No. 754,128. PATENTED MAR. 8, 1904.

C. G. CURTIS.

STEAM BOILER.

APPLICATION FILED MAR. 27, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

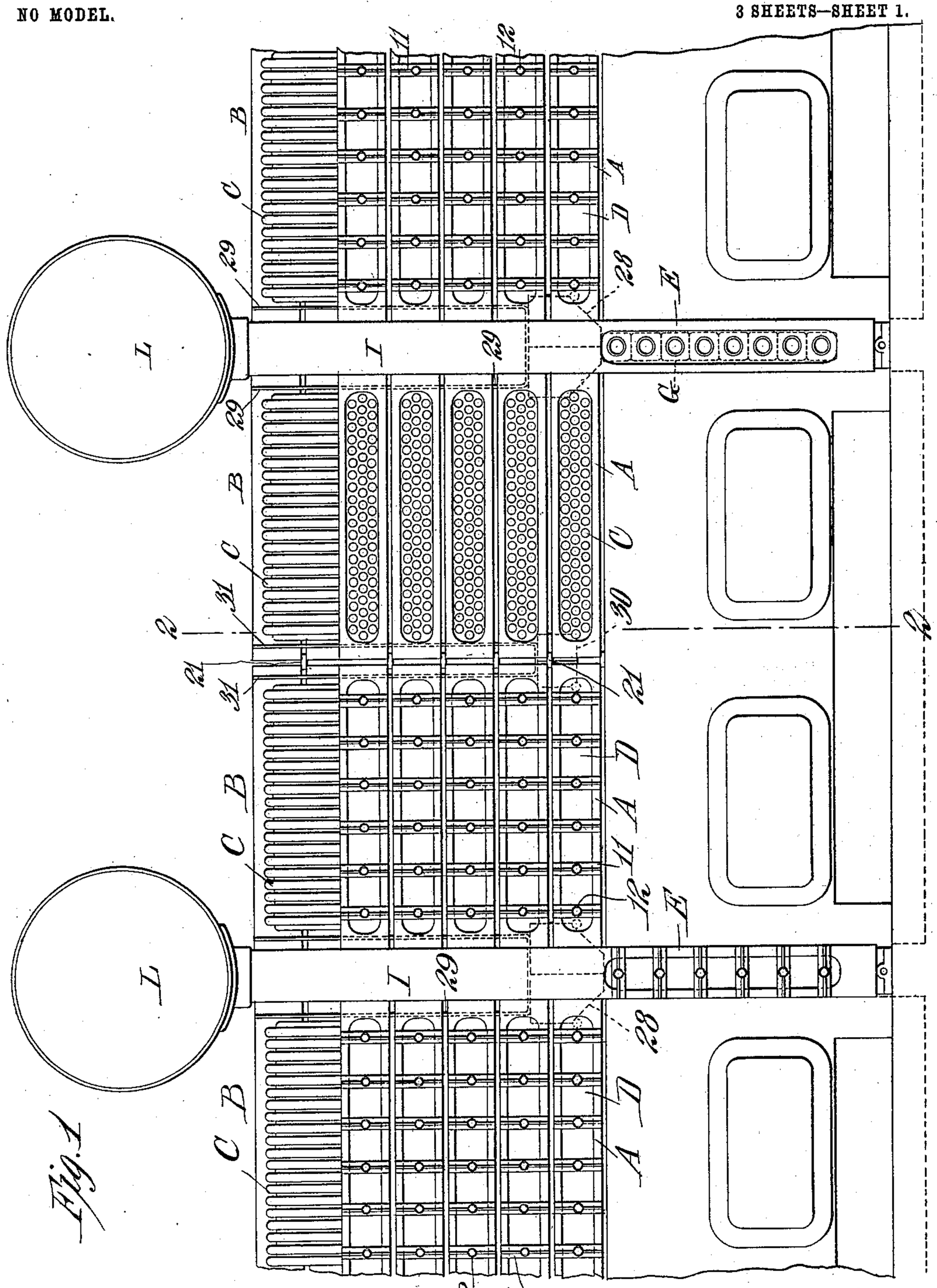

Fig. 1.

