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W. H. FARRIS.

HEATING AND CIRCULATING DEVICES FOR STEAM-BOILERS.

No. 184,465. Patented Nov. 21, 1876.

Fig. 1

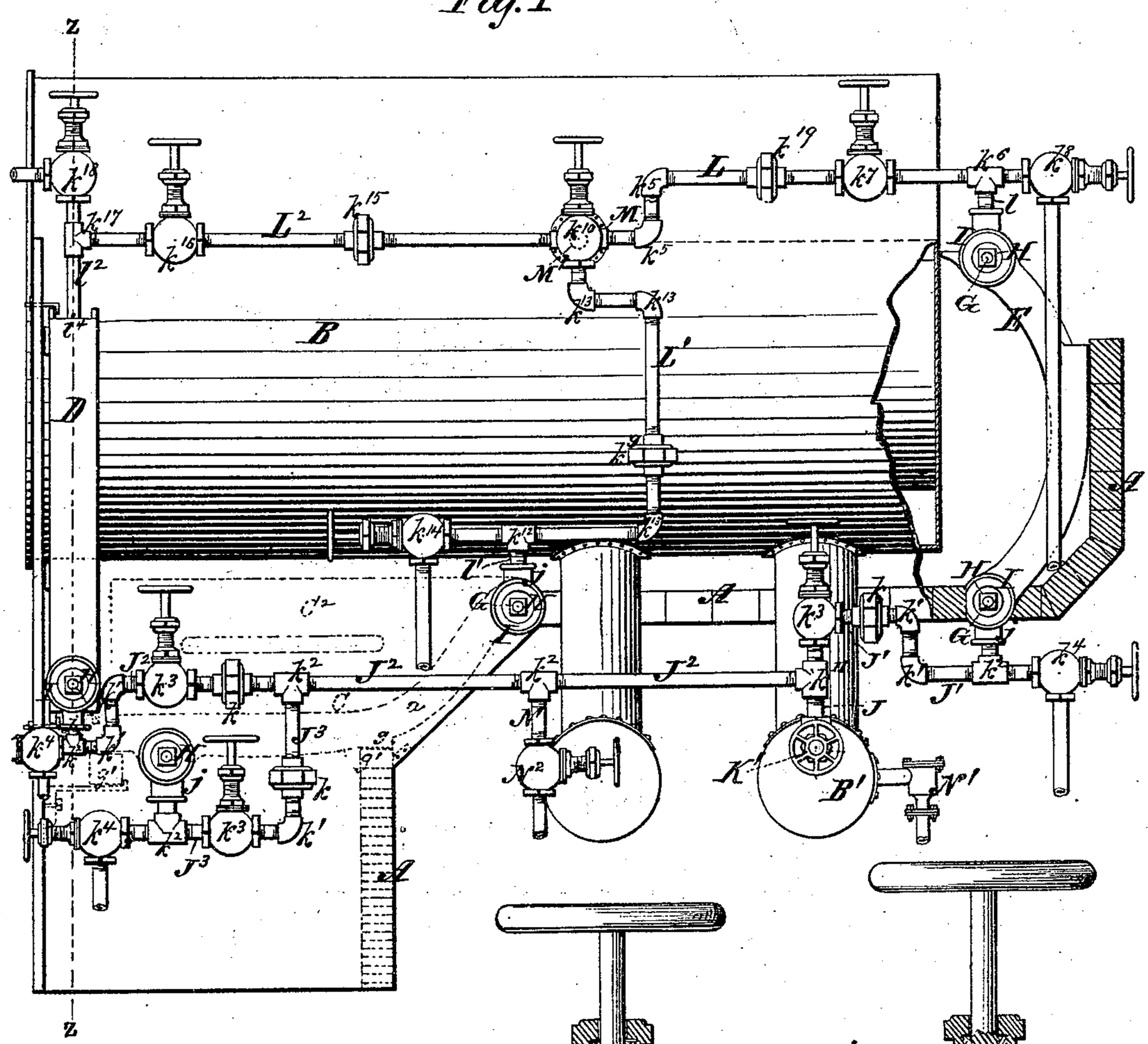


Fig. 2

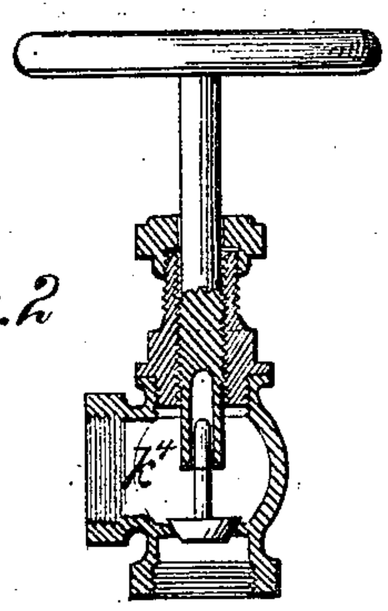
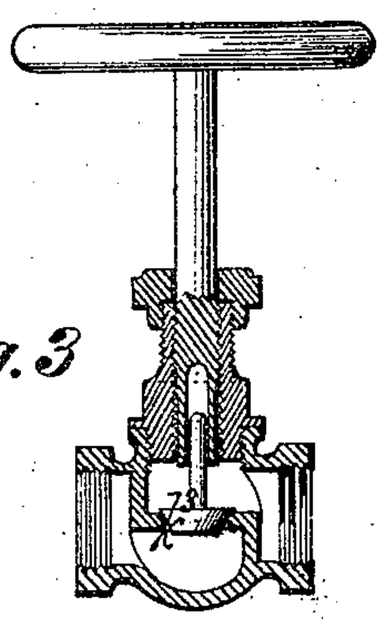


Fig. 3



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HEATING AND CIRCULATING DEVICES FOR STEAM-BOILERS.

