No. 622,935. Patented Apr. 11, 1899.

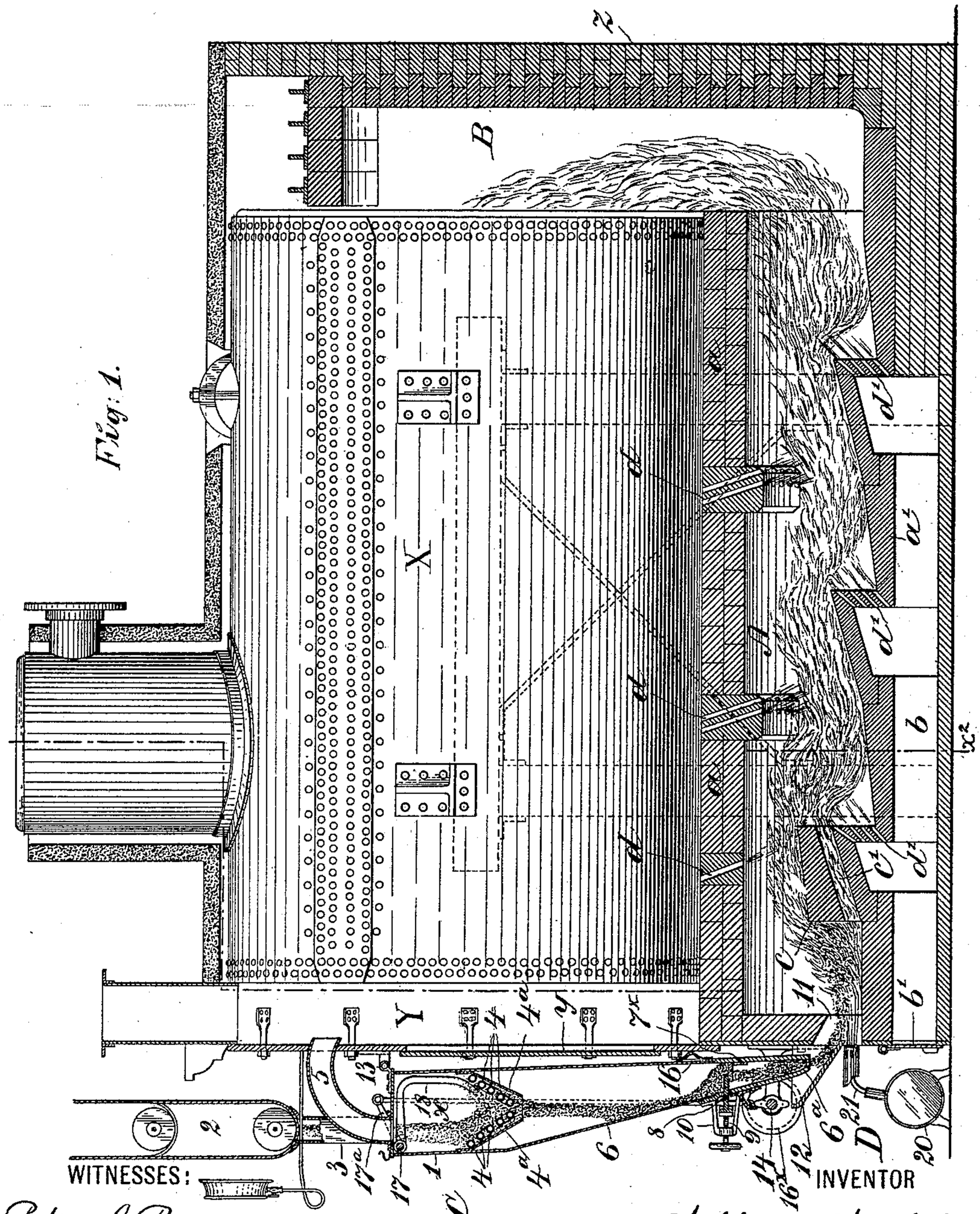
W. WESTLAKE.

MEANS FOR FEEDING AND BURNING PULVERIZED FUEL.

