(No Model.)

4 Sheets—Sheet 1.

# O. T. X. ADAMS.

## SLAG FURNACE.

No. 395,644. Patented Jan. 1, 1889.

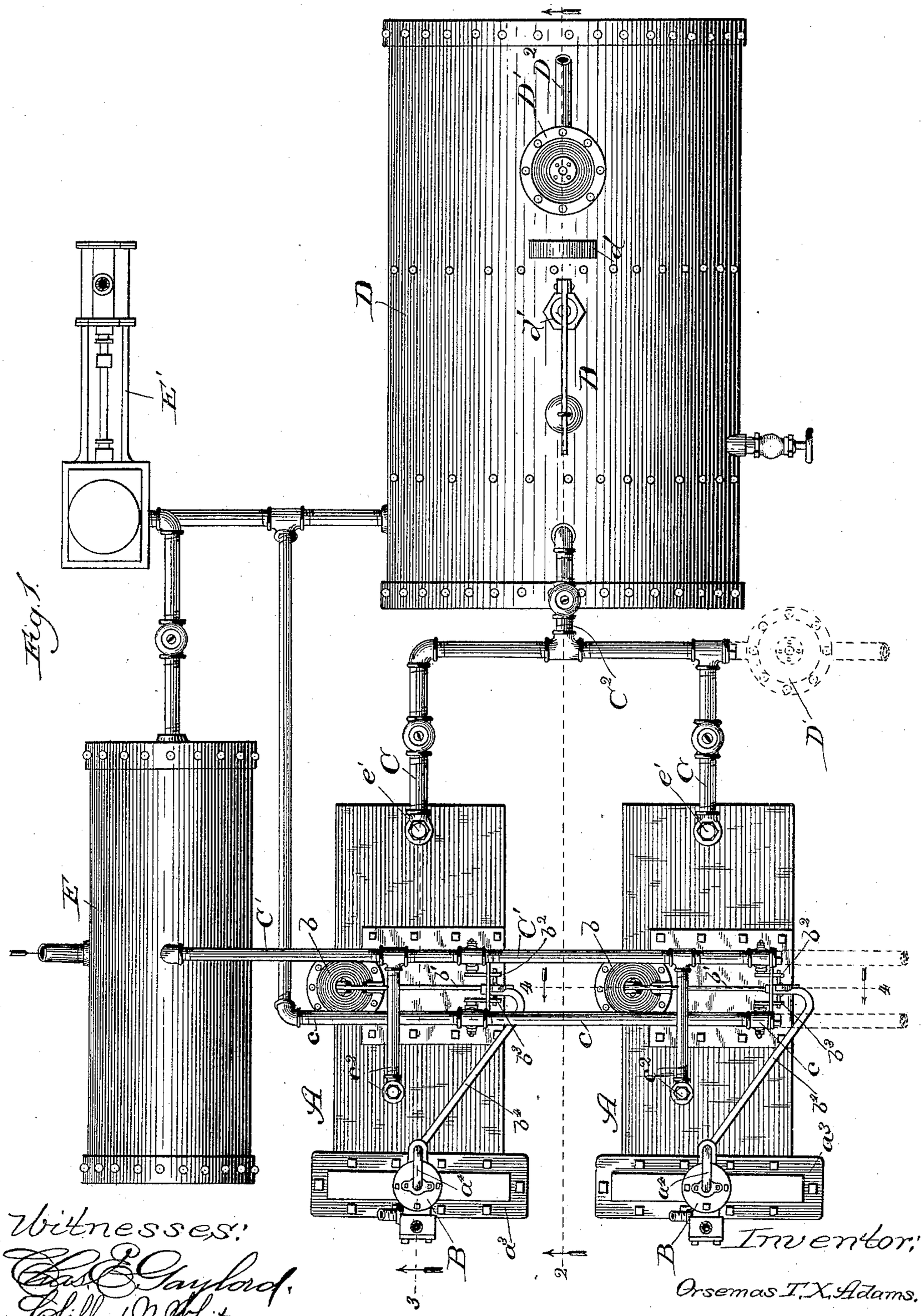


Fig. 1.

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Inventor:
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(No Model.)