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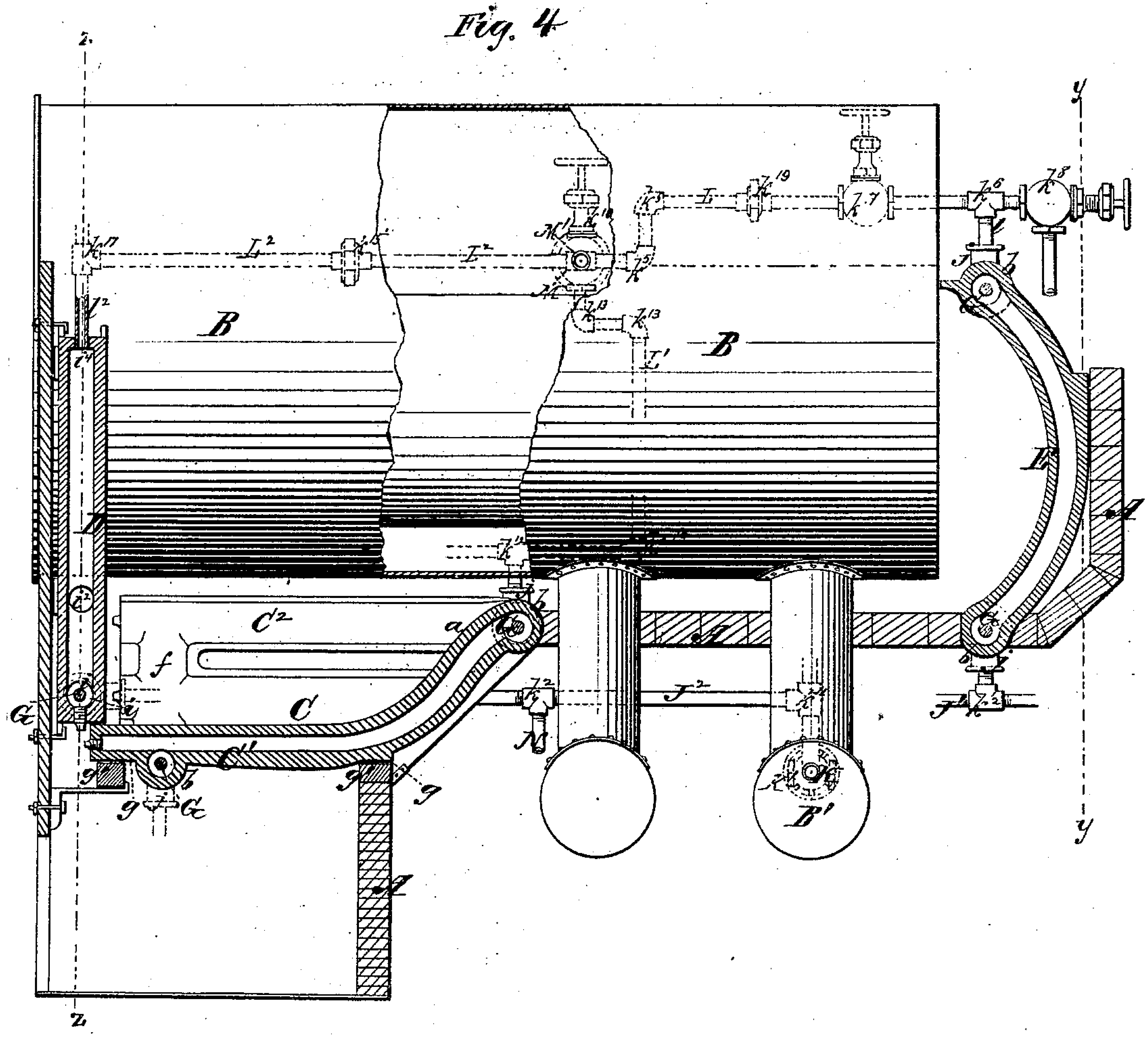
Fig. 4



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5 Sheets—Sheet 3.

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HEATING AND CIRCULATING DEVICES FOR STEAM-BOILERS.

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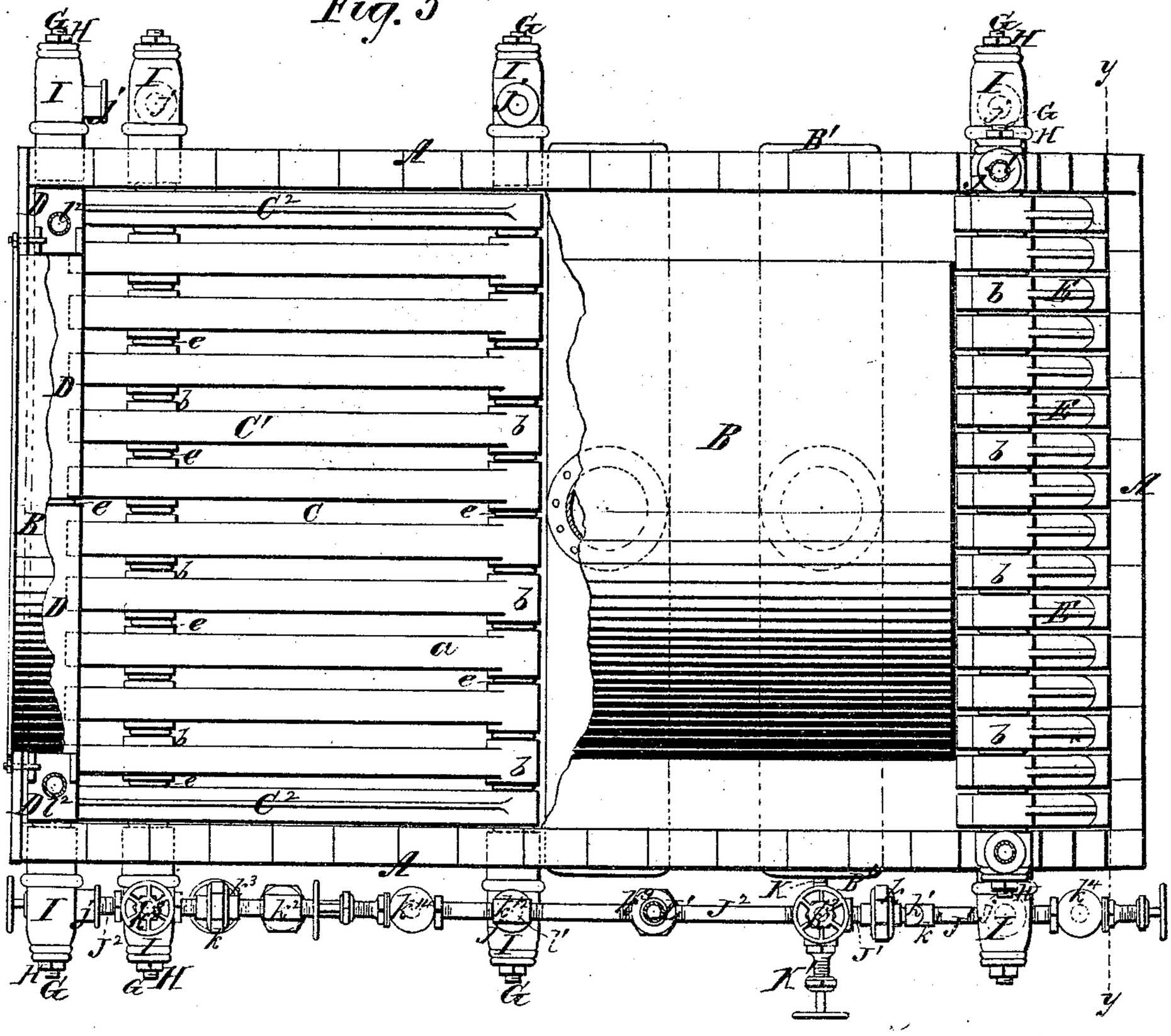
Fig. 5



