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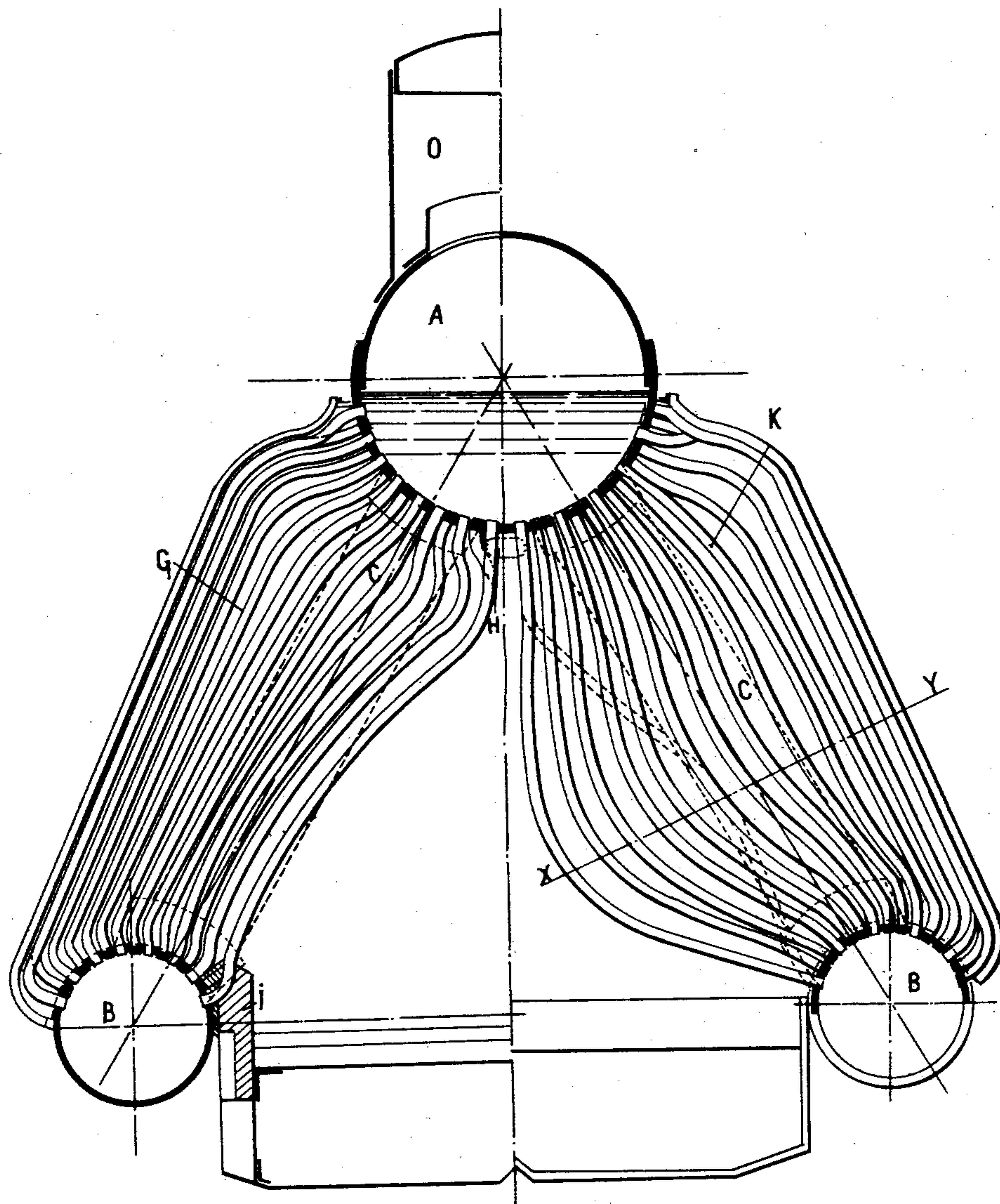
9 Sheets—Sheet 1.

A. NORMAND.  
STEAM BOILER.

No. 525,614.

Patented Sept. 4, 1894.