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 5

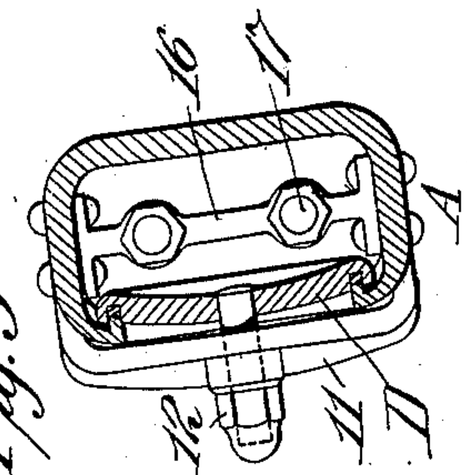


Fig. 4

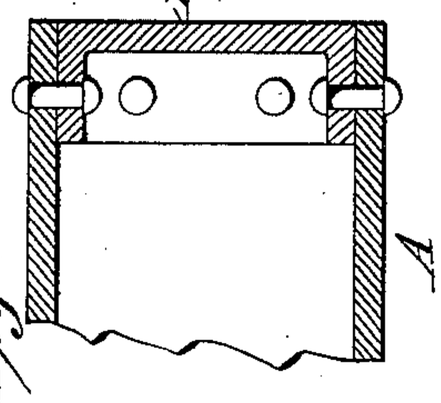
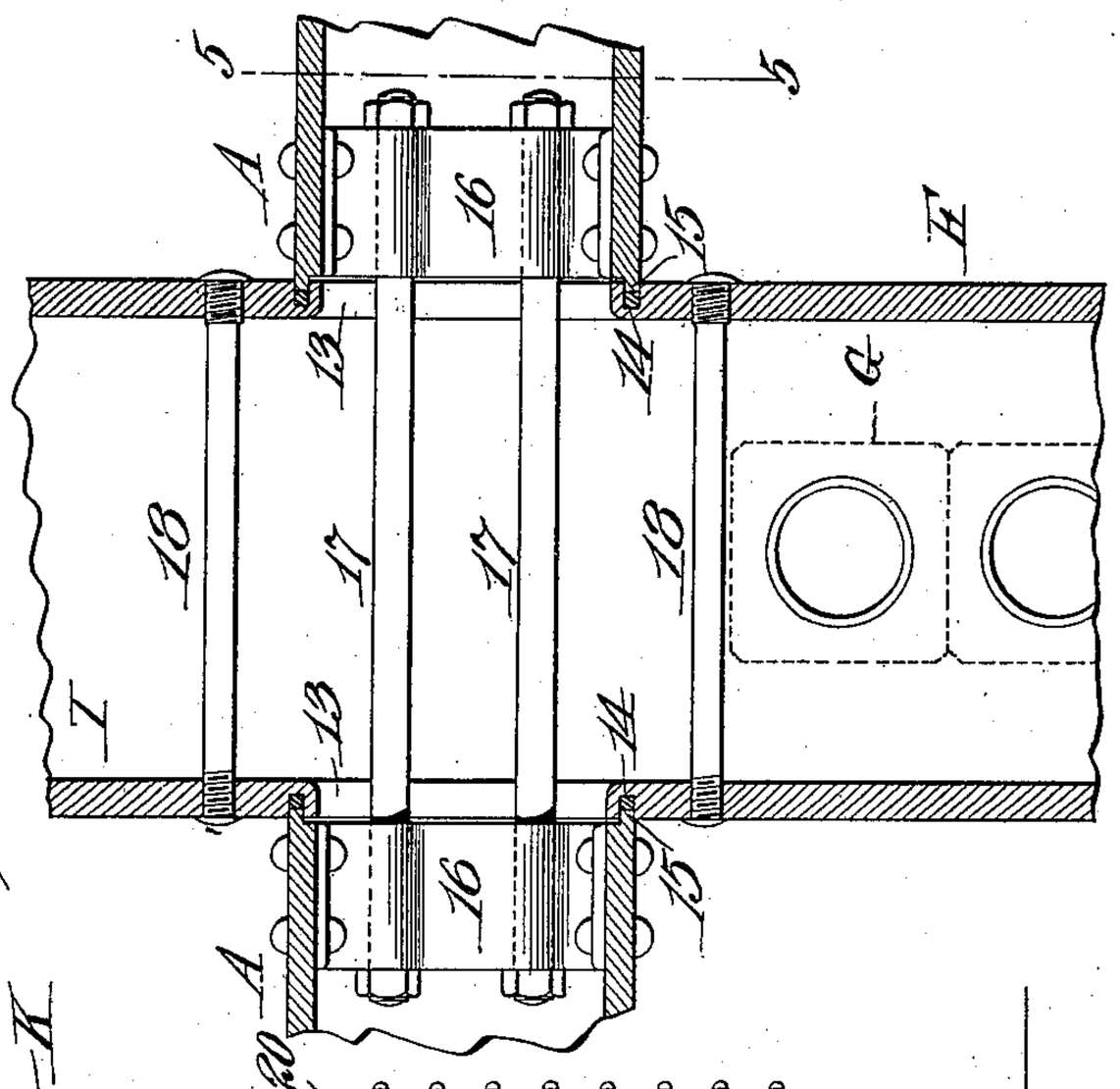


Fig. 3



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NO MODEL. 3 SHEETS—SHEET 3.