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HEATING AND CIRCULATING DEVICES FOR STEAM-BOILERS.

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Fig. 6

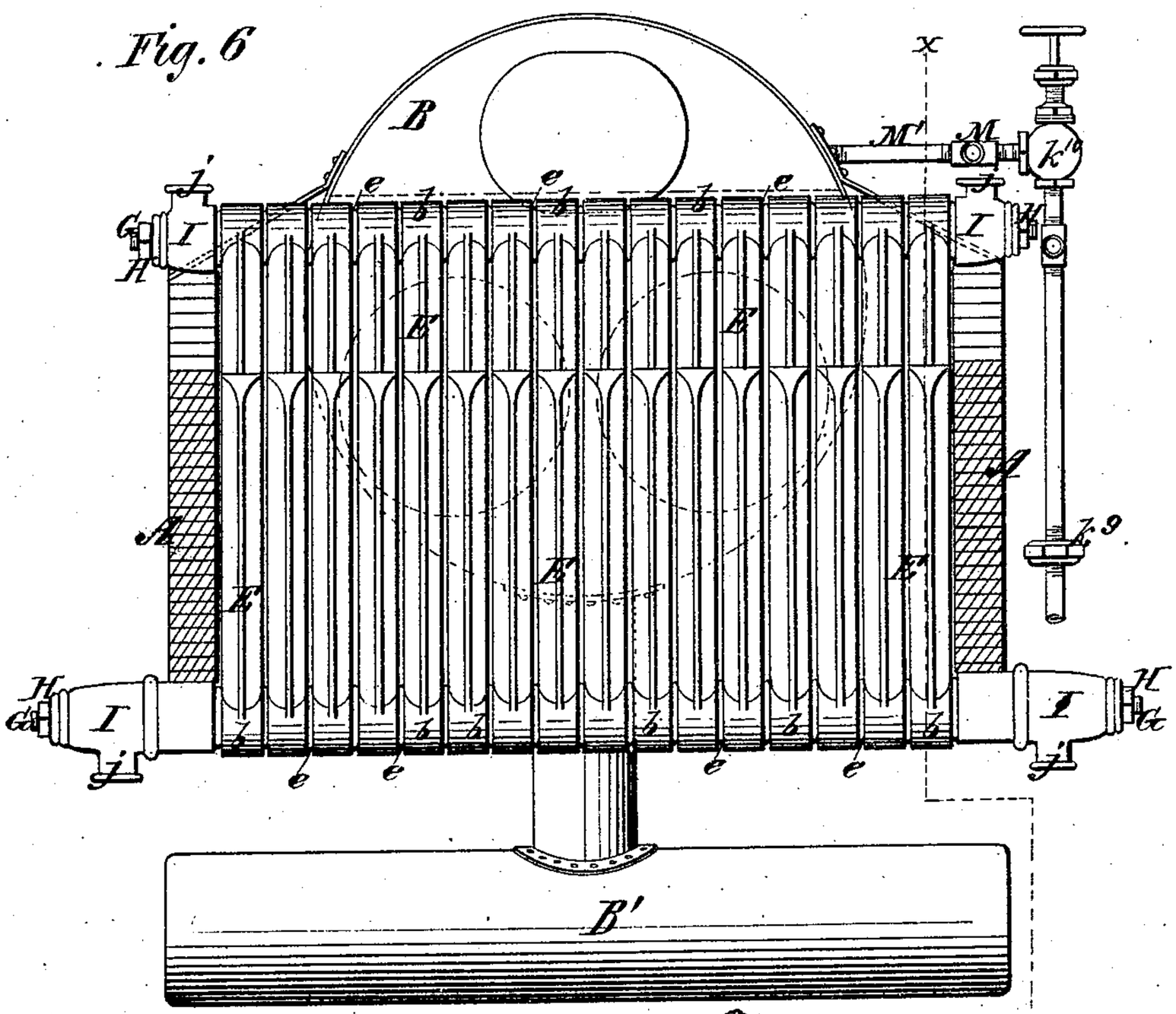
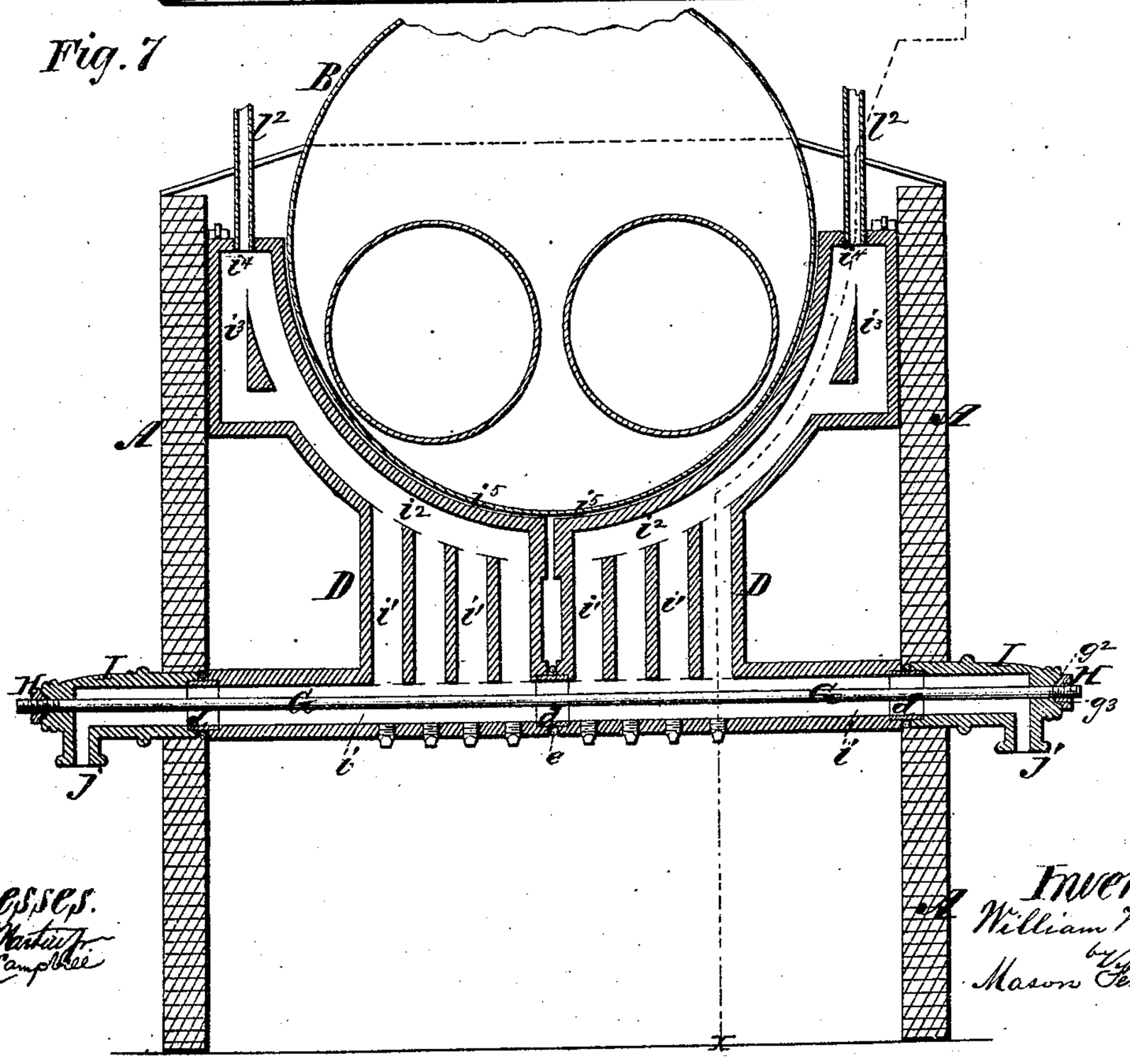