FIG. 1



Witnesses  
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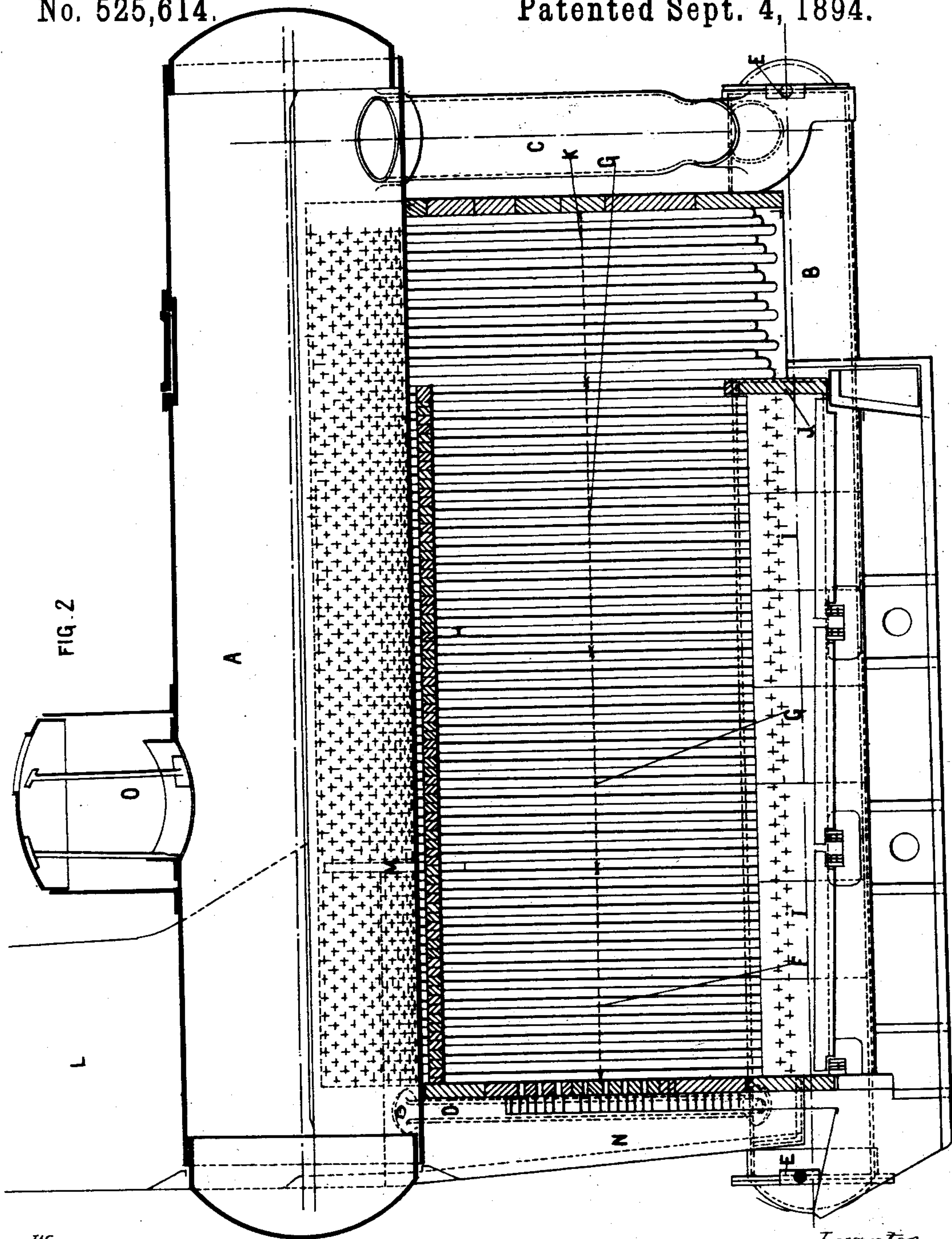
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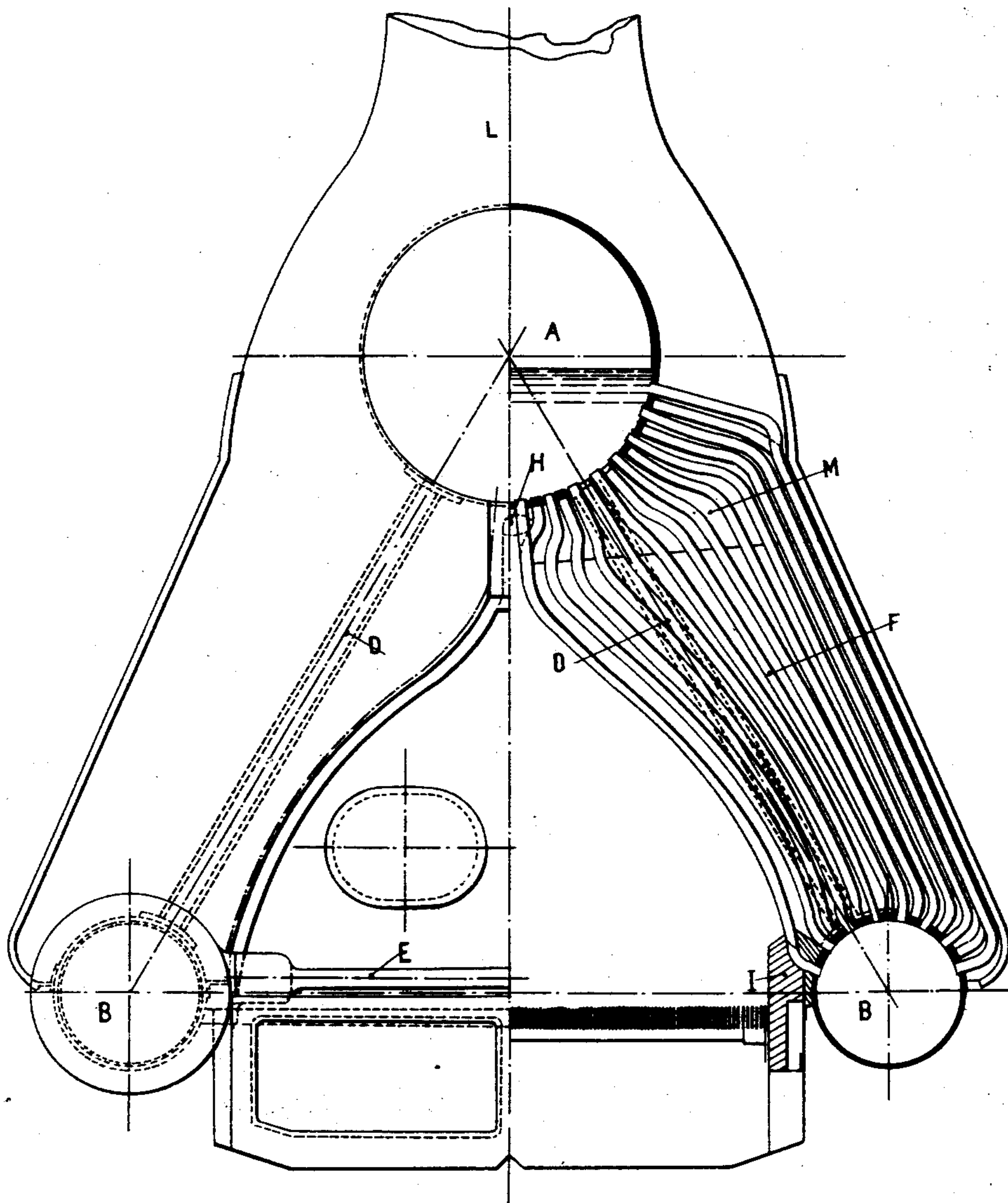
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FIG 3