(Application filed Apr. 4, 1898.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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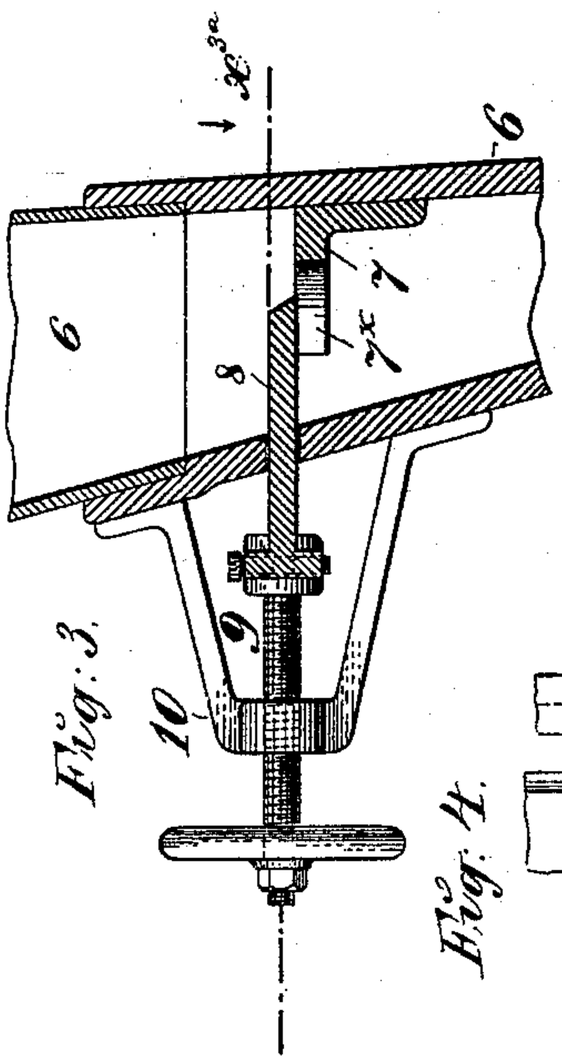

Fig. 3.

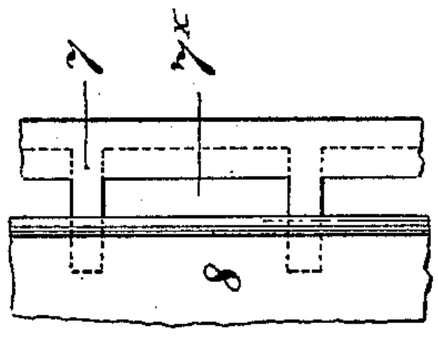

Fig. 4.