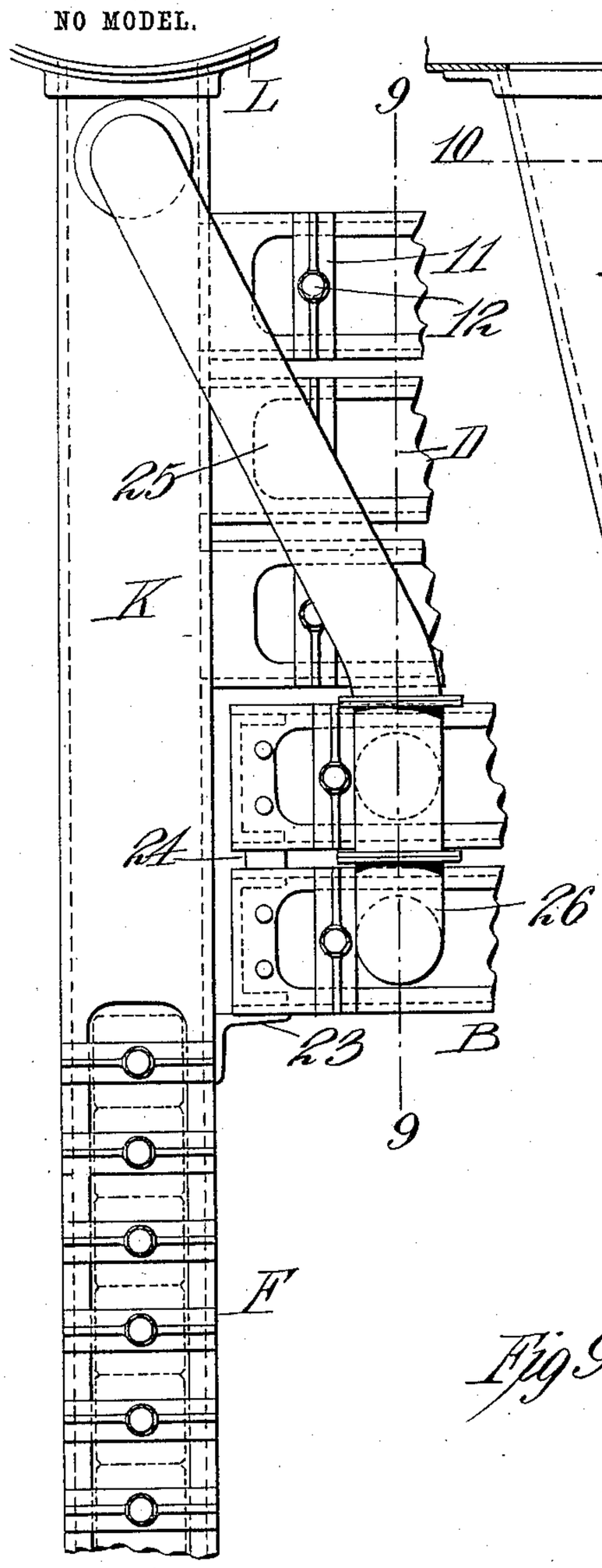

Fig. 8

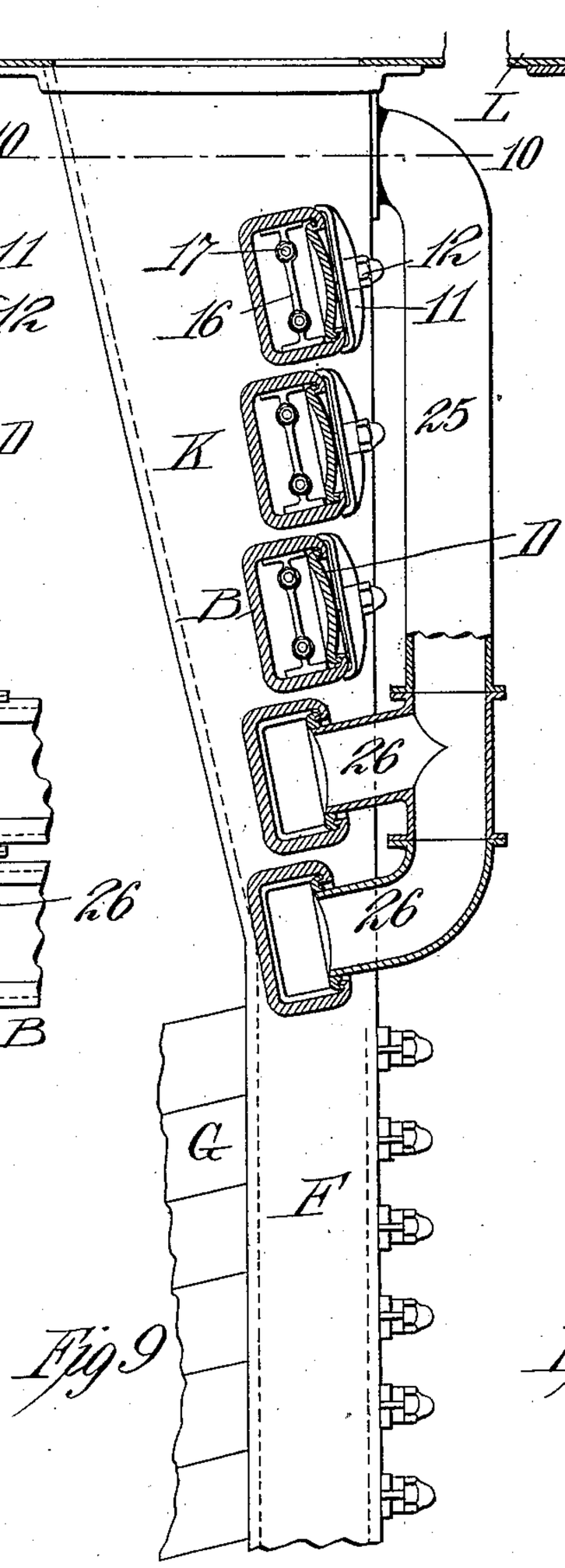

Fig. 9

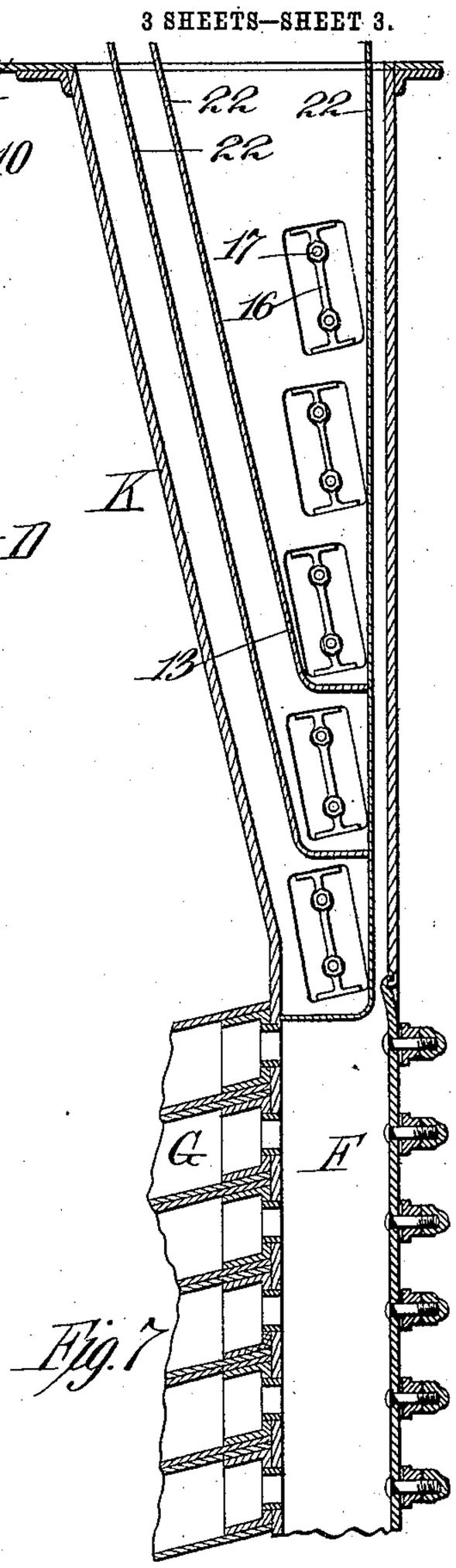

Fig. 7

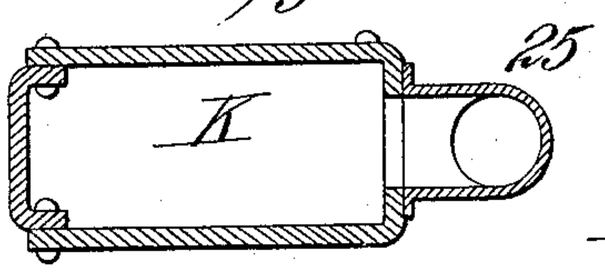

Fig. 10

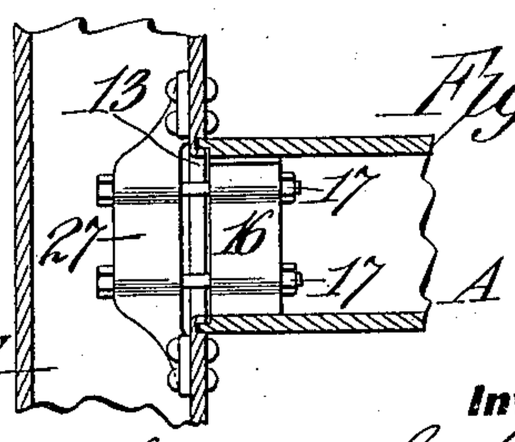

Fig. 6

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No. 754,128. Patented March 8, 1904.

UNITED STATES PATENT OFFICE.

CHARLES G. CURTIS, OF NEW YORK, N. Y.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 754,128, dated March 8, 1904.

Application filed March 27, 1903. Serial No. 149,837. (No model.)

To all whom it may concern:

Be it known that I, CHARLES G. CURTIS, a citizen of the United States, residing in the borough of Manhattan, city of New York, State of New York, have invented a certain new and useful Improvement in Steam-Boilers, of which the following is a description.

Experience has shown it to be exceedingly desirable that water-tube boilers should possess the following features: first, accessibility of the tubes for internal cleaning and for removal through removable covering-plates; second, absence of baffle-plates, which become warped and destroyed by the heat and collect dust and cinders; third, a close proximity of the tubes, so as to afford a comparatively limited area for the escape of the products of combustion, and, fourth, accessibility to the spaces between the tubes to enable their external surfaces to be cleaned from the front or rear of the boiler, and preferably without withdrawing the fires. These features have not heretofore been combined in the same boiler. The purpose of my invention is to accomplish this result.