4 Sheets—Sheet 2.

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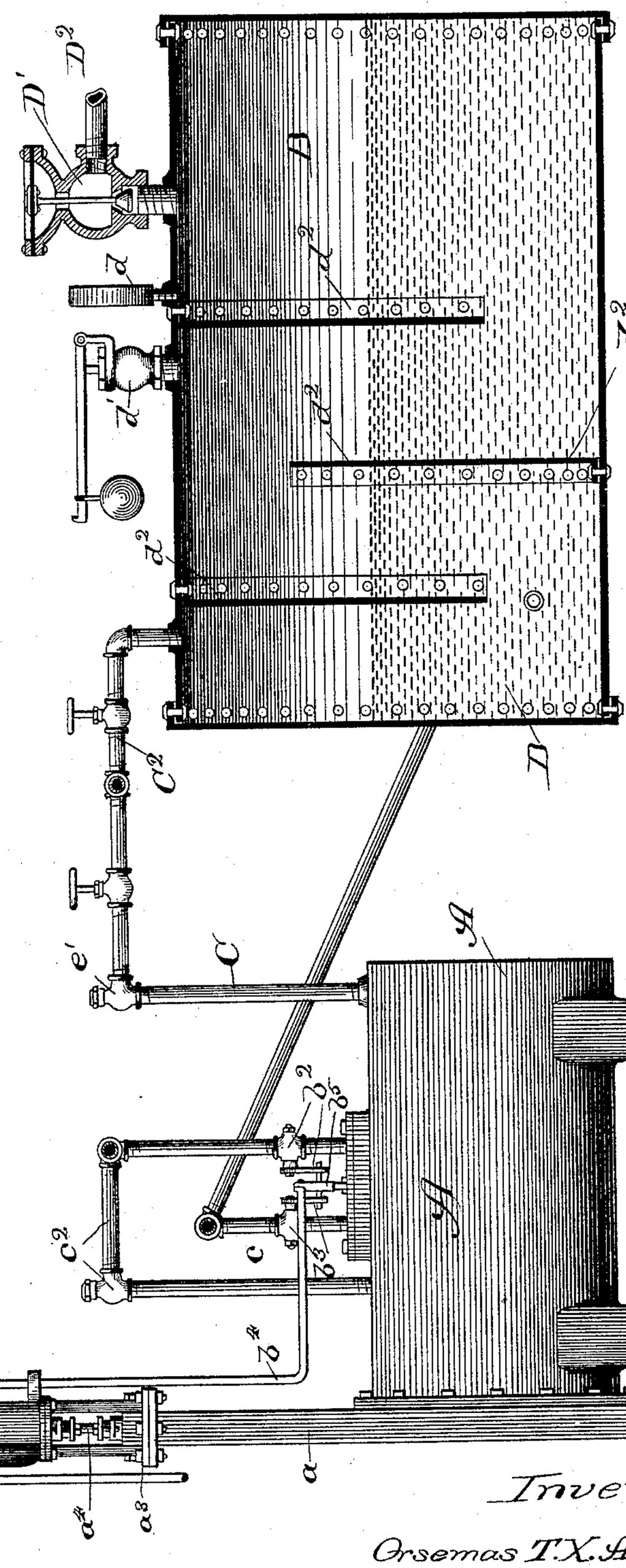


Fig. 2.

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(No Model.) 4 Sheets—Sheet 3.

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## SLAG FURNACE.

No. 395,644. Patented Jan. 1, 1889.

Fig. 4.