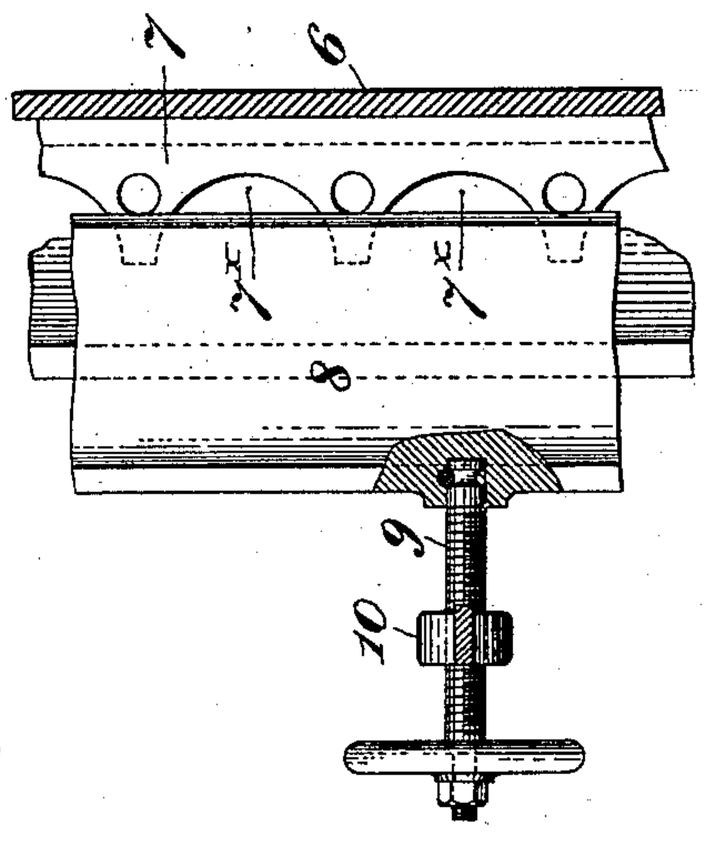

Fig. 3a.