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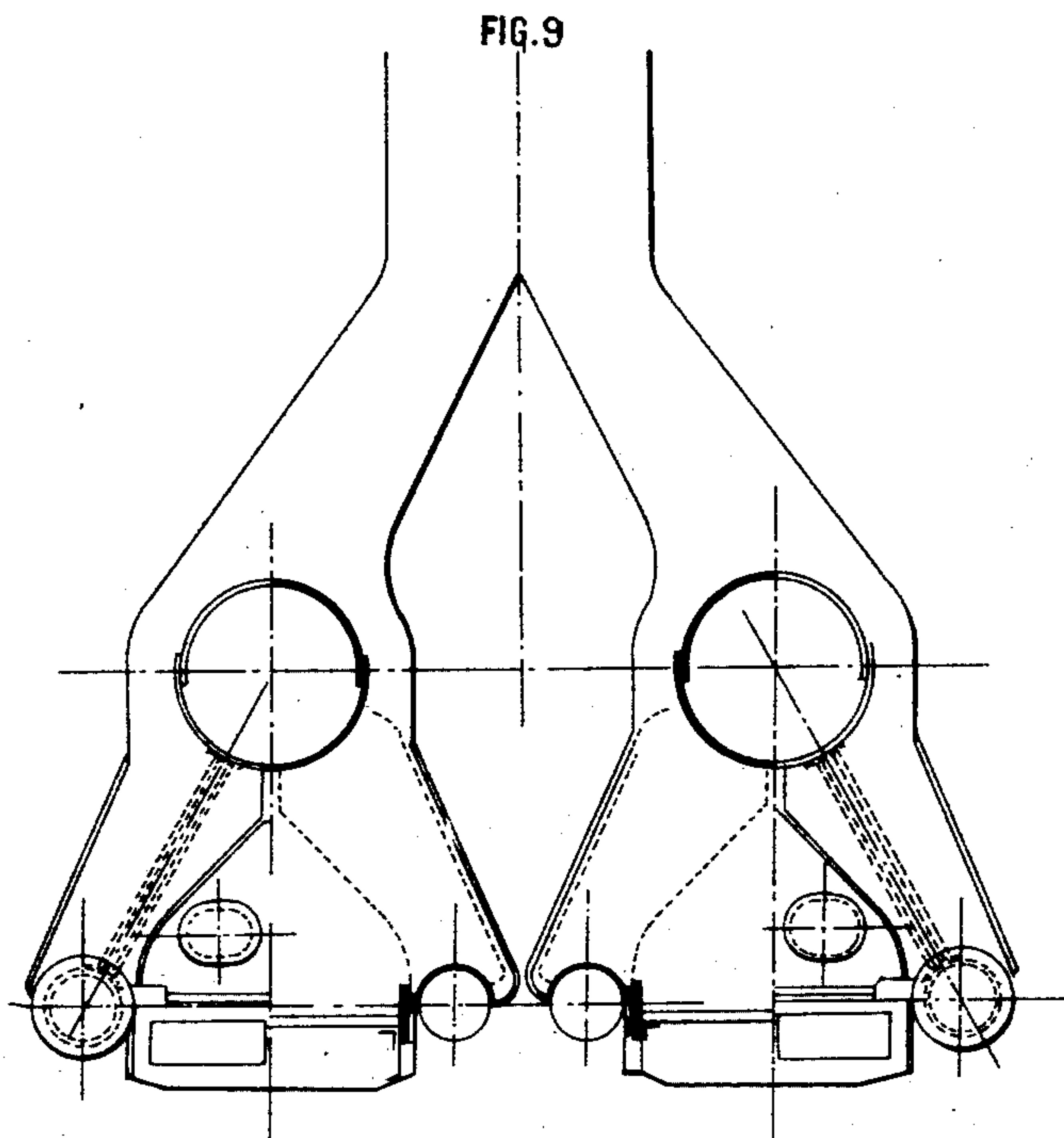
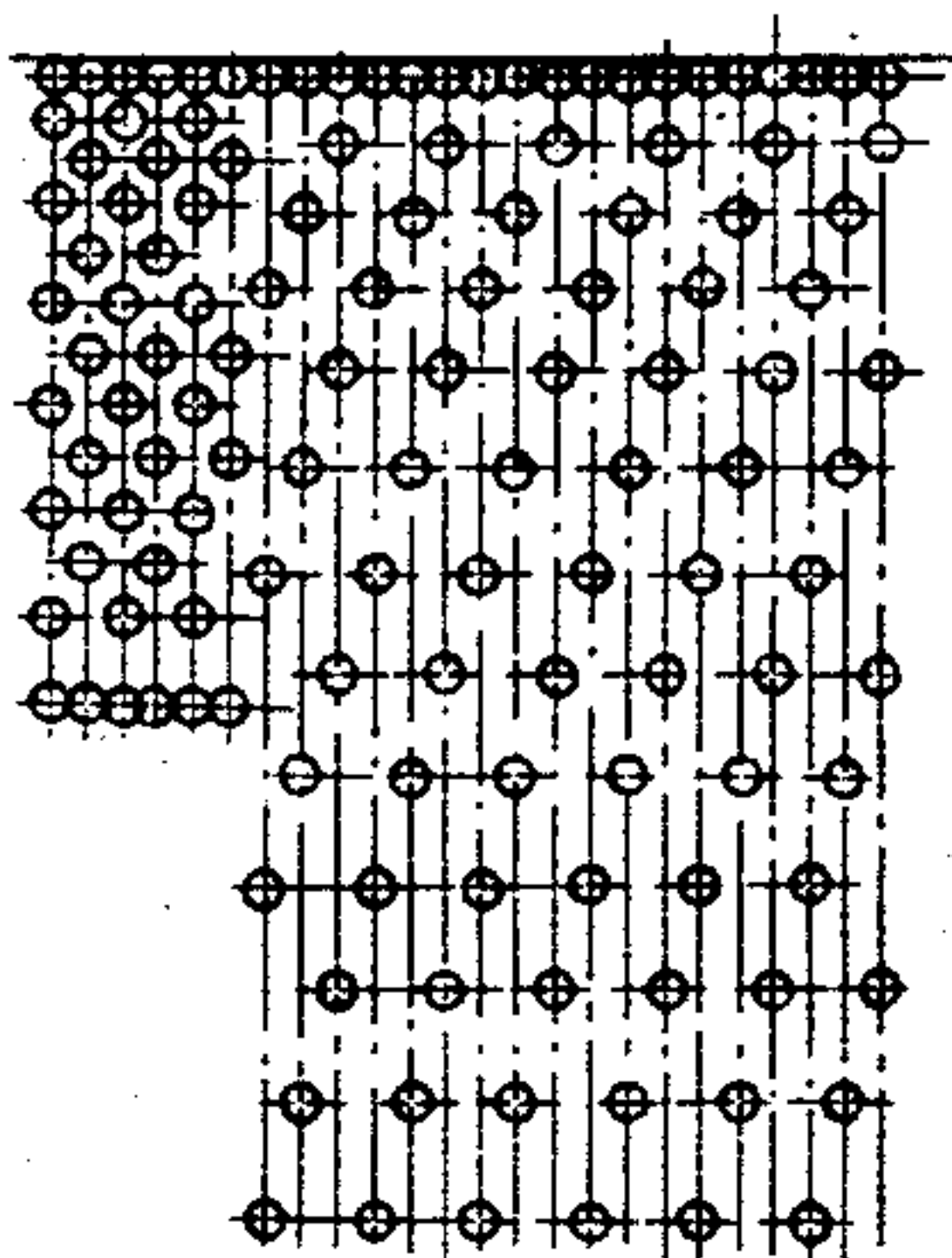