In my improved boiler a number of sections are employed composed of headers and water-tubes connecting their inner or adjoining walls, the hot gases of combustion passing transversely through the spaces between the tubes. The tubes are placed in such close proximity that the combined area of the tube-spaces to which the gases are confined in their escape may be the usual ten to twenty-five per cent. of the grate-surface, and a single passage of the products of combustion through a moderate number of superposed rows of tubes will afford abundant opportunity for the transfer of heat from the products of combustion to the water within the tubes, owing to the uniform distribution of the products in thin streams over the tubes. Efficient extraction of their heat may thus be secured with a moderate number of tubes and without baffle-plates to direct the gases two or more times through the tube-spaces. To give access to the tubes for cleaning them internally or for removal and replacement, the outer walls of the headers, or those at one end, are provided with covered openings which expose the ends of all the tubes. Each of these openings covers a group of tubes occupying a substantial portion of the transverse area of the boiler-section. The larger spaces or gaps which are necessarily left between tubes of adjoining groups or between the outside groups and the side walls or partitions of the boiler are closed, so as to confine the escape of the gases to the small spaces between the tubes. Openings for exposing single tubes cannot be employed with tubes of the desirably small size, because with the necessary close proximity of the tubes there is not room in the outer walls of the headers for the openings and their covers and steam-tight joints. Openings exposing each a small number of tubes are also impracticable, because the numerous small groups of tubes would produce numerous gaps between the groups which would have to be closed in order to confine the gases to the tube-spaces, and this would result in complication and in an undesirable reduction of tube-surface for a given transverse area. The oblong openings in the outer walls of the headers of my improved boiler are covered by oblong plates, such as are described in my application for patent, Serial No. 145,913, filed March 3, 1903, which are larger than the openings and are introduced into the headers through the openings by tilting them to an angle both lengthwise and crosswise, when they are drawn to seats on the inner side of the outer walls of the headers and held in place by cross-bars and bolts, the joints being made steam-tight by the use of tongue-and-groove joints with gaskets. The covers are thus fitted on the inner side of the openings, and the steam-pressure assists in keeping the joints steam-tight. The boiler-sections are preferably arranged horizontally one above another, the gases passing directly upward and transversely through the tube-spaces of the two or more sections, and the tubes of the sections are also inclined to insure the circulation of the water through them to and from the steam-drum. No baffle-plates being used, the dust from the products of combustion accumulates only on the surfaces of the water-tubes. I provide for the removal of the dust by supporting the superimposed headers so as to leave a space be-

tween them large enough to permit the introduction of a steam-hose and brushes at the front or rear of the boiler, or both, for removing the dust or scale from the tubes, thus doing away with the necessity of leaving spaces at the sides of the boiler or between divisions of the boiler for giving access to the boiler from the sides. The sections are connected with the steam-drum by removable connections, so that the sections can be independently removed from the boiler for inspection or repair or for replacement by new sections, thus enabling the maintenance of the boiler in good condition. The boiler is provided with water-leg partitions between divisions or at the sides of the boiler, these being formed by upright headers connected at least up to the level of the lowermost water-tube sections by rectangular water-tubes without spaces between them, these headers being continued upwardly as stand-pipes to the steam drum or drums, which are supported upon them. The headers of the water-tube connections, or at least one set of such headers, are connected directly at one end to the partition stand-pipes by removable connections located inside of the water-space and accessible through the openings in the headers, thus permitting the removal of the sections and providing for the connection of the headers with the steam-drum without a multiplicity of small nipples and joints. This construction in addition enables the headers of the water-tube sections and the partition-headers and stand-pipes to be made up of heavy-platework, like the Scotch boiler.

In the accompanying drawings, Figure 1 is a front elevation of the boiler with the front wall removed and the covers of a number of the front headers also removed. Fig. 2 is a vertical section on line 2 2 of Fig. 1, the front and rear walls or plates of the boiler being removed. Fig. 3 is a sectional view showing the manner of connecting the headers of the horizontal water-tube sections with a stand-pipe of one of the water-leg partitions. Fig. 4 is a sectional view showing the manner of closing the ends of the water-tube headers which are not connected with the stand-pipes. Fig. 5 is a cross-section of one of the water-tube headers, taken on line 5 5 in Fig. 3. Fig. 6 is a view similar to Fig. 3, showing the connection of a water-tube header with a stand-pipe of the water-leg partition forming the outer side of the outer division of the boiler. Fig. 7 is a vertical section through the rear stand-pipe of one of the water-leg partitions, showing the division of the stand-pipe into a number of water-circulating channels. Fig. 8 is an elevation taken at the rear of the boiler, showing a modified way of supporting and connecting the rear headers of the two lower water-tube sections with the water-leg stand-pipe. Fig. 9 is a section on line 9 9 in Fig. 8, and Fig. 10 is a section on line 10 10 in Fig. 9.

