are bundled together by links arranged in straps 30*a*. Overhead supported hangers 31 and 32 support the upper portions of the sets of tubes 29 and 30, from which in turn the straps are hung. Thus the sections of the secondary superheater are overhead suspended. The hangers may be carried by the roof or other portion of the customary overhead structure (not shown).

The secondary superheater tubes discharge or lead to the primary superheater tubes.

Similarly, the steam to be reheated is led to header 33 from which lead two sets of tubes 34 and 35 which are so arranged that they provide groups of rows of parallel return bend rear heater tubes bundled together by links arranged in straps 35*a*. As before, tubes 34 and 35 are supported by hangers 36 so that the groups of reheater tubes are overhead suspended in a fashion similar to the secondary superheater tubes.

The supply headers 8, 17 and 18 above mentioned are supplied by downcomers 17′ and 18′ which connect with the downcomer header 37, which in turn is supplied from drums 13 and 13′ by tubes 38.

It will be seen from the foregoing that the entire installation is very simple in character, despite the provision of the parallel gas passes and the utilization of elements of the generator for this purpose, and the parallel arrangement of secondary superheater and reheater, in addition to the advantages previously noted, makes

for low draft loss. Thus a high capacity installation having the other advantages hereinbefore noted can be obtained in a simple and therefore in a less expensive manner.

Moreover, the tubes which are bent inwardly and then upwardly to provide the gas passes may be utilized to support the secondary superheater tubes and the reheater tubes as diagrammatically indicated in Figure 7, wherein opposite ends of the return bend tubes are supported as by welding or from clips **40**, respectively carried by the tubes and the walls and upon which clips the tubes may rest for sliding movement to provide for expansion and contraction. The arrangement is therefore one which has the advantage of providing any one of a number of different methods of support which may be individually preferred. The primary superheater tubes are also supported intermediately by clips **40** on the tube portions **16***a* and **16***b*.

The installation may be fired in any of the conventional ways as, for example, by pulverized fuel as shown. Where pulverized coal or similar fuel is burned, the tubes which extend across the combustion chamber in advance of the primary superheater act as slag screen tubes, preventing the accumulation of slag in the next of superheated tubes.

Because of the great height of the installation, the tubes **7** and **16** may be made of lengths welded together.

The generator firing referred to above may satisfactorily utilize tiltable burners generally indicated at **42** and organized as disclosed by my copending application Serial No. 73,274, filed January 28, 1949, for "Steam Generator and Superheat-Reheat control Means Therefor" and it is when such tiltable burners are employed that the earlier-stated extensions in loading range variation (made possible by the here disclosed parallel arrangement of superheater and reheater elements) are achieveable while holding both the superheated steam temperature and the reheated steam temperature substantially constant.

Such tiltwise adjustments of burners **42** and such positional adjustments of dampers H'—H'' as are required to hold the named steam temperatures constant during changes in steam generator loading may of course be accomplished either manually or automatically; illustrative automatic control facilities being disclosed and claimed by my aforesaid copending application Serial No. 73,274.

I claim:

1. In a steam generator, an upright setting providing a chamber the lower portion of which is a combustion chamber and the upper part of which is a gas chamber receiving the gaseous products of combustion from the combustion chamber for discharge therefrom, steam and water drum means, water wall tubes lining each of two opposite walls of the setting and connected to deliver to said drum means, certain of the tubes lining each of said walls extending (*a*) inwardly upwardly toward the center of the combustion chamber at the top thereof to provide rows of tube portions substantially spanning the combustion chamber, (*b*) and then upwardly adjacent the center to form parallel rows spaced apart from one another in a direction between said walls, (*c*) and then in upright spaced rows, with the rows extending in a direction parallel to the said walls (*d*) and then to the drum means, whereby to provide with the walls of the gas chamber parallel gas passes extending upwardly from a point above the tube portion spanning the combustion chamber, fluid heating elements in said gas passes, said gas chamber having an exit for the gases leaving the passes, damper means for controlling the flow of gas through said passes, and downcomer means for supplying said wall tubes.

2. The steam generator of claim 1 in which primary superheater tubes extend across the chamber at a point between the fluid heating elements and the inwardly and upwardly extending portions of the side wall tubes.

3. The generator of claim 1 in which the fluid heating elements comprise a secondary superheater in one pass and a steam reheater in another pass and in which primary superheater tubes extend across the chamber at a point between the steam heating elements and the inwardly and upwardly extending portions of the side wall tubes, said primary superheater tubes being in series with the secondary superheater.

4. The generator of claim 1 in which the tube portions (*b*) are provided with refractories to form a baffle.

5. The generator of claim 1 in which the fluid heating elements are supplied by tubes suspended from the setting and are supported from said tubes.

6. The steam generator of claim 1 in which primary superheater tubes extend across the chamber at a point between the fluid heating elements and the inwardly and upwardly extending portions of the side wall tubes and in which said portions are provided with means for supporting said primary superheater tubes.

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