FIG. 4



Witnesses

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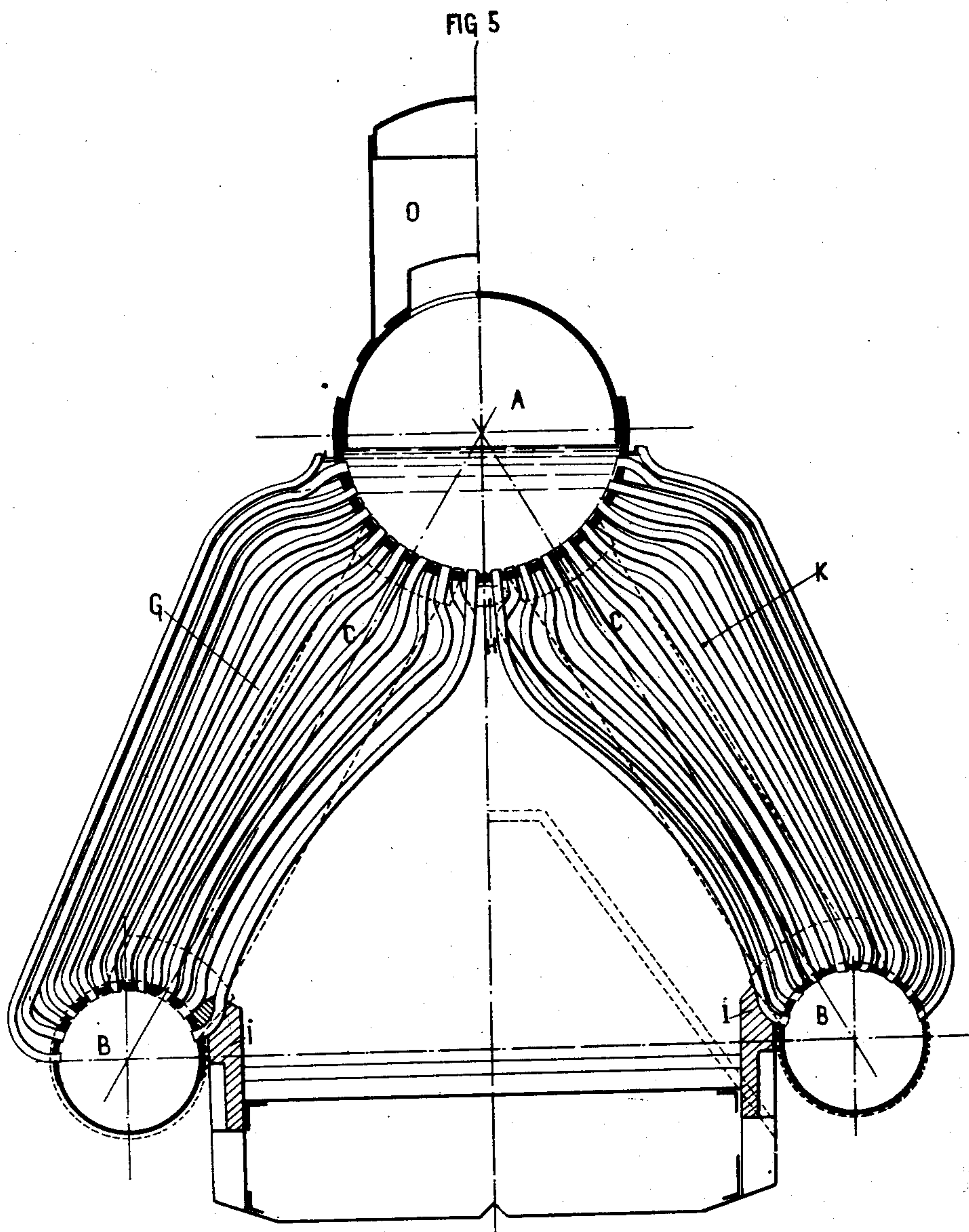
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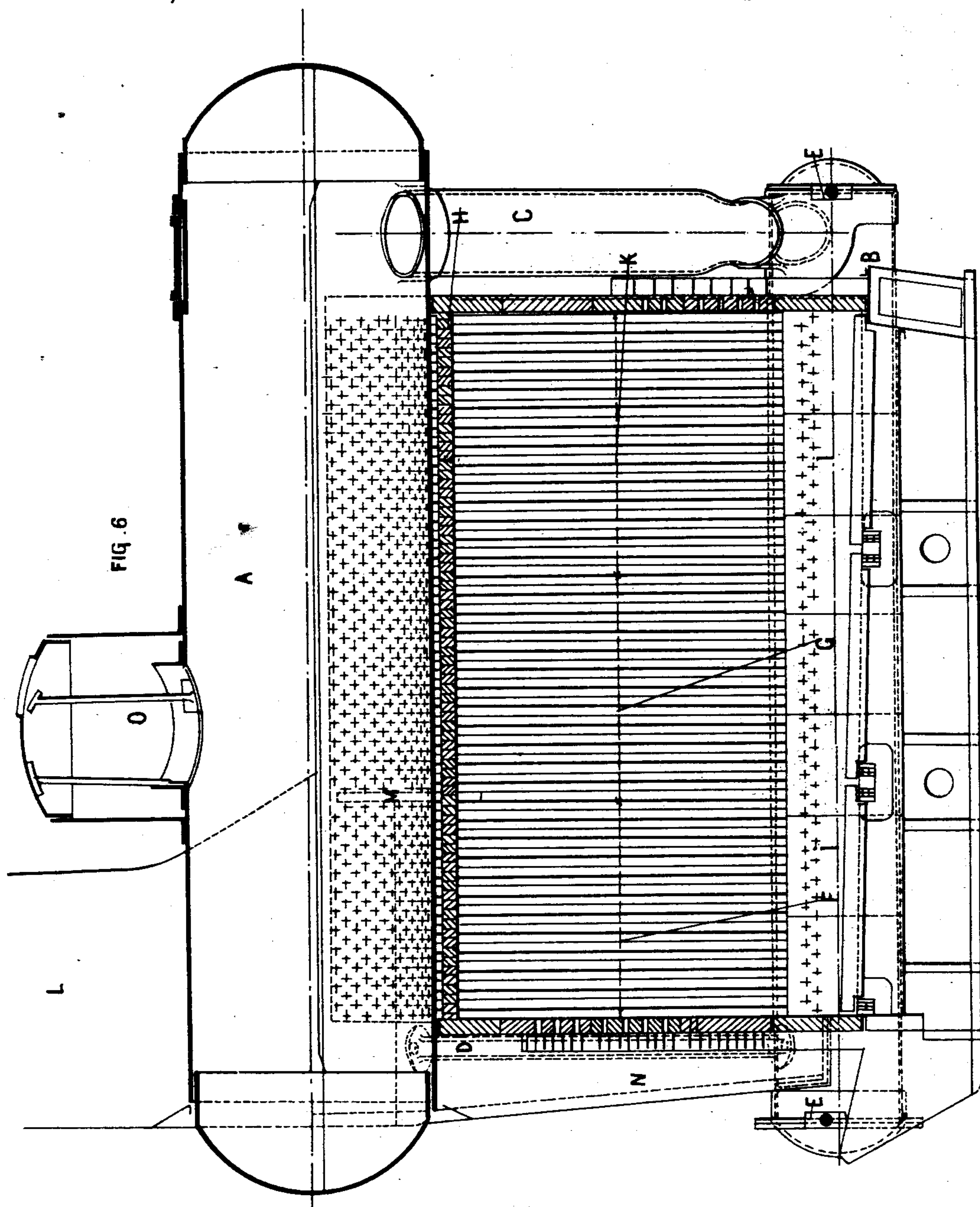