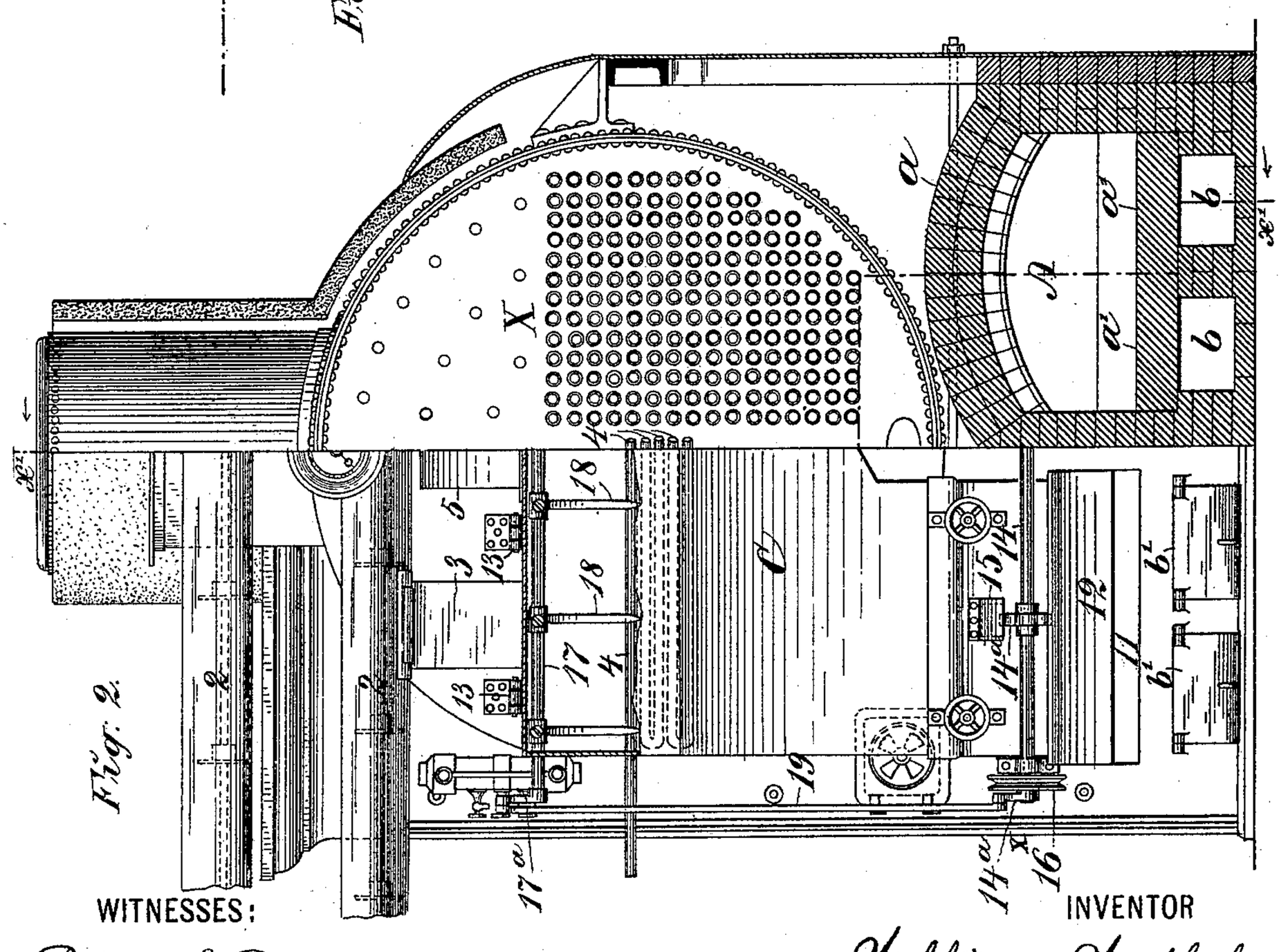

Fig. 2.

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Fig. 5.

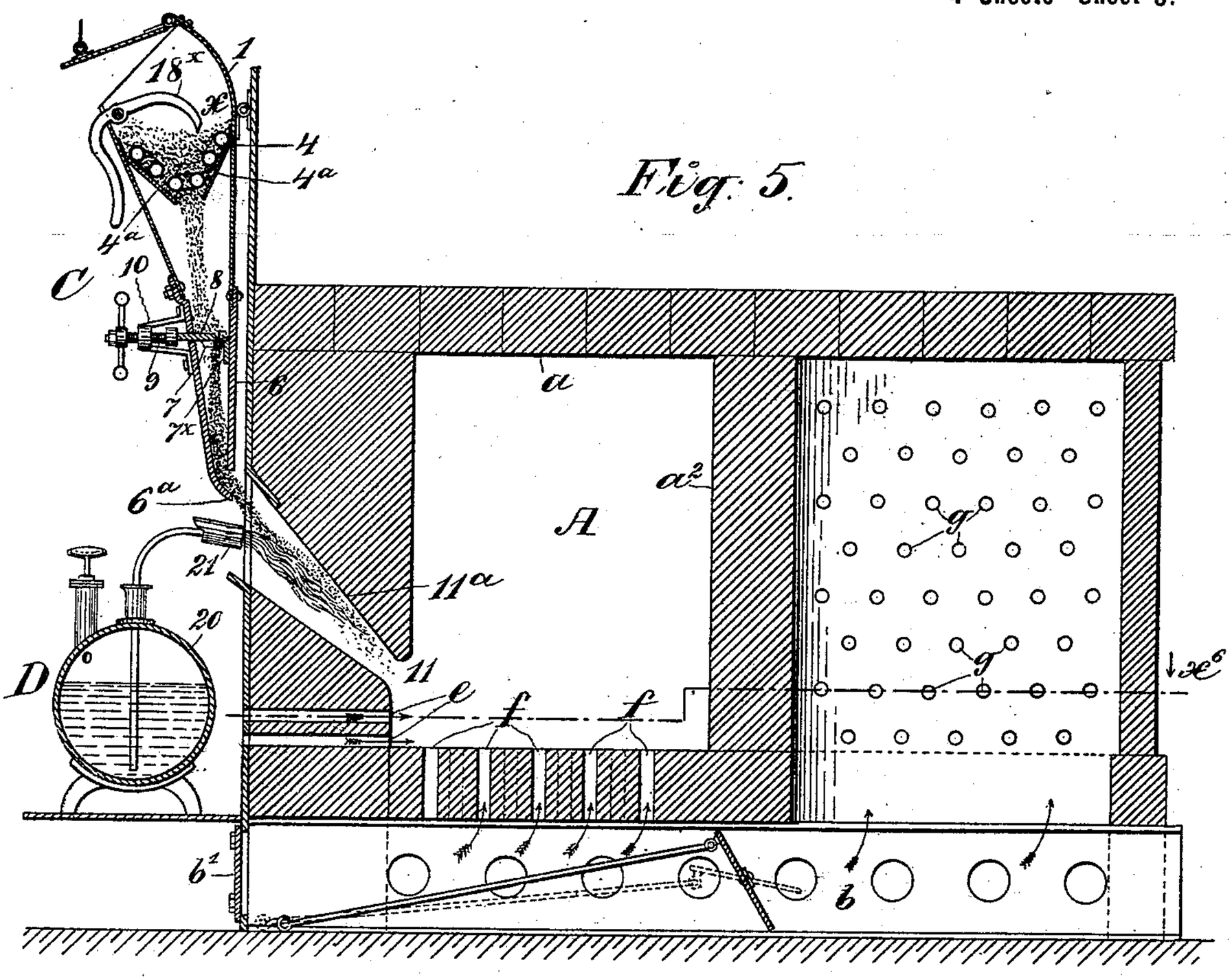

Fig. 6.