The boiler is made up of water-tube sections each composed of horizontal headers connected by inclined water-tubes and arranged one on top of another. The boiler is set up in divisions each containing, preferably, two stacks of these sections, the divisions being separated by water-leg partitions and having separate fire-boxes and grates. The headers A and B of the water-tube sections are made of wrought-steel and may be formed of tubes crushed into rectangular form in cross-section. The inner or adjoining walls of each pair of headers are connected by water-tubes C, which are expanded into openings in such walls. The outer wall of each header is provided with an oblong opening extending substantially the entire length of the header, which opening is closed by a steam-tight cover D, closing the opening from the inner side of the header by means of a tongue-and-groove joint, the cover being drawn to its seat and held in place by cross bars or yokes 11, through which bolts from the cover pass, receiving upon their outer ends nuts 12. (See Fig. 5.) The cover D is removable through the opening in the header, as described in my application, Serial No. 145,913, filed March 3, 1903. By providing a single oblong opening in each header extending practically its entire length the water-tubes of each section can be closely spaced and can be uniformly distributed over the entire space occupied by the inner wall of the header opposite such opening, so that the entire space between the headers, except for a necessary margin at the ends and at the top and bottom edges, can be filled with water-tubes uniformly distributed and separated the minimum practicable distance. The boiler is built up of stacks of these sections placed one upon another, one end of the sections (preferably the rear end) being elevated above the other end, so as to incline the water-tubes and cause the circulation of the water therethrough. As illustrated in the drawings, the boiler is formed of several divisions separated by water-leg partitions, each division being provided with two stacks of the water-tube sections. Each of the water-leg partitions is composed of two vertical headers E F of rectangular form made of plates riveted together, Fig. 10, and connected opposite the fire-boxes of the boiler-divisions by pipes G of rectangular section, which are inclined and which are connected with the headers, as is described in my application before referred to. These water-leg headers are provided with oblong covered openings in their outer walls throughout the space occupied by the pipes G, as described in said application. The rectangular pipes G are in contact with each other, so as to form a closed partition between the fire-boxes of the adjoining boiler-divisions. Each of these boiler-divisions is provided with a grate H. The headers E F of the water-leg partitions are continued upwardly in the form

of uprights or stand-pipes I K, which expand or enlarge in an upward direction, so as to afford a space enlarging upwardly for the circulation of the water. The stand-pipes of each pair I K are connected to the opposite ends of a steam-drum L, which is supported upon the stand-pipes. The ends of the headers A B of the water-tube sections adjoining the stand-pipes I K of each water-leg partition are connected to such stand-pipes, so as to circulate the water therethrough and so as to be supported thereby in any suitable manner. An effective way of doing this is illustrated in Fig. 3. The side walls of the water-leg stand-pipe are provided with openings 13, around which grooves 14 are cut on the outer surface of the walls. The ends of adjoining water-tube headers are reduced to form tongues 15, which enter the grooves 14 and in conjunction with gaskets placed in said grooves form steam-tight joints between the headers and the stand-pipe. To hold the parts in position, each of the headers is provided at its end with a cross-brace 16, which is secured by rivets within the header, and these cross-braces are connected by bolts 17, having nuts on their ends which can be set up through the openings in the outer walls of the headers. Above and below the openings 13 in the water-leg stand-pipe the side walls of the stand-pipe may be connected with one or more stay-bolts 18, which engage, by means of screw-threads, with holes of different sizes in such walls, the ends of these bolts being cut off and upset into the form of rivets after the bolts are screwed into place. The bolts 18 strengthen the stand-pipes at the openings 13, preventing either the spreading or collasping of the walls. Where two stacks of headers are used for each boiler-division, and therefore only one end of each header can be connected with a water-leg stand-pipe, the other ends of the water-tube headers are closed by plates 19, Fig. 4, which are riveted in the ends of the headers. The adjoining ends of the headers of the lowermost water-tube sections are supported on plates 20, and blocks 21, inserted between the headers and those next above, continue and complete the support for all the water-tube headers at their ends which are not supported by the water-leg stand-pipes. The upwardly-enlarging water-circulating space afforded by the water-leg stand-pipes may in the case of the rear stand-pipe of each water-leg, through which the hot water flows upwardly from the water-tubes, be divided by sheet-iron partitions, so as to separate this space into channels for preventing eddies and making the circulation more effective. In Fig. 2 one of such partitions 22 is shown in dotted lines, while in Fig. 7 three of such partitions 22 are shown, dividing the space into four channels, one of which receives the water from the water-pipes of the water-leg and one from the three upper water-tube sections, while the two lowermost water-tube sections are provided with separate channels. The important thing to provide is a good circulation for the water from the two lower water-tube sections, since the tubes of these sections receive the first effects of the products of combustion and extract a larger proportion of heat therefrom than do the tubes of the sections above. Since the tubes of the two lower water-tube sections are subjected to a high degree of heat, it may be desirable to provide for a limited expansion or increase in length of these sections due to the effect of this heat. For that purpose the construction illustrated in Figs. 8 and 9 may be employed. In these figures the rear headers B of the two lowermost water-tube sections are not connected with the rear stand-pipes K of the water-legs, but have their ends adjoining the water-leg stand-pipes closed by plates, as illustrated in Fig. 4. The lowermost section is supported at the stand-pipe by a bracket 23, while a block 24 between the headers supports the upper of these two headers. For connecting the headers with the water-leg stand-pipe, so as to secure the return of the hot water to the steam-drum, a pipe 25 is employed, having connections 26 which extend to the covers of the headers. The pipe 25 extends obliquely upward and connects with the rear wall of the stand-pipe K near the steam-drum. The length of the pipe 25 permits a limited movement of the headers B of the two lower sections without breaking the connections. In Fig. 6 is illustrated the connection between the header of a water-tube section and one of the water-leg stand-pipes located at the outer side wall of the boiler and terminating the boiler in that direction. There being no header connected with the other wall of the stand-pipe, the bolts 17 extend from the brace 16 through a bracket 27, secured within the stand-pipe and crossing the opening 13.