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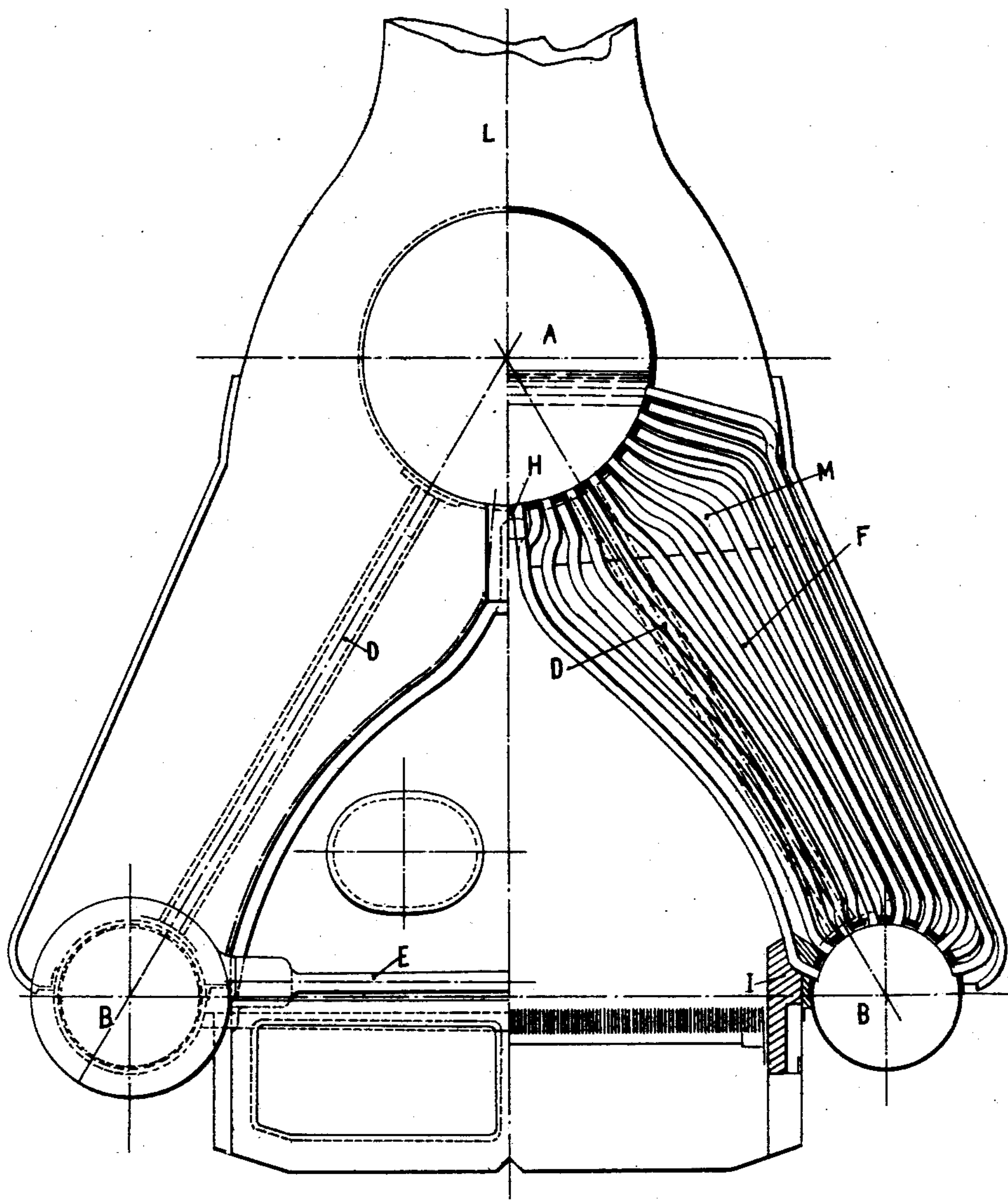
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FIG. 7