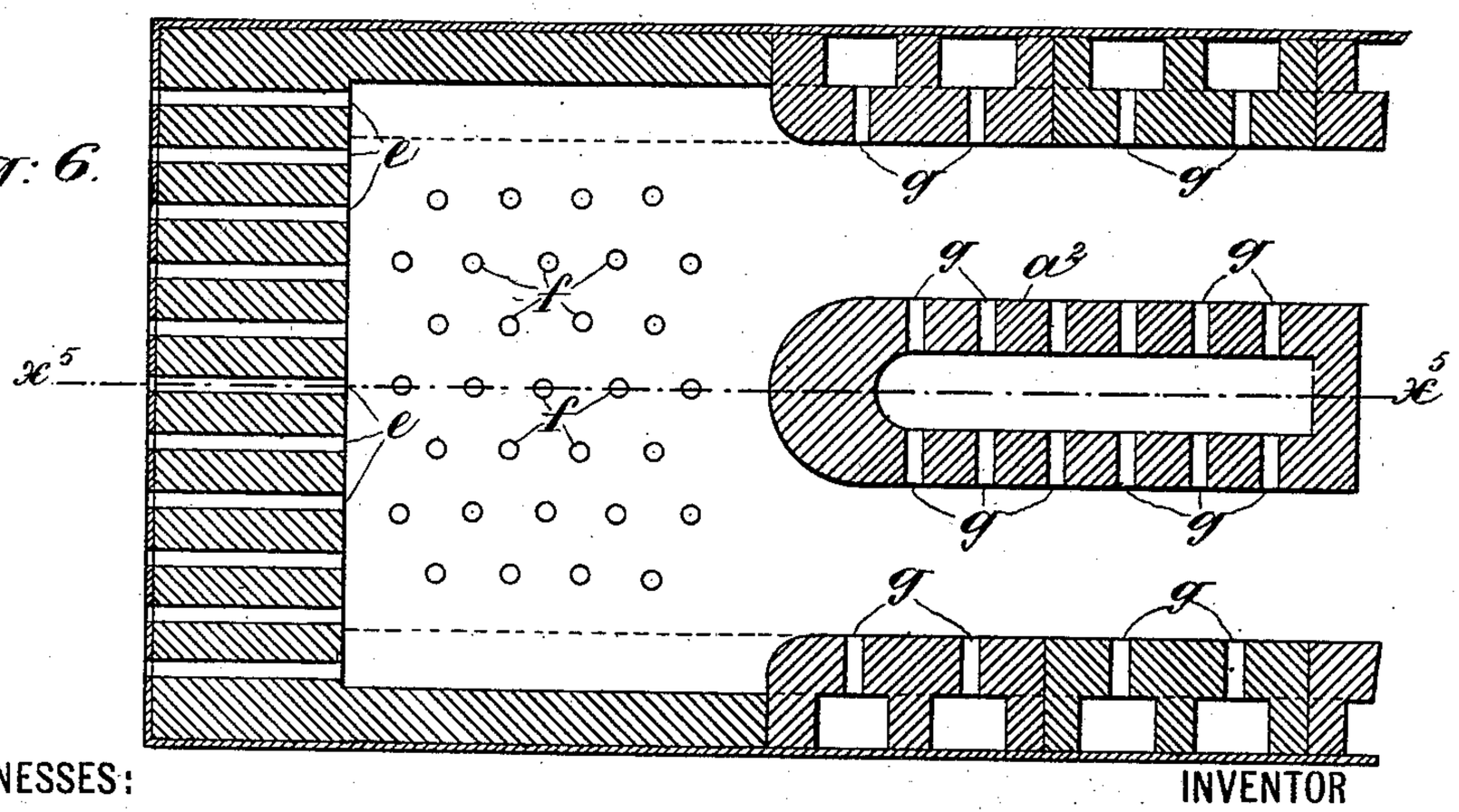

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Fig: 7.