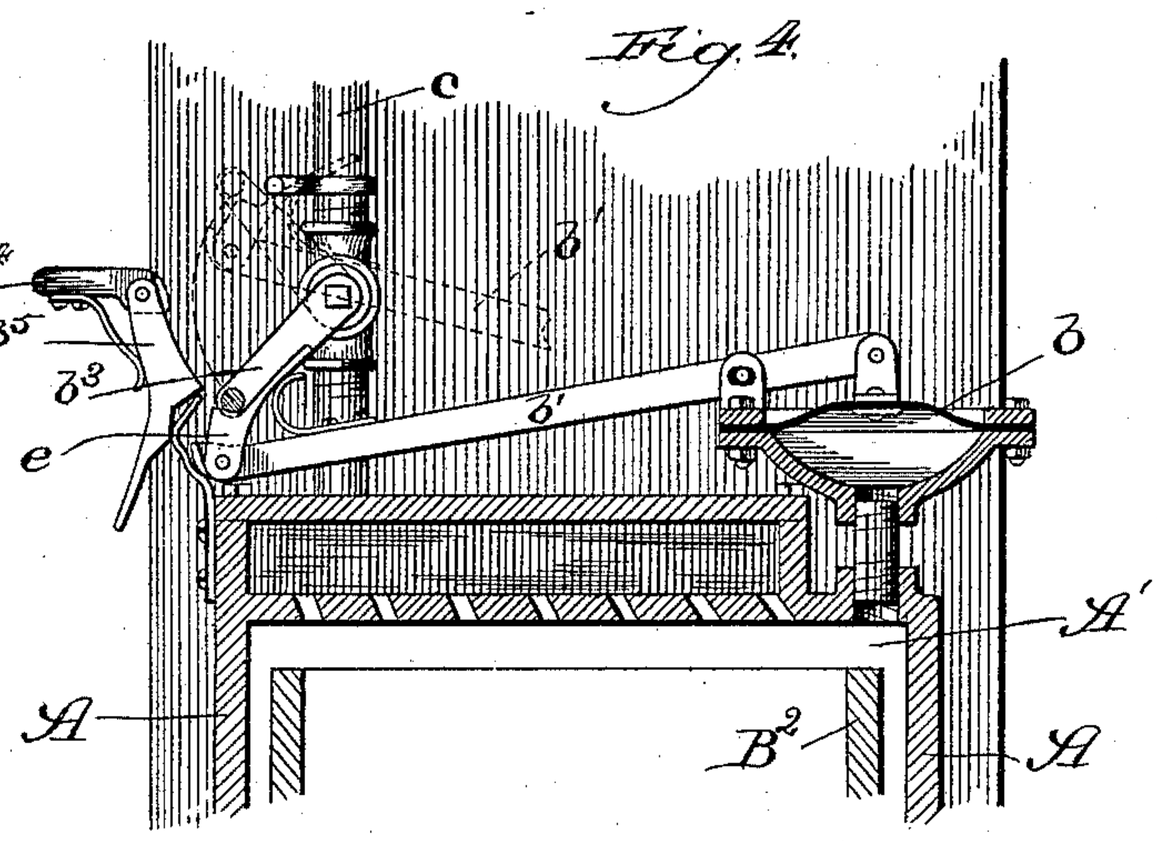
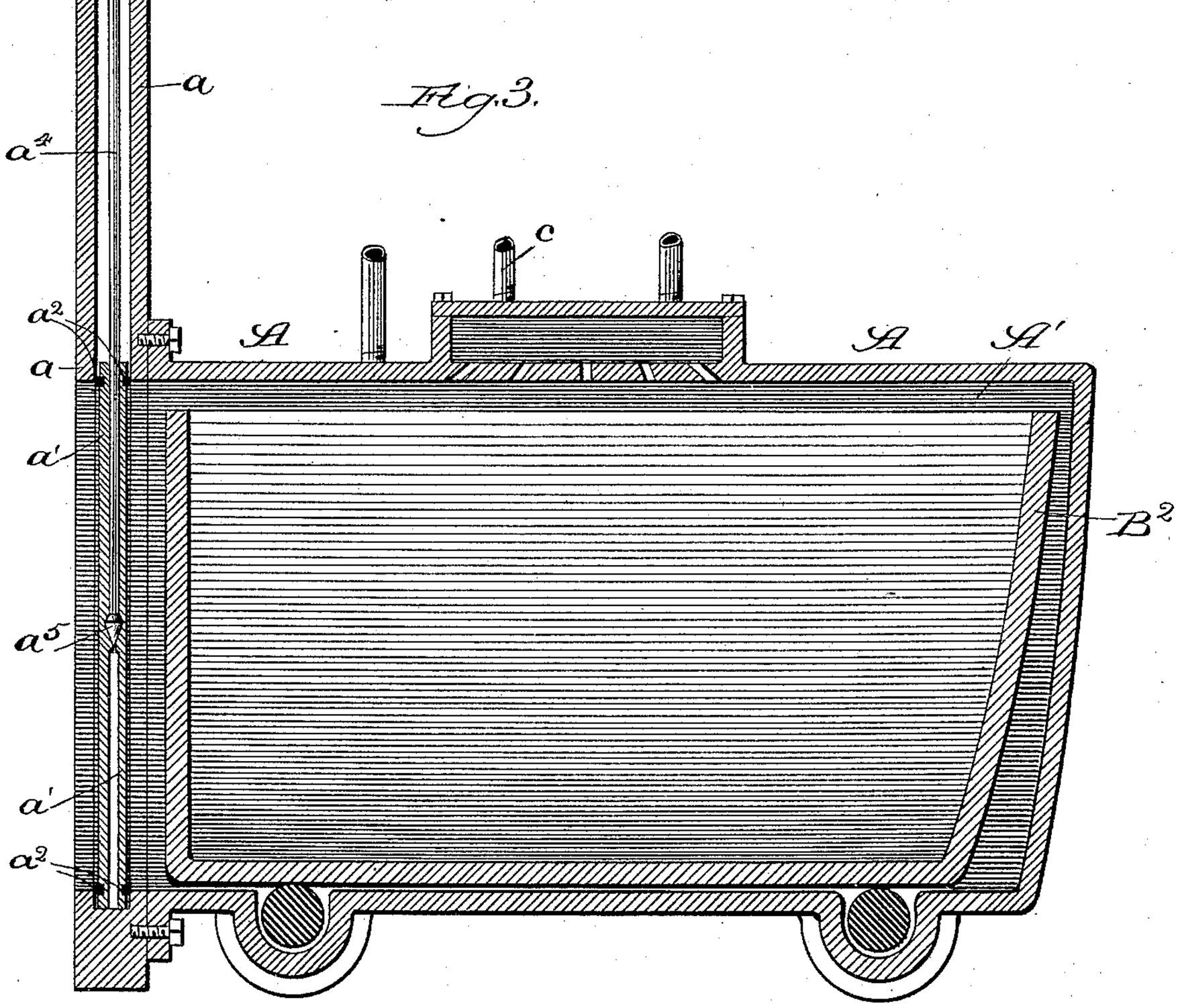



Fig. 3.

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(No Model.)

4 Sheets—Sheet 4.

# O. T. X. ADAMS.

## SLAG FURNACE.

No. 395,644. Patented Jan. 1, 1889.