Fig. 7



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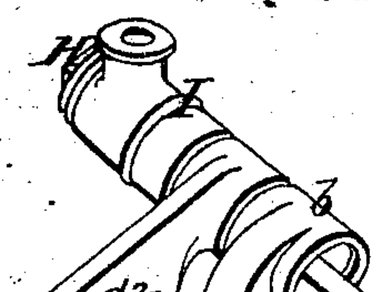
HEATING AND CIRCULATING DEVICES FOR STEAM-BOILERS.

No. 184,465. Patented Nov. 21, 1876.

Fig. 17

Fig. 16

Fig. 8



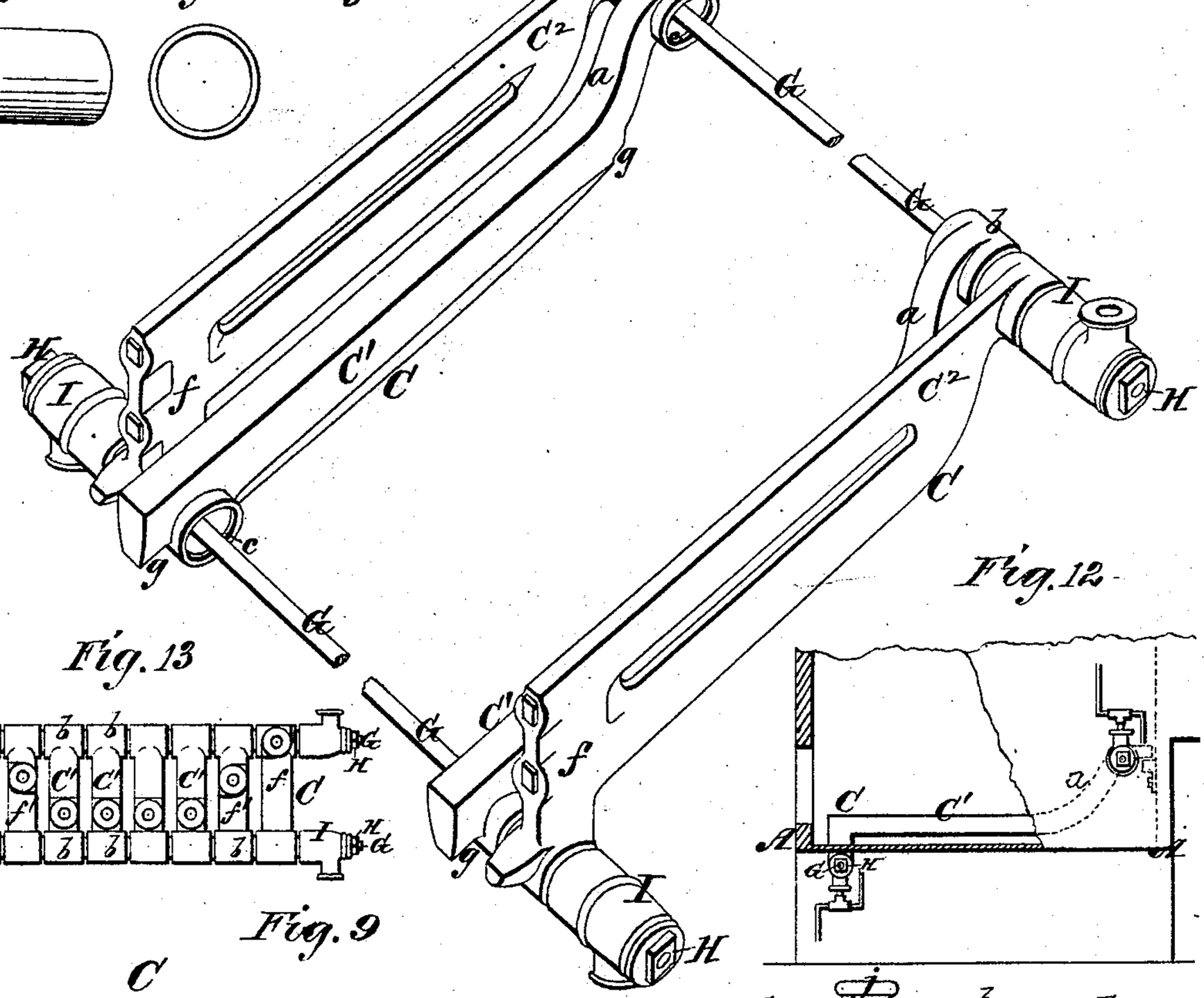


Fig. 13

Fig. 9

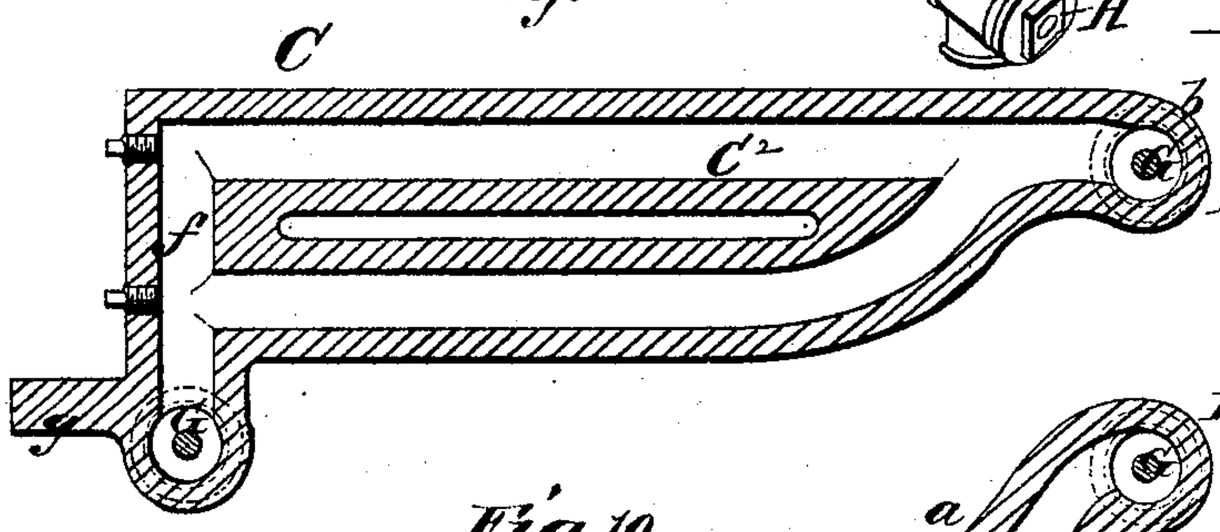