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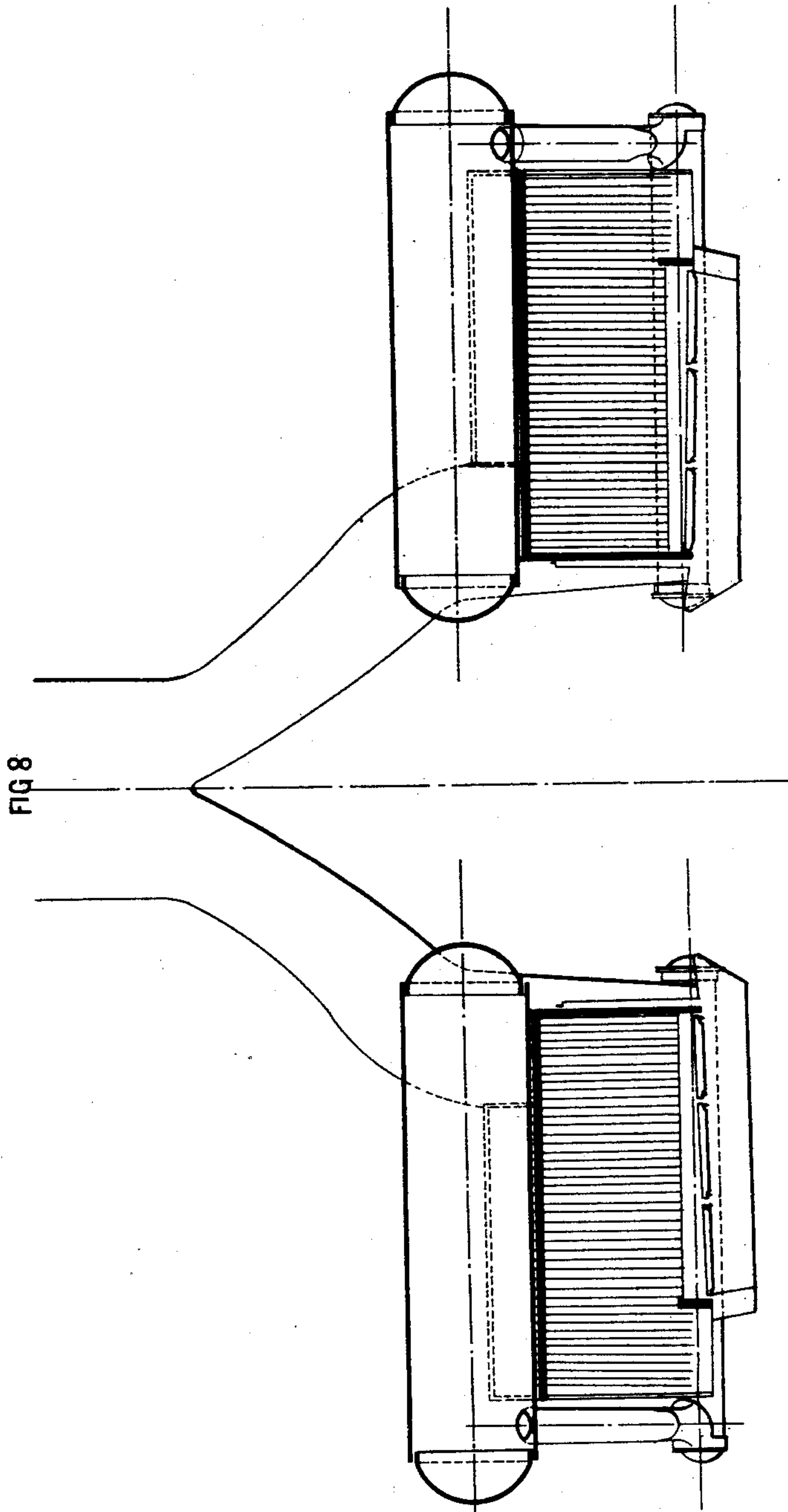
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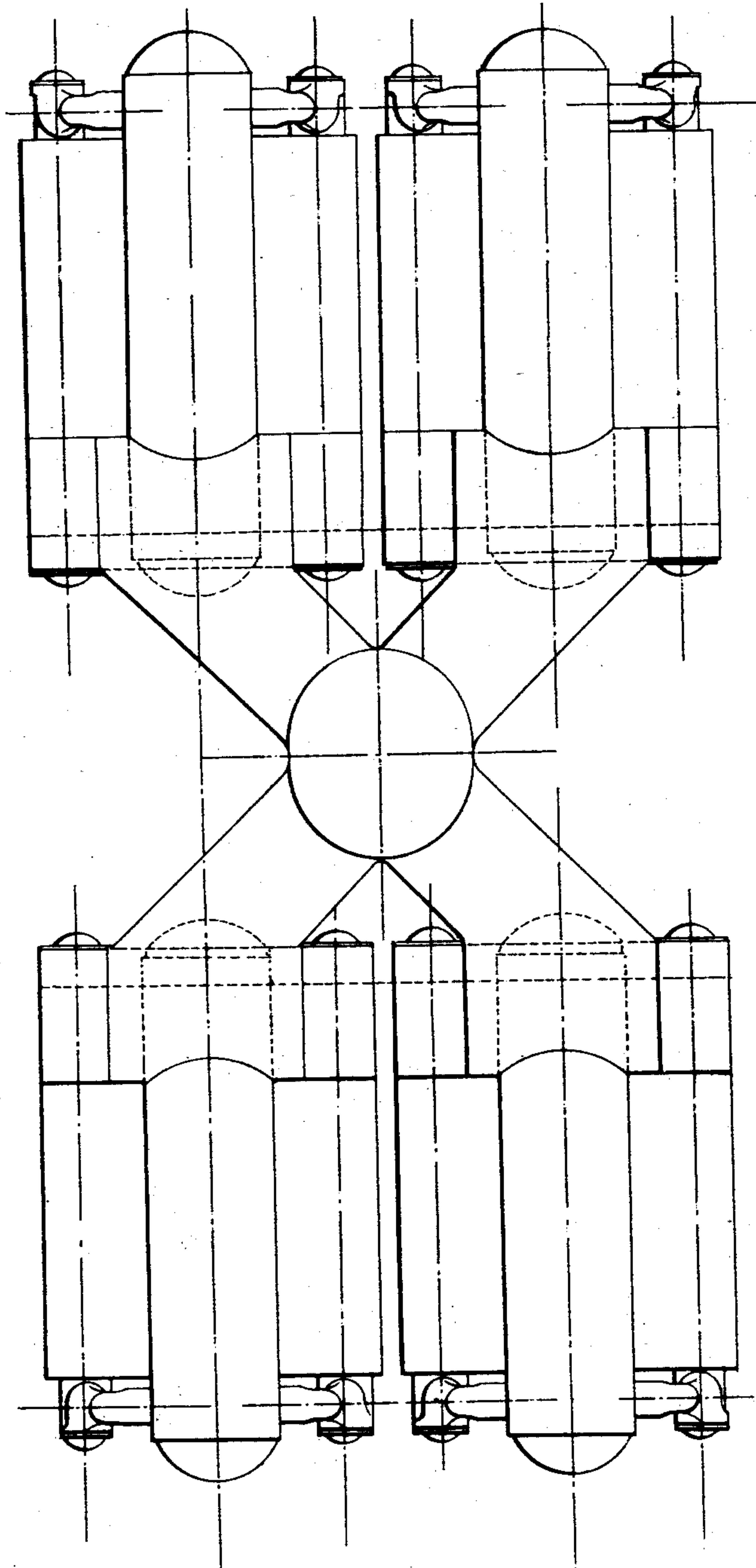
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FIG. 10.