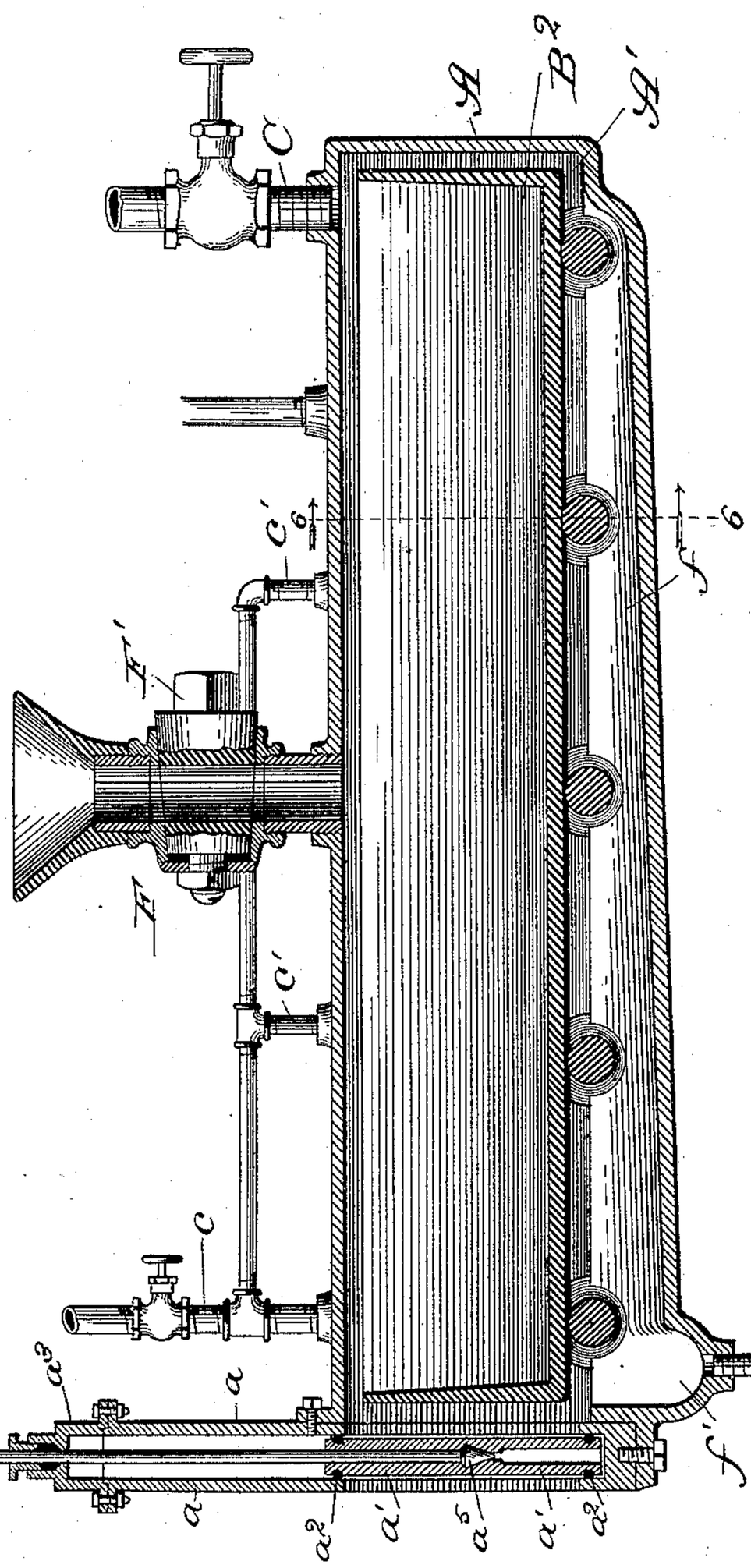


Fig. 5.

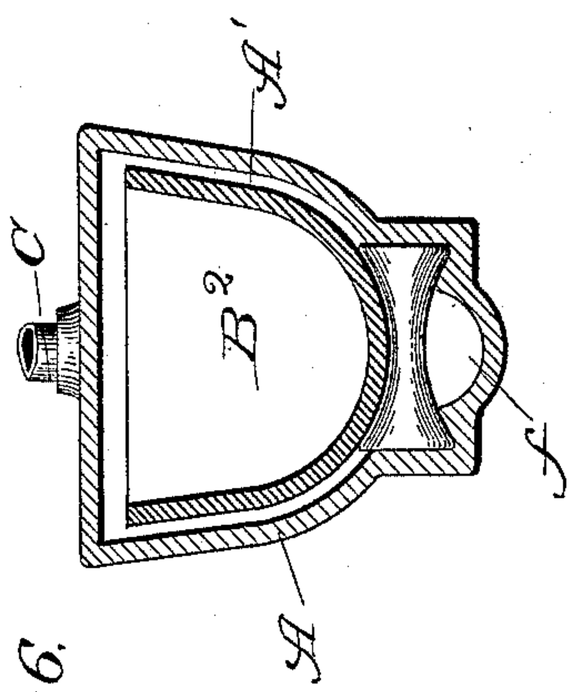


Fig. 6.

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Inventor:
Orsemas T. X. Adams.

# UNITED STATES PATENT OFFICE.

ORSEMAS T. X. ADAMS, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE AMERICAN SLAG FURNACE COMPANY.

## SLAG-FURNACE.

SPECIFICATION forming part of Letters Patent No. 395,644, dated January 1, 1889.

Application filed May 21, 1888. Serial No. 274,458. (No model.)

*To all whom it may concern:*

Be it known that I, ORSEMAS T. X. ADAMS, a citizen of the United States, residing at Chicago, in the county of Cook, State of Illinois, have invented certain new and useful Improvements in Slag-Furnaces, of which the following is a specification.

The object of my invention is to construct a slag-furnace whereby the great heat of molten slag that flows from a blast or smelting furnace may be utilized in the generation of steam by bringing water into contact with it, and to provide means for so treating and governing the steam-generator as to afford a continuous uniform supply and pressure of steam for use, and to provide means for automatically governing and operating the operating parts of the generators by the steam-pressure within them; and my invention consists in the combination and relation of parts and features and details of construction hereinafter described and claimed.