Fig. 10

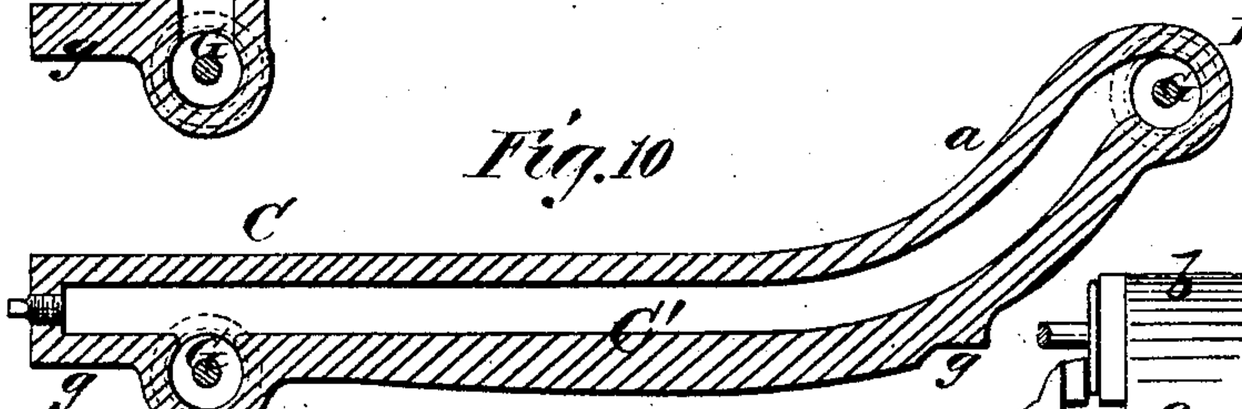


Fig. 12

Fig. 11

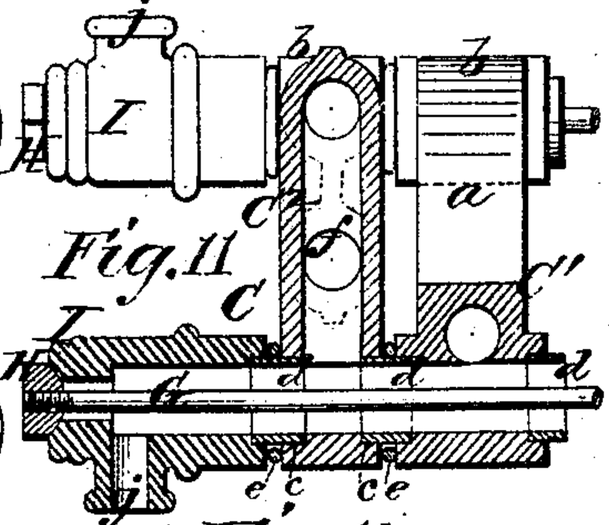
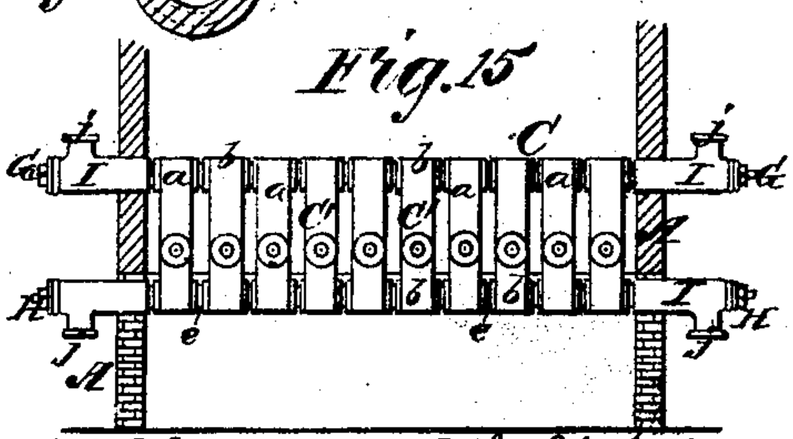


Fig. 14

Fig. 15



Witnesses. Jas. Martin Jr. J. N. Campbell

Inventor. William H. Farris by Mason Fenwick Lawrence

UNITED STATES PATENT OFFICE.