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# UNITED STATES PATENT OFFICE.

AUGUSTIN NORMAND, OF HAVRE, FRANCE.

## STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 525,614, dated September 4, 1894.

Application filed March 15, 1894. Serial No. 503,756. (No model.)

*To all whom it may concern:*

Be it known that I, AUGUSTIN NORMAND, a citizen of France, and a resident of Havre, in the Department of the Seine Inférieure, France, have invented a new and useful Improvement in Steam-Boilers, of which the following is a specification.

This invention relates to improvements in steam generators or boilers of the class in which an upper chamber or upper chambers is or are connected to a lower chamber or lower chambers by two systems of tubes one system being composed of a large number of tubes of small diameter giving a large superficial area and exposed to the action of the fire and the other system being composed of a small number of tubes of larger diameter which are situated outside of the furnace and which serve to conduct the water previously conveyed to the upper chamber or chambers by the small tubes and which has not been converted into steam, back again into the lower chamber or chambers, an object of the invention being to provide an increased heating surface and to arrange the chimney at the front end of the generator whereby a group of boilers may be connected together by one chimney.

In most steam generators of this kind the flames and hot products of combustion rise vertically toward a chimney situated about the middle of the boiler crossing on their way the group of tubes. This gives a large volume of hot gases coming in contact with a relatively small heating surface only, a condition which utilizes only to a very small extent the heat contained in the products, while some of the tubes are not acted upon by the gases which pass up the chimney without their heat being properly abstracted and sometimes in a state of combustion.

In a more improved form of generator forming the subject matter of an invention for which Letters Patent were granted to me, dated January 7, 1890, No. 203,008, by the Republic of France, this disadvantage is obviated, the gases taking a horizontal course before reaching the chimney which is situated at the extreme end of the boiler remote from the firing space or stoke-hole.

In the boiler or steam generator forming the object of the present invention this ad-

vantage is retained while a return passage of the gases and flames is effected. That is to say the gases take a horizontal course but after having reached the end of the boiler remote from the stoke-hole return in an opposite direction across the groups of tubes to the smoke box and chimney situated at the front of the boiler.

In order that my said invention may be fully understood I shall now proceed more particularly to describe the same and for that purpose shall refer to the several figures on the annexed sheets of drawings the same letters of reference indicating corresponding parts in all the figures.