In the drawings, Figure 1 is a top plan of my improved slag-furnace, showing two furnace or generating chambers with their various attachments and parts, the steam wash, storage, and regenerating chamber with its attachments and parts, the feed-water-heating drum or tank, and the pump for forcing the water through the various water feed-pipes; also showing the various water and steam pipes and valves connecting the several parts together, and also showing the relations of the several parts to each other. Fig. 2 is a vertical longitudinal elevation and section of Fig. 1 on the line 2, looking in the direction of the arrows, showing a side elevation of one of the furnace or generating chambers with its valves and connections, the steam-cylinder attachment for raising and lowering the sliding valve-plate, and the wash, storage, and regenerating chamber with its exhaust-steam pressure-reducer in section, and its other attachments and connections in elevation. Fig. 3 is a longitudinal vertical section of one of the furnace or generating chambers on the line 3 of Fig. 1, looking in the direction of the arrows, with a slag-vessel located in the chamber, and with most of the attachments and connections removed, designed to specially show the sliding valve-plate and the design of the upper part of the valve-plate box. Fig. 4 is a vertical cross-section and elevation of a part of Fig. 1 on the line 4, looking in the direction of the arrow, showing the diaphragm attachments for automatically operating the feed-water and auxiliary exhaust-steam valves in section. Fig. 5 is a longitudinal vertical section of one of the furnace or generating chambers, showing a modification in its shape to provide means for a drainage pipe or passage, showing the chamber and slag-vessel longer, the main water feed pipe or passage entering near one end of the chamber with several auxiliary water feed pipes or passages entering nearer the main steam-exhaust pipe or passage, the main steam-exhaust pipe or passage communicating near the opposite end of the generating-chamber from the main water-supply passage and showing a passage located in the top side of the furnace or generating chamber provided with means for opening and closing the same, whereby the molten slag may be poured or emptied into the slag-vessel while it is in the chamber and the sliding or end valve is closed. Fig. 6 is a cross vertical section of Fig. 5 on the line 6, looking in the direction of the arrows, showing the trough or groove in the bottom of the chamber for drainage purposes, the slag-vessel in the chamber, and the passage for pouring or emptying the molten slag therein through the top.

In the drawings, A is the furnace or generating-chamber shell or walling; A′, the furnace or generating-chamber; *a*, the sliding valve-plate boxing; *a′*, the sliding valve-plate; $a^2$, metallic or other pliable packing in the same; $a^3$, the removable head to the box *a*; B, the engine or cylinder for opening and closing the valve-plate through the rod $a^4$; *b*, the diaphragm attachment; *b′*, the lever operated by the same for opening the auxiliary steam and closing the water valves $b^2$ and $b^3$; $b^4$, an extended arm, operating the rod $a^4$ for opening said water-valves and closing said steam-valve; C, the main steam-exhaust pipes from the chambers A; C′, the auxiliary steam-exhaust pipes; *c*, the main water-supply pipe to the furnace or generating-chamber; *c′*, Fig. 5, the auxiliary water-supply pipes; $c^2$, safety-

valve and exhaust-pipes from the generating-chamber; D, the steam wash, storage, and regenerating chamber or drum; D′, the pressure-reducer from the same; D², the exhaust-pipe from the same; *d*, the steam-gage on the same; *d′*, the safety-valve on the same; *d²*, diaphragms or partitions in the same; E, the feed-water-heating tank or drum; E′, the pump for forcing the water into the various chambers; F, Fig. 5, the secondary passage or pipe in the top of the generating-chamber, through which to pour or pass slag into the slag-vessel while the same is within the generating-chamber; *f*, a drainage groove or trough in the bottom of the generating-chamber for drainage purposes; *f′*, a depression or recess at one end of the chamber, into which the trough empties, and *f²*, a pipe or passage from the recess or depression *f′*.

In describing and referring to the furnace and steam-generating chamber I will term it the "generating-chamber;" but it will be understood that this chamber is properly a furnace-chamber in addition to a generating-chamber, and I will also refer to and term the steam wash, storage, and regenerating chamber or drum as the "storage-chamber;" but it will also be understood that the important office of this chamber, with the water contained in it is to wash and cleanse the steam and bring it to a uniform temperature in addition to condensing and regenerating the same under the varying degrees of pressures and temperatures exerted by its connection with the two or more generating-chambers in which steam is generated irregularly in consequence of these chambers being repeatedly filled with hot slags, cooled, emptied, and refilled, as well as for storage purposes.

In making my improved slag-furnace for the generation of steam I construct one or more chambers, preferably to be operated in conjunction with each other, in many respects like the one described and claimed in certain applications for United States Letters Patent filed by me April 2, 1888, Serial No. 269,229; but in addition to the features shown in that application I preferably provide a sliding valve-plate, *a′*, composed of two pieces, to open and close the main passage for the introduction and removal of slags to and from the generating-chamber, as shown in Fig. 3, and adapted to be forced apart or in place by the wedge *a⁵* when the plate is down or over the passage to be closed, and I arrange a soft metallic wire or ring, *a²*, preferably by pressing into a groove for the purpose around the edge of the said plate in such a manner as to afford a packing or bearing to render the valve steam-tight when there is a downward pressure of the rod *a⁴*, and consequent downward movement of the wedge *a⁵*, or the internal steam-pressure of the generating-chamber. The object of this soft metallic packing is to afford a soft bearing-surface to make the steam-tight joint, so that in the event of small particles of dust or foreign substance getting or lodging on the surface upon which it bears it will yield to the said substance and still come in close and absolute contact with the bearing-surface where the steam-tight joint is required. I preferably make this soft packing of copper, and secure it so as to be removed and replaced, although other soft metallic substances may be used, or any other suitable substances—such as rubber packing—may be substituted. I also provide the upper extended end of the valve-plate box with a removable head, *a³*, which may be taken off by removing the bolts with which it is secured, and thus leaving a free passage for the removal of the valve-plate by lifting it upward and out of the box. The object of providing this means for removing the valve-plate is to afford free access to it for the removal and replacement of the packing *a²* when the same has been worn out. I also provide, preferably, a steam engine or cylinder, B, mounted upon and secured to the extended upper end of the boxing *a*, through which, by the upward-extended end of the rod *a⁴*, the valve-plate is raised and lowered.