WILLIAM H. FARRIS, OF CAIRO, ILLINOIS.

IMPROVEMENT IN HEATING AND CIRCULATING DEVICES FOR STEAM-BOILERS.

Specification forming part of Letters Patent No. **184,465**, dated November 21, 1876; application filed January 19, 1875.

To all whom it may concern:

Be it known that I, WILLIAM H. FARRIS, of the city of Cairo, county of Alexander, State of Illinois, have invented new and Improved Additional Water-Heating Surfaces for Steam-Boilers and Water-Heaters; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 is a side elevation of a horizontal boiler, with my improvements applied to it. Figs. 2 and 3 are sections of globe check-valves used in connection with the apparatus. Fig. 4 is a longitudinal section of the boiler in the line *x x* of Figs. 5, 6, and 7. Fig. 5 is a top view, with a portion of the boiler proper broken out, and a portion of the pipes and valves left off. Fig. 6 is a vertical transverse section in the line *y y* in Figs. 4 and 5, looking toward the front of the boiler. Fig. 7 is a vertical section in the line *z z* of Figs. 1 and 4. Figs. 8, 9, 10, 11, 12, 13, 14, and 15 are views in perspective, elevation, and section of the water-circulating and steam-generating grate in different forms, and as adapted for different kinds of fire-boxes. Figs. 16 and 17 are views of the joint-packing thimble and ring which are used between the bars of the grate and rear arch, and also at the joints of the fire-front lining.

The nature of my invention consists, first, in hollow grate-bars for fire-boxes of steam-boilers or water-heaters, constructed or arranged in form of a basket or chamber within the fire-box, and made to communicate with the steam or water space of the boiler or other water-heating vessel, as hereinafter described, whereby a large amount of water-circulating and heating surface is presented to the free flame and gases of the fire, and thus water is heated or steam generated by the heat which is in part lost under ordinary arrangements.

Second, it consists in a water-circulating fire-front lining, constructed between its outer and inner surfaces, with a series of tubular passages communicating with one another, and with the water or steam chamber of the boiler, in which passages the water circulates, and is heated or converted into steam by the flame and heat from the fire upon the grate, and thus is effected a still further saving of the fuel and heat which is lost under ordinary arrangements.

Third, it consists in hollow rear end bars, constructed of curved tubes, united and held together by rods, and packed tight at the joints, and closed in, in any suitable manner, and communicating with the water or steam space of the boiler, whereby a large water-circulating and steam-generating surface is provided at the end of the boiler proper, and which is impinged upon by the flame and hot gases from the fire upon the grate, as the same turns and enters the flues of the boiler.

Fourth, it consists in circular expansible thimbles, copper rings, rods, and nuts for uniting the parts and forming the joints between the bars of the grate, arch, and fire-front lining.

Fifth, it consists in the combination of the tubular grate-bars and a horizontal pipe leading from the boiler to the lowest tubular passage of said bars, and a pipe leading from the highest tubular passage of the bars into the boiler through a pipe at or near the water-line, the connecting-pipes mentioned having suitable check-valves, a waste and blow-off valve, and accommodating joint-connections, also, a stop-valve.

Sixth, it consists in the combination of the tubular fire-front lining, a horizontal pipe leading from the water-space of the boiler to the lowest tubular passage of said fire-front lining, and a pipe leading from the highest tubular part of the lining into the boiler through a pipe at or near the water-line, the connecting-pipes mentioned having suitable check-valves, a waste and blow-off valve, and accommodating joint-connections, also a stop-valve.

Seventh, it consists in the combination of the tubular rear arch-bars, a horizontal pipe leading from the boiler to the lowest tubular passage of the rear arch-bars, and a pipe leading from the highest tubular passage of the said bars into the boiler through a pipe at or near the water-line, the connecting-pipes mentioned having suitable check-valves, a waste and blow-off valve, and accommodating joint-connections, also a stop-valve.

Eighth, it consists in the combination of hollow water-circulating grate-bars, a tubular fire-front lining, and rear arch-bars, with the boiler, by means of a connected train of pipes furnished with check-valves, blow-off and waste-valves, and a stop-valve, and fitted with accommodating joint-connections, whereby the water circulating from the boiler into the grate-bars, fire-front lining, and rear arch is heated and caused to circulate by the one fire upon the grate.

Ninth, it consists in a combination of devices for preventing damage in the event of leakage or breakage occurring.

A represents the wall of the furnace; B, the boiler; C, the grate; D, the fire-front lining of the combustion-chamber, and E the rear arch back bars. The bars C^1, forming the bed of the grate, are curved at their rear, as shown at *a*, so as to form a bridge-wall for the furnace. Each bar on opposite sides is formed with a boss, *b*, at its front and rear ends, which is perforated from end to end transversely, and from the bore of these bosses the bars are made tubular along their whole length. The bosses are each formed with a counter-bore or seat, *c*, for the reception of the end of a split or expansible thimble, *d*, around which a copper ring, *e*, is placed, so as to come between the bosses when the bars are placed side by side one another. The bars C^2, which form the basket or side of the grate, are constructed in all respects in the same manner as the bars C^1, except that they are not provided with lateral extensions on the bosses; and the first one is made with a vertical tubular leg, *f*, at its front end, and extends back onto the bridge-wall on a straight line, and the second one thereof has a shorter front leg, *f'*, and extends back on a lower plane than the bar *f*, and near its terminus takes a curved form and rises to the plane of the top of the bridge-wall, as shown in Figs. 13 and 14 of the drawings. The side bars are sometimes cast with two longitudinal passages in them, which unite in one leg, *f*, as shown in Fig. 8, 9, and 11, and thus form, with the bars C^1, a basket-grate. The grate might be formed entirely of bars like C^1, and in that case the side walls of the fire-box would form the basket, as shown in Figs. 12 and 15, and, whenever the last-mentioned grate-bars are used in combination with the connections hereinafter described for effecting a circulation through them of water from the boiler and then back into the boiler, I claim the same under this patent.