Figures 1, 2, 3 and 4 of the drawings represent views of one form of boiler constructed according to this invention, Fig. 1 being a transverse section on the lines 1, 1 and 2, 2 of Fig. 2, Fig. 2 being a central longitudinal section, Fig. 3 a half transverse section on the line 3, 3 and a half front elevation (Fig. 2), and Fig. 4 a transverse section on the line X Y (Fig. 1). Figs. 5, 6 and 7 represent similar views of a modified form of boiler constructed according to this invention, Fig. 5 being a transverse section on the lines 4, 4 and 5, 5 (Fig. 6), Fig. 6 a central longitudinal section and Fig. 7 a half front elevation and a half transverse section on the line 6, 6 (Fig. 6). Figs. 8, 9 and 10 show the arrangement of a group of four generators constructed according to the present invention, and arranged suitably for a steam-ship. Fig. 8 shows a longitudinal section through two of the boilers, Fig. 9 a part transverse section and part front elevation of a pair of the boilers, and Fig. 10 a general plan of the group of boilers.

Referring to Figs. 1 to 4 the upper drum or chamber A, which is partially filled with water communicates with the lower drums or chambers B by tubes C of large diameter situated outside of the furnace and by rigid stay tubes D the heat of which tubes is limited to that derived from the water and which are situated at the opposite end to the tube C. Horizontal stays E at either end also serve to form a rigid connection between the lower drums or chambers B, the three chambers thus forming a whole sufficiently rigid to withstand the steam pressure and the stresses due to the distortion of the heating tubes.



The said heating tubes are arched or curved so as to be able to expand and contract freely. They are secured in the upper drum A below the water level and are composed of three systems or groups longitudinally with the boiler. The two first groups F G form a kind of vault or arch the first or inner rows of tubes of each of these groups being arranged in the same plane and so form a kind of screen the impermeability or tightness of which is obtained either by arranging the tubes in such a manner that they form an unbroken surface or by allowing a slight space between the said tubes which may be filled with some material such for example as woven or fibrous asbestos which being in contact with these heating tubes which are always full of water will last for a considerable time. The space situated below this arch forms the combustion chamber and the gases cannot escape vertically or at least, such small volumes as may escape between the tubes will be so small as to be quite inconsiderable in the working of the boiler. The screen is completed by a central longitudinal line of bricks H at the top and by brickwork I and a lining of asbestos or the like to cover the spaces at the lower ends of the tubes.

Beyond the bridge J is a second group of tubes K, made up of tubes spaced some distance apart so as not to extinguish the gases not yet consumed. These gases are then diverted to the right and left returning in an opposite direction namely toward the front of the boiler through the two groups of tubes F G. The tubes of the outer row of each of the three bunches or groups are placed close together so as to form a screen as far as the opening to the chimney, where they separate at the top so as to give a free passage for a portion of the gases. The remaining portion of the gases deflected by the inverted bridge M continues its horizontal movement finally being discharged into the smoke box N. The said box N is preferably constructed so as to reach down to the lower drums B so that the draft caused by the chimney forces a part of the gases into the box to heat the lower parts of the tubes in front of the generator. The bunched tubes are inclosed by a thin sheet iron casing made as tight as possible to prevent the admission of air which would tend to destroy the draft. The readmission of air into the furnace and above the grate after the said air has been raised in temperature by contact with the outer casing may also be applied to this generator in the same manner as this is effected in an earlier boiler constructed by me.

The heating tubes are preferably expanded into the drums or chambers and may be of steel, iron, copper or any other suitable metal and they may be say of from twenty to forty millimeters internal diameter. The lower drums or chambers B are preferably cylindrical and of an internal diameter sufficiently

large to admit a child or a slender adult, a diameter of say about sixteen inches being sufficient for this purpose.

Instead of having a steam dome as shown in Figs. 1 and 2 the diameter of the upper drums or chambers may be increased as in the arrangement shown in Figs. 8, 9 and 10 of the drawings so as to give an increased steam space.

One of the principal advantages of the boiler constructed as hereinbefore described consists in that the heated gases do not penetrate immediately into the groups of tubes and being caused to travel a distance of sufficient length under the vault or archway formed by the tubes the height of the said tubes above the grate surface may be diminished and their number be increased. In the accompanying drawings the tubes are shown as being of uniform diameter but the tubes may also have two different diameters except those in the rows which form the screens.

In the slightly modified arrangement of the boiler Figs. 5, 6 and 7 the fire grate extends the whole length of the groups of tubes F. G. K. the groups F. G, as in the boiler hereinbefore described, having each of their innermost rows of tubes arranged close together to form a practically continuous surface, but the group K which is most remote from the front of the generator having its inner row openly arranged so as to permit of the free passage of the gases, the number of tubes of different curvatures in the said groups being as few as possible. The same system of reducing the number of different curvatures of the tubes forming the group situated behind the fire-bridge J may be applied in the arrangement of generator hereinbefore described with reference to Figs. 1, 2, 3 and 4.

By placing the chimney at the front end of the generator the grouping of generators is facilitated and diminishes the number of chimneys necessary on board steam-ships. In Figs. 8, 9 and 10 for example four generators are shown with but a single chimney. In this arrangement the firing space or stoke-hole is shown common to all the four boilers. If the boiler room be considered too long by this arrangement, necessitating a partition or bulkhead between the two pairs of boilers, this only tends to encumber the firing space. Communication between the two holes can however be easily made.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

In a steam-generator, the combination with an upper chamber and lower chambers, of two or more groups of curved pipes of small diameter connecting said chambers and arranged in the form of an arch, the innermost and outermost tubes of the group over the grate being arranged in close juxtaposition



to form a return flue, and the tubes in the rear group being arranged in open order for the passage of the gases therethrough to said flue, a casing inclosing said tubes, flues of  
5 large diameter connecting the said chambers outside of the casing, a smoke flue communicating with the return flue near the front of the generator, a smoke box connecting the return flue and the combustion chamber,  
10 and an inverted bridge M for diverting a

portion of the products of combustion into said smoke box, substantially as described.

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

AUGUSTIN NORMAND.

Witnesses:

J. HARNÉ,

G. C. KING.