As the arrangements of these parts and their operations will be readily seen and understood by reference to Figs. 2 and 3, I do not think it necessary to further describe them, and while I have only shown and described one means or design of placing or inserting a soft metallic or other suitable packing in the sliding valve-plate, I do not wish to confine myself to this particular method of accomplishing this object.

To provide means for automatically operating the water-supply and auxiliary steam-exhaust passages, I provide a diaphragm, *b*, for each of the generating-chambers communicating with the same and arrange an extended lever, *b′*, secured and held at one end to the diaphragm, as shown, especially, in Fig. 4, to be operated or moved up and down by the upward or downward motion of the diaphragm *b*, which is made in quite the ordinary way of spring metal. This extended lever is hinged, as specially shown in Fig. 4, so that the end opposite from that attached to the diaphragm will raise or be raised as the diaphragm recedes or sinks, and through its ratchet *e* will raise the handle of the valve *b³*, as indicated by the dotted lines in Fig. 4, and thus open the auxiliary steam-exhaust-passage valve *b³* and allow the steam in the generating-chamber to escape through the auxiliary steam-exhaust pipe C′ and be condensed in the tank or drum E, and, as will be readily seen in Figs. 1 and 2, the water-supply pipe or passage *c* and its valve *b²* are placed so as to be connected to and operate in conjunction with the auxiliary steam-exhaust-pipe valve *b³*, and the arrangement of the handles upon the valves is such that when they are raised upward by the extended end of the lever *b′* and its ratchet *e* the water-supply passage will be closed, and the auxiliary steam-exhaust passage will be opened by the

same movement. It will be seen that when the handles $b^2$ and $b^3$ are clear up the ratchet $e$ will become disengaged from them. When the slags have become cooled and through this operation the supply of water to it and the generating-chamber has been shut off, and through the auxiliary steam-exhaust passage all or about all of the steam within the same has been relieved, and the consequent internal pressure, the sliding valve-plate $a'$ may be raised by means of the engine or cylinder B, and the cooled slags removed through the passage afforded by the opening or raising of the said valve-plate, when the cooled slags may be emptied and a fresh supply or quantity of hot or molten slags be placed in the slag-vessel, which then may be returned into the chamber, when through the operation of the said engine B the valve-plate may be lowered or dropped and the generating-chamber again rendered steam-tight.

I also preferably provide an extended arm, $b^4$, connected to the upper extended end of the rod $a^4$, and so crooked and shaped that while the valve-plate and the rod $a^4$ are being lowered this extended arm through its ratchet $b^5$, as shown in Figs. 1, 2, and 4, will press the valve-handles $b^2$ and $b^3$ downward, closing the auxiliary steam-exhaust passages and opening the water-supply passage, thus permitting the water to flow on the freshly-supplied hot or molten slag in the generating-chamber. This extended arm $b^4$, it will be seen, is to operate the valves and handles $b^2$ and $b^3$ in a reverse direction from the diaphragm-lever $b'$, so that in this manner when a fresh quantity of molten or hot slag has been placed in the generating-chamber, and as the valve-plate is lowered or dropped, rendering the chambers steam-tight, except the auxiliary steam-passage, through this extended arm $b^4$ and its ratchet $b^5$, the auxiliary steam-exhaust passage is closed and the water-supply passage is opened, permitting the water to pass or to be passed in the chamber and in contact with the heated slag until it has been cooled so as to allow the steam-pressure within to sufficiently decrease to permit the diaphragm to recede and operate the lever $b'$ to again close the water-passage and open the auxiliary steam-exhaust passage, when the operation of the removal of the cooled and refilling with hot slag may be repeated.

Of course it will be understood that the main steam-exhaust pipe or passage C is provided with a check-valve, $e'$, as described in my application, Serial No. 269,229, referred to before, and as shown in Fig. 1. This main steam-exhaust pipe preferably communicates by the pipes $C^2$ with the storage chamber or receiver D, so that a high pressure and supply of steam within the chamber A′ will be relieved by opening this check-valve and allowing the steam as it is generated to pass through this valve and into the storage chamber or receiver as long as the slag in the generating-chamber remains sufficiently hot, and I also preferably provide a safety-valve, $c^2$, for the relief of an extreme internal pressure in the chamber A′. While I have shown and described an automatic attachment for operating the water-supply and auxiliary steam-exhaust passages as a diaphragm attachment, I do not wish to confine myself to this particular mechanical means of accomplishing this end or result, as various modifications may be made. I wish to reserve the right to use any mechanical means of automatically operating or opening and closing the water-supply and steam-exhaust passages by the varying degrees of internal steam-pressure of the generating-chamber in this connection.

As before stated, I preferably operate two or more of these generating-chambers in conjunction, as shown in Fig. 1, and connect their main steam-exhaust pipes C to a common steam-pipe, $C^2$, and preferably use a steam storage, wash, and regenerating chamber, D, or which, as before stated, I will term as a "steam-storage drum," into which I introduce this common pipe $C^2$, so that the steam generated in the two or several generating-chambers will pass into this storage-drum. I also preferably arrange one or more partitions, $d^2$, in this drum D, as shown in Fig. 2, part of which I extend transversely inside of the drum from the top side to below the water-line, which I maintain at about the level zero, Fig. 2, in the drum, and also preferably extend one or more of the said partitions $d^2$ from the bottom of the inside of this drum to above the water-line. This main or common steam-pipe $C^2$, communicating with the various generators, I preferably connect with the drum D at its upper side and near the end. I then preferably connect the steam pipe or passage $D^2$, from which the steam for use at an engine or other place is to be taken with the steam-pressure reducer D′, communicating with the drum D at its top side, near the opposite end from the entrance of the pipes $C^2$, thus necessitating the steam that passes through the drum D to pass under and over the partitions $d^2$ and through the water in the drum. The object of the pressure-reducer is to reduce and even the pressure of steam that is taken for use from the drum D, in which the pressure may be excessive or uneven, raising and lowering as the slag in the generators is changed. I also preferably provide a steam-gage, $d$, communicating with drum D and the safety-valve $d'$, to let off excessive pressure that may occur.