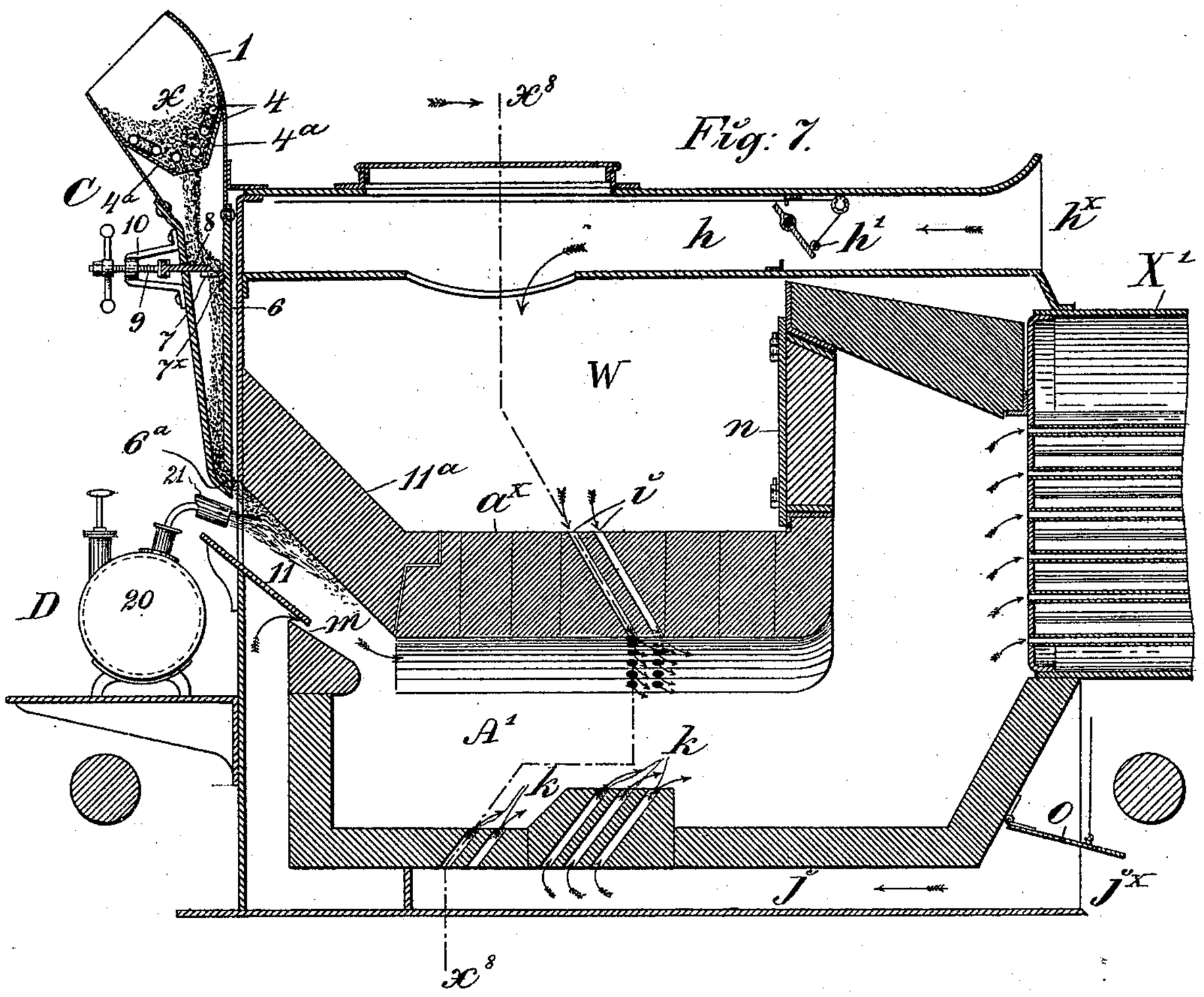


Fig: 8.