In order to confine the escape of the products of combustion to the spaces between the water-tubes, I provide the following arrangement: At each water-leg partition there is supported upon the uppermost pipe G a line of fire-bricks 28, filling the space between the front and rear stand-pipes I K and extending up to or above the lower row of tubes of the second water-tube sections, as illustrated in dotted lines in Fig. 1. Upon this wall of fire-brick is placed a U-shape or double partition 29, of sheet-iron, which extends upwardly to the top of the uppermost water-tube sections, completing the separation of the two divisions of the boiler at this point and also confining the gases to the spaces between the water-tubes. At the center of each division of the boiler a similar arrangement is employed. This consists of a double line of fire-bricks 30, (shown in dotted lines in Fig. 1,) supported by the tubes at the adjoining ends of the lowermost water-tube sections and ex-

tending upwardly to the tubes of the sections next above. Upon this line of fire-bricks is supported a U-shape or double partition 31, of sheet-iron, which closes the space between the adjoining groups of water-tubes and prevents the gases from passing upwardly except through the spaces between the water-tubes themselves.

The products of combustion pass directly upward through the water-tubes without being deflected by baffle-plates. I am able to bring the tubes so close together that the cross-sectional area of the space through which the gases pass bears the usual relation to the grate area—*i. e.*, from ten to twenty-five per cent. of that area—so that the gases are choked back and caused to be distributed uniformly over the tubes, which afford the desirable large heat-absorbing surface compared with the size of the column of escaping gases to effectively extract the heat from such gases. It will be also observed that the steam-drums are connected with the water-tube sections through the stand-pipes of the water-leg partitions, thus doing away with the numerous connections which are necessary when vertically-arranged water-tube sections are employed which are individually connected with the steam-drums. It should be observed that by separating the headers of the superimposed water-tube sections for a short distance by means of the blocks 21 I provide a sufficient space between these headers to enable the introduction of a steam-hose for blowing the dust off of the water-tubes, a feature of great importance.

What I claim is—

1. In a steam-boiler, the combination of water-tubes located transverse to the flow of the products of combustion in the close proximity described, with removable covers, each exposing the ends of a number of the water-tubes, substantially as set forth.

2. In a steam-boiler, the combination of water-tubes located transverse to the flow of the products of combustion in the close proximity described, with removable covers, each exposing the ends of a number of water-tubes, and means for confining the escape of the gases to the small spaces between the tubes, substantially as set forth.

3. In a steam-boiler, the combination of water-tubes located in the close proximity described, with removable covers each exposing the ends of a group of water-tubes, and means for closing the larger spaces or gaps between the groups of water-tubes, substantially as set forth.

4. In a steam-boiler, the combination of two or more sections each composed of two headers connected at their inner walls by water-tubes located transverse to the flow of the products of combustion in the close proximity described, with oblong openings each exposing the ends of a group of tubes occupying a substantial portion of the transverse area of the section, and removable covers for such openings, substantially as set forth.

5. In a steam-boiler, the combination of two or more sections each composed of two headers connected at their inner walls by water-tubes located transverse to the flow of the products of combustion in the close proximity described, with oblong openings each exposing the ends of a group of tubes occupying a substantial portion of the transverse area of the section, and removable covers for such openings seated on the inner side of such openings, substantially as set forth.

6. In a steam-boiler, the combination of two or more sections each composed of two headers connected at their inner walls by water-tubes having the close proximity described, with oblong openings in the outer walls of the headers each exposing a group of tubes occupying a substantial portion of the transverse area of the section, removable covers for such openings, and means for confining the escape of the gases to the small spaces between the tubes, substantially as set forth.

7. In a steam-boiler, the combination of two or more sections each composed of two headers connected at their inner walls by a plurality of rows of small water-tubes located transverse to the flow of the products of combustion in the close proximity described, with oblong openings each exposing the ends of a group of tubes occupying a substantial portion of the transverse area of the section, and removable covers for such openings, substantially as set forth.

8. In a steam-boiler, the combination of two or more water-tube sections each composed of two headers, and water-tubes located transverse to the flow of the products of combustion connecting the inner walls of such headers and having the close proximity described, with a single oblong opening exposing the entire area occupied by the ends of water-tubes, and a single oblong cover for said opening seated on the inner side of the opening, substantially as set forth.

9. In a steam-boiler, the combination of two or more horizontal water-tube sections each composed of two headers and water-tubes having the close proxmity described, with means for confining the escape of the gases to the small spaces between the water-tubes, removable covers in the outer walls of the headers for exposing the ends of the water-tubes, upright stand-pipes connected with the steam-drum, and removable connections between the headers and such stand-pipes, substantially as set forth.

10. In a steam-boiler, the combination of two adjoining stacks of horizontal water-tube sections, each section being composed of two headers connected by water-tubes placed in the close proximity described, with removable covers in the outer walls of the headers for

exposing the ends of the water-tubes, stand-pipes supporting the headers at their outer ends and connecting them with the steam-drum, and means for closing the gaps between the water-tubes of the adjoining headers of the two stacks of sections, substantially as set forth.

11. In a steam-boiler, the combination of two or more divisions, each division being provided with two adjoining stacks of horizontal water-tube sections, and each of such sections being composed of two headers and water-tubes connecting their inner walls and located in the close proximity described, stand-pipes between the headers of adjoining divisions supporting such headers and connecting them with the steam-drum, means for closing the gaps between the water-tubes of the adjoining sections in each division of the boiler, and means for closing the gaps between the water-tubes of the adjoining sections of different divisions of the boiler, substantially as set forth.