The arrangement of these parts will be readily understood by an examination of Figs. 1 and 2, so that I do not deem it necessary to further describe them, and while I have described the steam-pressure reducer as being located on the steam-drum D, this drum may be dispensed with, if desired, and the pressure-reducer located on the main steam-pipe, as indicated by the dotted lines D′ in Fig. 1. The object of having or using water within the

drum D and using partitions $d^2$ in this manner is to require the steam that enters and passes through the drum to be forced under and over them and through the water contained in it, which will collect any impurities or dust that may be carried from the generating-chamber, which might injure an engine if it were permitted to remain in the steam while being used, and in this manner the steam is washed and cleansed and rendered pure before being used.

Another object of having water in the drum and forcing the steam through it is that when there is an excess supply of steam from the one or several generators occasioned by a renewal of the hot or molten slag within them, which excess supply will be at a higher temperature than that in the storage-drum D, and will also occasion the pressure within the said drum to rise, when the water contained therein will collect and condense the hot steam under the rising or ascending pressure, and retaining it in a fluid state until such time as the slags within the generating-chamber have become so cooled as to allow a decreased supply of steam at a lower pressure and temperature, and in consequence allow the pressure within the drum D to decrease, at which time the excess steam before generated, supplied, and condensed in the water, as described, will regenerate and supply such deficiency of steam as may be occasioned for short periods in this way. So it will be seen that the water in the drum serves the purposes of storing the steam and evening its temperature and pressure by condensation and regeneration, and of washing it and cleansing it by collecting and retaining particles of dust and other impurities that may be carried from the generating-chamber by the steam. I design in the operation of these parts to set the steam-pressure reducer D′ in such a manner as to retain the pressure within the generating-chambers and storage-drum D considerably higher or greater than that supplied for use by the pipe $D^2$. In this way, by the aid of the steam-pressure reducer and the water contained in the drum D, which serves, as described, the purpose of washing or cleansing the steam, bringing it to a uniform temperature and in a measure to a uniform pressure, I am enabled to supply steam continually at the uniform pressure to the engine or other place of use through this pipe $D^2$.

In Fig. 5 I have shown the generating-chamber somewhat modified, making the same longer and with a groove, *f*, lengthwise of the chamber in its bottom side, preferably slanting or inclining from the back end of the chamber toward its front or sliding valve end, and preferably terminating in a recess or depression, *f*′, near this end, as shown in Fig. 5, from which I arrange a suitable drainage pipe or passage, $f^2$, the object of these being to collect and carry off such water as there may be unconverted into steam when the slags have become cooled and ready for removal from the chamber, although, while I prefer to use these arrangements, they may be dispensed with, if desired. I also construct the slag-vessel $B^2$, Fig. 5, longer in like proportion to the chamber A′ and arrange the main steam-pipe C to communicate with the chamber A′ near one end. I then connect the main water-supply pipe *c* near the opposite end of the chamber, and preferably provide two or more auxiliary water-supply pipes or passages, *c*′, with the generating-chamber nearer the exhaust-pipe C, as shown in Fig. 5. The object of this arrangement of pipes or passages is that the water injected through the pipe *c* will be converted into steam and be well heated and rendered dry while passing over the slag to reach the exhaust-pipe C at the opposite end, and the auxiliary pipes C′ will supply a sufficient quantity of water to prevent the steam from becoming too highly heated in the manner described. I have also arranged and shown a passage, F, which I term an "auxiliary" slag-passage through the top of the generating-chamber and adapted to allow hot or molten slags to be poured or emptied through it into the slag-vessel $D^2$ while it is in the generating-chamber. This passage may be closed by means of the cock F′, or other convenient means, when a desired quantity of slag has been placed in the slag-vessel. The special features shown in Figs 5 and 6 and described are designed to be used, if desired, on all of the generating-chambers, they only being shown in these figures as modifications for convenience and to enable a clearer comprehension of the parts.

It will of course be understood that there is a steam-pump, E′, or other sufficient means employed for forcing the water in the generating-chamber and storage chamber or drum, and the drum or tank E is used to heat the feed-water by means of the steam from the generating-chambers that is exhausted preparatory to opening them for the removal of a cooled slag.