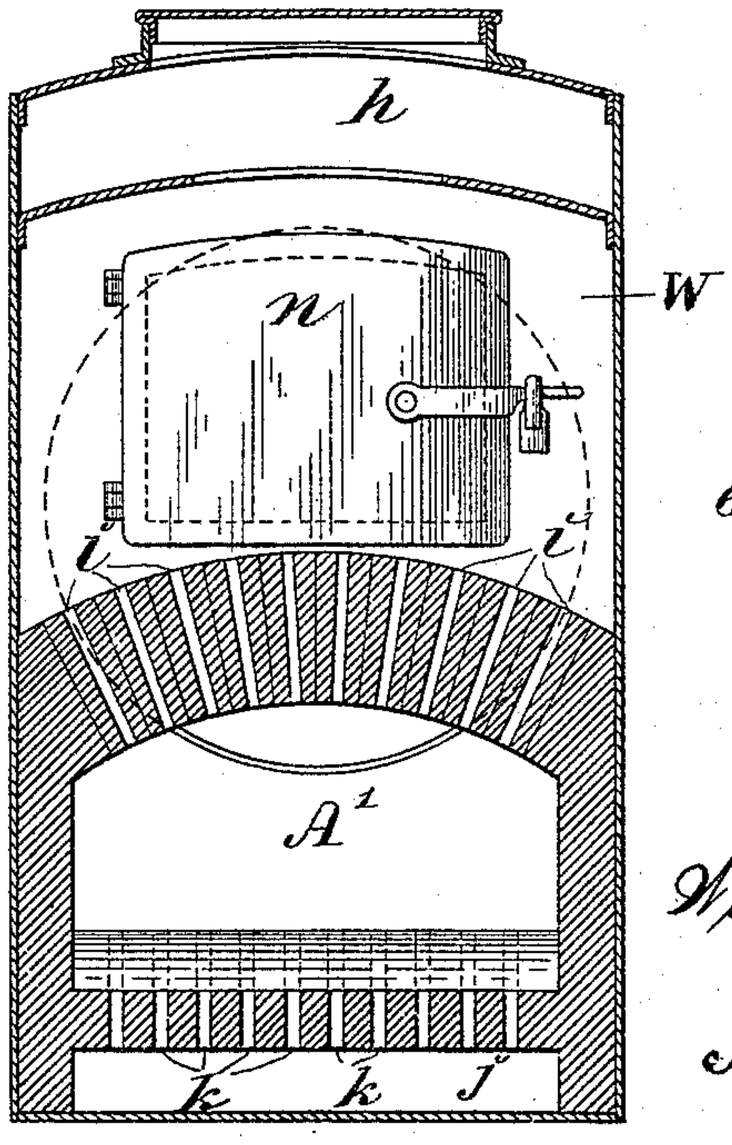
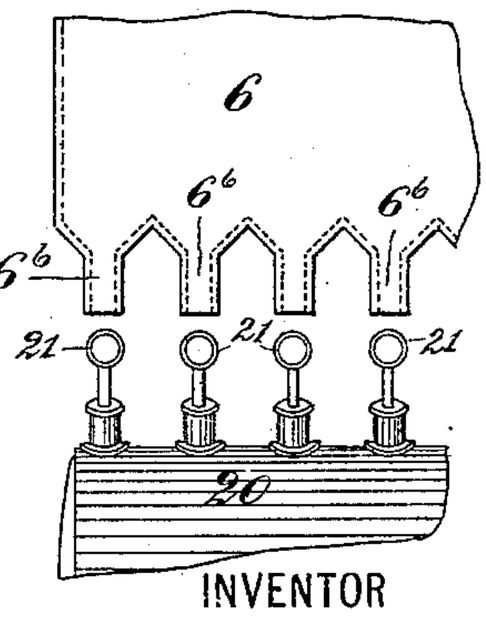


Fig: 9.