The bed-bars of all of the styles of grate are constructed with front and rear bearing-surfaces *g g*, and are set on bearers g^1 g^1, which are arranged to give them a slight inclination downward from the bridge-wall. In order to unite the several bars together and compress the copper-packing rings, so as to make water or steam tight joints, rods G, nuts H, and T side pipes I are provided. The rods G pass through the T-pipes and through the bosses *b*, and receives the nuts H on their ends outside of the furnace-walls. Each of the T side pipes is constructed with a counter-bore in its inner end, and between a side grate-bar and the counterbored end of the T side pipe a thimble, *d*, with packing *e* is applied, as shown. The outer end of each T side pipe is made with a concave seat, g^2, which receives a conical bearing-face, g^3, of the nut H. The operation of screwing up the nuts causes a compression of the copper rings, and, thereby, perfectly water or steam tight joints between the side pipes and grate-bars to be made. The nuts and concave seats also make tight joints with one another.

The fire-front lining, Fig. 7, is formed of two equal sections, united together by thimbles *d*, copper rings *e*, screw-rod G, side T-pipes I, and nuts H. Each section of the lining has a transverse circular passage, *i*, formed in it, also vertical passages i^1, a segmental circular passage, i^2, and a short vertical circular passage, i^3, as shown. All of these passages unite. The passage *i* discharges into the side pipes and through the leg *j* of the T, and the passages i^1 i^2 i^3 discharge through an opening, i^4. The two sections are exactly alike, and form a concave seat, i^5, corresponding to the circle of the boiler, so as to allow the boiler to be placed over it, as shown. The fire front lining is fitted against the inner wall of the fire-front, and in outline corresponds to the fire-front of the furnace. The dividing of the circulating-chamber into a number of channels, which are circular in cross-section, gives great strength, and effects a diffusion of the circulating-water over the entire fire-front lining, and thus exposes the water in divided or small streams to the action of the fire upon the grate, and insures a freer circulation.

The lining, being made of two equal parts instead of in one piece, is less liable to warp and spring, and in case one section should get out of repair, it will not be necessary to take away and replace the whole fire-front lining, as would be the case if made in one piece. It might be made of one piece, but not so advantageously as of two pieces.

Each of the rear arch-bars E is made of segment form, with a boss, *b*, at both ends. The bosses are perforated transversely, and the bars between the bosses are made tubular along their whole length. The series of bars are united together by rods G, T side pipes I, and nuts H, and packed with thimbles *d* and copper rings *e*, as shown. The T side pipes pass through the side walls and adjoin the outer arch-bars by means of thimbles and copper rings. The arch-bars form the inclosing end of the boiler-flues, and the spaces which exist between the bars, on account of the packing-rings being introduced between them, are closed in tight by brick-work and plaster, or other suitable material.

From the foregoing description it will be understood that the grate-bars in their united character form, by means of their bosses, a

lower transverse passage, and an upper transverse passage, and a series of longitudinal passages, and that all these passages are united, and the transverse ones extend, by means of T side pipes, outside of the walls of the furnace to the respective legs *j* of the T side pipes.

The same plan of construction is followed in the manufacture and arrangement of the fire-front lining, and in the rear arch of bars.

It will also be understood that each transverse passage has a T side pipe, I, on each side of the furnace, and that each section of fire-front lining has a discharge-passage, i^4.

For the purpose of connecting the aforesaid several additional water-heating and steam-generating surfaces with the lowest water-space and the highest water-space of the boiler, the following parts are employed:

K is a horizontal supply-pipe, having a stop-valve, K′, inserted into the drum B′ of the boiler. J is a vertical branch extending up from said valve, and entering a T-coupling, k^{11}. J^1 J^2 J^3 are pipes formed of sections, and leading, respectively, to the lowest transverse passages of the arch back bars, tubular fire-front lining, and hollow grate-bars. These pipes have union-joints *k*, elbow-couplings k^1, T-couplings k^2, check-valves k^3, and blow-off valves k^4, and are connected to the legs *j* of the T side pipes, as shown.

The valves employed are constructed, respectively, as shown in Figs. 2 and 3. The pins of these valves move in a guide in the stem, as shown, and the extent of movement is controlled by screwing down the stems. In all cases, the valves are located so as to have the pressure or circulation on the under side. The valves are closed by the screw-stems.

The water is supplied to the boiler through its drum B′ in any well-known manner, and passes from the drum into the pipe J when the valve K′ is open, and circulates along the pipes J^1 J^2 J^3, and therefrom into the arch back bars, grate-bars, and fire-front lining.

For passing the water from the rear arch-bars, grate-bars, and fire-front lining into the boiler about or near the water-line, sectional pipes L L^1 L^2 are provided, and made to unite in a cross, M, of a horizontal pipe, M′, which leads out laterally from the boiler to a globe check-valve, k^{10}. The pipes L L^1 L^2 are connected, respectively, by their other ends, to branch pipes *l* l^1 l^2, which extend from the T side pipes of the grate-bars and rear arch-bars, and from the upper open ends i^4 of the fire-front lining. The pipe L is constructed with a union-joint, k^{19}, and elbow-joints k^5 k^5, and with a T-coupling, k^6. It also is furnished with a globe check-valve, k^7, and a waste-valve, k^8. A union joint, k^9, check-valve k^{10}, T-coupling k^{12}, elbow-joints k^{13}, waste-valve k^{14}, all similar to those on pipe L, are used on the pipe L^1. The pipe L^2 is likewise provided with a union-joint, k^{15}, check-valve k^{16}, T-coupling k^{17}, and waste-valve k^{18}, as shown.

I have described the water-heating surfaces as used together, and will state that when it is desired to have only the hollow grate-bars operate for heating water or generating steam, an elbow-connection must be substituted for the T-coupling k^{11} of supply-pipe J, and a similar coupling substituted for the T-coupling k^2 of pipe J^3, and the pipe M′ with its cross M removed and substituted by a pipe which leads directly from the boiler to the check-valve k^{10}. Under this construction the fire-front lining and the rear arch back bars and the connections thereof are not constructed upon the boiler.