The method of operating my slag-furnace is to open the sliding valve-plate, pour a desirable quantity of hot or molten slag in the slag-vessel, and place the vessel containing the slag in the chamber, and drop or close the valve-plate; or, where the auxiliary slag-passage F is used, the vessel may be placed in the generating-chamber empty and the sliding valve-plate closed or lowered and the desired quantity of hot slag poured or placed in the vessel while it is in the chamber through the auxiliary slag-passage, which may then be closed by the means provided for the purpose. In the latter case the water-supply pipe or passage may be turned on by hand; or, if the valve-plate is not closed until the hot slag has been placed in the vessel in the generating-chamber, the rod $a^4$ in its movement downward, by means of the arm $b^4$ and its ratchet $b^5$, moves the valve-handles $b^2$ and $b^3$ downward, thus opening the water-supply pipe or passage and closing the auxiliary steam-ex-

haust passage. The water thus introduced is generated into steam and cools the slag, and the resulting steam opens the check-valve and passes off into the storage or wash drum, when one is used, and at the same time the steam-pressure within the generating-chambers will extend or press the diaphragm-plate upward, and through its lever $b'$ the ratchets $e$ engage into the valve-handles $b^2$ and $b^3$, which have been pressed down by the rod $a^4$, arm $b^4$, and ratchet $b^5$, or otherwise, and as the slag becomes so cooled as not to generate a sufficient quantity of steam to sustain the high pressure within the generating-chamber the check-valve in the main steam-pipe will close, and the decreasing pressure in the generating-chamber will allow the diaphragm, which has been distended by the high steam-pressure, to recede, and thereby through its said connections $a^4$, $b^4$, and $b^5$ will shut off the water-supply and open the auxiliary steam-exhaust passage, and the remaining steam will exhaust from the generating-chamber and will be condensed in the feed-water-heating tank. Then the sliding valve-plate may be opened and the cooled slag removed, and the operation repeated. When the wash and storage drums are not used, the pressure-reducer may be used upon the main steam-exhaust pipe, or, preferably, upon a common steam-pipe connecting several generating-chambers. It will be seen and understood by reference to Fig. 4 that the ratchets $e$ and $b^5$ will be disengaged alternately from the handles $b^2$ and $b^3$ at the proper time to permit the other to become engaged with and act upon them.

I prefer to retain the mean steam-pressure within the generating-chambers and storage-drum somewhat higher than the desired pressure for use at the engine or other place to insure, through the aid of the pressure-reducer, a constant desired pressure for use at all times.

While I have termed my invention as a "slag-furnace" and used the word "slag" all through the specification, and shall use the same term in the claims, I wish it especially understood that it is applicable to the treatment for the generation of steam of any hot or molten substance, such as iron cinders, hot ores, and metals; hence I do not wish to confine myself to the use and treatment of slag, but wish to reserve the right to use any hot or molten material that can be treated in this manner in my furnace.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a slag-furnace, the combination of one or more generating-chambers having feed and steam-exhaust pipes or passages thereto, one or more passages to the said chamber or chambers for the introduction or removal of slags, one or more valves having a sliding valve-plate composed of two plates provided with means for raising and lowering said plates, and means for spreading or forcing them to their seats to close the said passage and render it steam-tight when they are lowered, substantially as described.

2. In a slag-furnace, the combination of a steam-generating chamber, water feed and steam-exhaust passages thereto, means for opening and closing the same, a passage to the said chamber for the introduction or removal of slag, a valve having a sliding valve for opening and closing the same, and a packing for rendering the steam-valve tight when down and in place, substantially as described.

3. In a slag-furnace, the combination of a steam-generating chamber having one or more passages for the introduction or removal of slag, means for opening and closing the same, one or more water-supply and steam-exhaust pipes, and means for opening and closing one or more of the pipes, substantially as described.

4. In a slag-furnace, the combination of a steam-generating chamber having one or more passages for the introduction or removal of slag, means for opening and closing the same, one or more water-supply and steam-exhaust pipes or passages, means for opening and closing the same, and a diaphragm-regulator communicating with the said chamber and connected with pipe or pipes, as described.

5. The combination, with a slag-furnace having one or more steam-generating chambers, one or more passages thereto for the introduction or removal of slag, means for opening and closing the same, one or more water-supply and steam-exhaust passages or pipes, and means for opening and closing the said pipes or passages, of a steam wash and storage drum or chamber having plates for forcing, driving, or deflecting the steam that may pass through it into or through the water that may be contained in the said chamber or drum, and a pipe or passage for the steam to pass from the generating-chambers to the said wash and storage chamber, and a pipe or passage for the steam to pass therefrom, substantially as described.

6. The combination, with a slag-furnace having one or more steam-generating chambers adapted to receive hot or molten slag, and means for opening and closing the same and provided with water-supply and steam-exhaust passages, of a steam-exhaust pressure-reducer communicating with the said chamber or chambers in such a manner that the steam will pass through the pressure-reducer before being used, substantially as described.

7. The combination, with a slag-furnace having one or more steam-generating chambers provided with means for operating the same, of a steam-generating storage-chamber having a passage for the steam to flow from the generating chamber or chambers to the said storage-chamber and a steam-pressure reducer communicating with the said storage-chamber through which the steam from the said storage-chamber must pass for use, substantially as described.

8. In the combination of a slag-furnace, a steam-generating chamber having a main

passage for the introduction or removal of slag, means for opening and closing the same, one or more water-supply and steam-exhaust passages, and an auxiliary passage for the introduction of hot or molten slag, having means for opening and closing the same, substantially as described.

9. In a slag-furnace, the combination of a steam-generating chamber having one or more passages for the introduction or removal of slag, means for opening and closing the same, one or more water-supply and steam-exhaust pipes or passages thereto, means for opening and closing the same, and a drainage pipe or passage from the said chamber, substantially as described.

10. In a slag-furnace, the combination of a steam-generating chamber having one or more passages for the introduction or removal of slags, means for opening and closing the same, water-supply and steam-exhaust pipes, and a groove in the bottom of said chamber communicating with a recess at one end, and a pipe or passage from such recess, substantially as described.

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