12. In a steam-boiler, the combination with a horizontal header for a water-tube section, of an upright stand-pipe connecting the header with the steam-drum, a removable joint between the header and the upright, means for securing the header and upright together located within the water-space, and a cover on the header for giving access to the connecting devices, substantially as set forth.

13. In a steam-boiler, the combination with an upright connected with the steam-drum, of two headers for water-tube sections connected in line with each other on opposite sides of the upright, means for simultaneously clamping the two headers to the upright located in the water-space, and removable covers on the headers for giving access to the connecting devices, substantially as set forth.

14. In a steam-boiler, the combination with an upright connected with the steam-drum, of two headers for water-tube sections connected in line with each other on opposite sides of the upright, means for simultaneously clamping the two headers to the upright located in the water-space, removable covers on the headers for giving access to the connecting devices, and braces connecting the walls of the upright adjoining the clamping devices, substantially as set forth.

15. In a steam-boiler, the combination of two or more water-tube sections each composed of two headers connected by water-tubes located transverse to the flow of the products of combustion in the close proximity described, the escape of the products of combustion being confined to the spaces between the water-tubes, with spaces between the headers for permitting the cleaning of the outer surfaces of the tubes, and removable covers on the outer walls of the headers each exposing the ends of a number of the water-tubes, substantially as set forth.

16. In a steam-boiler, the combination of two or more superposed horizontal water-tube sections each composed of two headers, and water-tubes connecting such headers and having the close proximity described, with means for confining the escape of the gases to the small spaces between the water-tubes, spaces between the headers for permitting the cleaning of the outer surfaces of the tubes, and removable covers on the outer walls of the headers, each exposing the ends of a number of the water-tubes, substantially as set forth.

17. In a steam-boiler, the combination of the horizontally-arranged water-tube sections, the water-leg partitions separating divisions of the boiler, stand-pipes from said water-leg partitions connecting with the steam-drums, direct connections between opposite sides of such water-leg stand-pipes and the headers of adjoining water-tube sections, and a partition separating the space between the tubes of the water-tube sections connected with the stand-pipes, consisting of a wall of fire-brick filling the space between the tubes of the lowermost water-tube sections and a double metal partition extending from each side of the fire-brick wall to the top of the boiler, substantially as set forth.

18. In a steam-boiler, the combination of horizontally-arranged water-tube sections, stand-pipes to which the headers of said water-tube sections are directly connected in pairs at one end, the other ends of such headers being closed, and partitions between the adjoining closed ends of the headers closing the space between the water-tubes of the adjoining sections, consisting of a wall of fire-brick closing the space between the tubes of the lowermost sections and a double metal wall rising from opposite sides of the fire-brick wall to the top of the boiler, substantially as set forth.

19. In a steam-boiler, the combination with water-leg partitions separating the divisions of the boiler and having stand-pipes connected with the steam-drums, of horizontally-arranged water-tube sections placed one above another, two stacks of such sections being located between each pair of water-leg partitions, the ends of the headers of such sections adjoining the water-leg partitions being directly connected to the water-leg stand-pipes and the other ends of such headers being closed, and partitions filling the spaces between the water-tube sections at the water-leg partitions and between the tubes at the closed ends of the headers, consisting of walls of fire-brick and double metal partitions rising from the outer edges of such fire-brick walls to the top of the boiler, substantially as set forth.

20. In a steam-boiler, the combination with the horizontally-arranged water-tube sections, of the water-leg partitions, the stand-pipes from such partitions to which the headers of the water-tube sections are connected, such

stand-pipes being expanded upwardly, and partitions in said stand-pipes, substantially as set forth.

21. In a steam-boiler, the combination with the water-leg partitions and stand-pipes therefrom, of the horizontally-arranged water-tube sections, the headers of the upper water-tube sections being connected directly with such stand-pipes, the headers of the lower sections being connected to only one of such stand-pipes, and a connection from the other headers of such lower sections to the stand-pipe through a pipe or pipes permitting of the expansion of the water-tube sections, substantially as set forth.

22. In a steam-boiler, the combination of a plurality of layers of water-tubes arranged transverse to the flow of the products of combustion, water-chambers at the ends of the tubes, openings in the water-chambers with removable covers each exposing the ends of a number of tubes, spaces between the water-chambers giving access to the spaces between layers of tubes for cleaning the outer surfaces of the tubes, and means for confining the escape of the gases to the small tube-spaces, substantially as set forth.

23. In a steam-boiler, the combination of a plurality of layers of water-tubes arranged transverse to the flow of the products of combustion, each layer of water-tubes being composed of a plurality of groups of such tubes, water-chambers at the ends of the tubes, openings in the water-chambers with removable covers each exposing the ends of one of such groups of tubes, spaces between the chambers giving access to the spaces between layers of tubes for cleaning the outer surfaces of the tubes, and means for closing the gaps between the groups of tubes, substantially as set forth.

This specification signed and witnessed this 23d day of March, 1903.

CHARLES G. CURTIS.

Witnesses:
JNO. ROBT. TAYLOR,
JOHN LOUIS LOTSCH.