To use only the fire-front lining for heating water, the T-couplings k^{11} and k^2 of pipes J^2 and J^3 must be removed, and an elbow substituted for k^{11}, and the pipe J^2, with its check-valve and blow-off valve, made to connect only with the fire-front lining, and the pipe L^2, with its check-valve and blow-off valve, must connect with said lining and with the boiler by a lateral horizontal pipe, M′.

To use the rear arch back bars alone, the pipe L, furnished with valves k^7 and k^8, should enter the horizontal lateral pipe M′, leading from the boiler, and not communicate with any other pipe, and the pipe J^1 should connect with a pipe, J, which connects only with the drum B′.

It is obvious that any two of the three aforesaid additional heating or steam-generating surfaces can be used together upon the same boiler by simply having pipes and connections which do not provide for the use of a third water-heating surface. Further, in the event that it is not necessary or desirable to use all of the three surfaces provided on one boiler; or, if one or more of the three surfaces should become disabled, the remainder may be continued in use by plugging the passages formed by the disconnection of the disabled section or sections; or this may be done by screwing down the check-valve or valves of the disabled section or sections, and wasting water through the disabled sections after the pressure and supply are nearly shut off by the valve K′.

At N I have shown an intermediate pipe, with a valve, N^2, leading into the supply-pipe J^2. By means of this pipe a connection may be made with the waste water of the heater of the doctor or tank, as the case may be, in the event of a leak or break occurring in any part of said heating-surfaces, and it has become necessary to shut off the water and pressure from the said surfaces by closing the valve K′. The water thus passed through the said heating-surfaces will not enter the boiler, as the boiler-pressure will have closed the upper check-valves, but will circulate and overflow, and pass out through the waste-valves. The effect of this separate circulation and wasting of water through the said surfaces will be to reduce the pressure in the pipes, and thereby stop the flooding of the fire-box or other part of the furnace, and thus avoid detention from such accident; also, to save the most exposed

parts from being fatally injured by undue strain and intense heat.

Instead of employing the entrance-pipe N for this purpose, the valve K′ and the check and waste valves might be made to answer the same end by closing them just far enough to permit a slight leakage thereof, which will be sufficient for moistening the steam and reducing its pressure upon the surfaces after the main pressure of steam and supply of water from the boiler have been almost wholly cut off.

At N^1 the ordinary main check-valve of the main supply-pipe from the doctor is shown on the drum B′, and it will be understood that the water is not pumped through the heating-surfaces, but is supplied to the boiler, and by circulation from the boiler passes through said surfaces, and then back into the boiler in a highly-heated condition, or in form of water and steam.

In applying the pipes on river-boilers, the arrangement provided on one side is duplicated on the opposite side, except that the blow-off and waste-water valves will be only on one side, and the auxiliary supply-pipe N only on the opposite side to said valves; and for land-boilers, a system of pipes, check and blow-off valves, and a single stop and supply valve, K′, will answer, as such boilers do not change their horizontal position, as river-boilers do, from the rolling of the boat.

The operation is as follows: The water is supplied to the drum B′ of the boiler, and rises in the boiler and circulates through the pipes J J^1 J^2 J^3, and therefrom rises in the hollow grate-bars, fire-front lining, and arch-back bars to the water-line.

When the water is at the proper level, and the furnace running at the proper heat, the hot water or steam passes up and along the pipes L L^1 L^2, and therefrom into the boiler at or near the water-line, and thus the circulation continues so long as everything works right; and, in the event of a leakage or breakage in any of the additional surfaces, the valves are either set to work with a slight leak of water, to moisten the steam, or waste water is allowed to circulate through pipe N, and overflow, and pass off through the waste-valves. That one of the aforesaid additional heating-surfaces which leaks or has a breakage in it will be the only one, of course, that the leak of water or flow of water through it will be necessary, and, therefore, only its check and waste valves will be set to operate as stated.

What I claim as new is—

1. Hollow side grate-bars for fire-boxes, constructed separately or together, at different altitudes, and arranged in relation to the hollow bed grate-bars, so as to form with the latter a basket or chamber within the fire-box, said side bars and the bed-bars being in communication with one another, and with the boiler at relatively low and high points, and the bed-bars constructed to form a hollow bridge-wall, all substantially as and for the purpose described.

2. The water-circulating fire-front lining for a fire-box, constructed with division-partitions forming separate circulation-passages, which unite, substantially as shown, and for the purpose described.

3. The hollow rear-end arch, made separate, and united and jointed together, substantially as and for the purpose described.

4. The combination of the expansible thimbles, copper ring, screw-rods, and nuts with a circulation tube or chamber, for uniting the parts, and forming and packing the joints, either between the bars of the grate, the arch-bars, or the parts of the fire-front lining, substantially as described.

5. The combination of the hollow grate-bars, a loosely-jointed supply-pipe, J J^2 J^3, leading from the boiler to the lowest tubular passage of the bars, a circulation-pipe, L L^1 L^2, also loosely-jointed, leading from the highest tubular passage of the bars into the boiler, and a stop valve, a check-valve, and a waste-valve, substantially as and for the purpose described.

6. The combination of the tubular fire-front lining, loosely-jointed pipe leading from the water-space of the boiler to the lowest tubular passage of said fire-front lining, the loosely-jointed pipe leading from the highest tubular part of the lining into the boiler through a pipe at or near the water-line, check-valve, waste-valve, and stop-valve, substantially as described.

7. The combination of the tubular rear arch, made of separate sections united and jointed together, loosely-jointed pipe leading from the boiler to the lowest tubular passage of the rear arch-bars, a loosely-jointed pipe leading from the highest tubular passage of the said bars into the boiler, at or near the water-line, and a check-valve, a waste and blow-off valve, and a stop-valve, substantially as described.

8. The combination of the hollow grate-bars, tubular fire-front lining, rear arch-bars, and the several pipes, check-valves, blow-off and waste valves, and stop-valves, substantially as described.

9. The pipe N, waste-cock N^2, valve K′, and check and waste valves, for wasting water through either one or all of the additional water-heating and circulating surfaces, in the event of a leak or break occurring in either of said surfaces, and when the pressure and supply from the boiler are wholly or partly cut off by the valve K′, substantially as and for the purpose described.

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