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UNITED STATES PATENT OFFICE.

WILLIAM WESTLAKE, OF NEW YORK, N. Y.

MEANS FOR FEEDING AND BURNING PULVERIZED FUEL.

SPECIFICATION forming part of Letters Patent No. 622,935, dated April 11, 1899.

Application filed April 4, 1898. Serial No. 676,281. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM WESTLAKE, a citizen of the United States, residing in the borough of Brooklyn, in the county of Kings and city and State of New York, have invented certain new and useful Improvements in Means for Feeding and Burning Pulverized Fuel, of which the following is a specification.

This invention relates to means for burning fuel in the form of dust or fine granules in order to produce heat, the object being to produce a close approximation to absolutely perfect combustion.

Heretofore, so far as known, serious difficulties have been experienced in burning powdered fuel, such as coal, these difficulties arising in part from inability to attain perfect combustion of the fuel and the consequent accumulation of the fuel in the chambers of the furnace, in part from inability to feed the fuel to the furnace or the burning-point in a manner to attain the proper admixture of oxygen with the particles of carbon, and in part to the inability to effect the object sought with a forced draft or blast, a method of universal use in all attempts to burn powdered fuel so far as known.

The present invention has for its object a drier for the powdered fuel adapted for drying the latter thoroughly at the moment before it is fed to the furnace, whereby the feeding of the fuel in separate dust-like particles is assured. This drying heats the fuel and in a good degree assures that each particle shall be surrounded by air when it reaches the point of combustion.

The invention has also for its object the feeding of the dried dust-like fuel by gravity in a thin sheet to the furnace-mouth; and it relies in the main on the natural draft of the furnace for producing combustion.

Another feature of the invention resides in the use of a burner or series of burners employing a liquid hydrocarbon ejected by compressed air to heat the bricks or other refractory material at the furnace-mouth at starting the furnace in operation or continuously during the operation of the furnace, as circumstances may require.

The invention also includes and is embodied in a special construction of the furnace itself or the combustion-chamber thereof, whereby air is supplied within the combustion-chamber of the furnace to combine with the carbon monoxid produced by the primary ignition of the fuel and convert the same into carbon dioxid, the resultant of perfect combustion.

In the accompanying drawings several embodiments of the invention are illustrated—as, for example, an adaptation of the invention to a new installation for a steam boiler or generator, an adaptation to replace a furnace already constructed on the ordinary principles, and an adaptation to a locomotive-furnace.

In the drawings, Figure 1 is a longitudinal vertical section of a boiler-furnace, taken substantially in the plane of the line x' in Fig. 2; and Fig. 2 is a front view of said furnace, the left side being an elevation and the right side a vertical transverse section in substantially the plane indicated by the line x^2 in Fig. 1. These views show the invention embodied in a new installment of a boiler-furnace. Fig. 3 is a vertical section on a large scale; and Fig. 3^a, a fragmentary sectional view of the feed-regulating device for the fuel, the sectional plane of Fig. 3^a being at line x^{3a} in Fig. 3. Fig. 4 is a plan view illustrating a slight modification of the device as seen in Fig. 3^a. Fig. 5 is a longitudinal vertical section at line x^5 in Fig. 6, illustrating an embodiment of the invention in a furnace adapted to replace a boiler-furnace of the usual kind; and Fig. 6 is a transverse vertical section of the same in the plane indicated by line x^6 in Fig. 5. Fig. 7 is a longitudinal vertical mid-section of a locomotive-furnace embodying the invention, and Fig. 8 is transverse vertical section of the same in the plane indicated by line x^8 in Fig. 7. Fig. 9 illustrates another form of the feeding device.

Referring primarily to Figs. 1, 2, 3, and 3^a, X represents an ordinary tubular return-flue boiler, Y the breeching at the front end of the boiler to lead the gases to the chimney, and Z the brickwork, in which the boiler is set.

Under the boiler are two like combustion-chambers A, arranged side by side and having each an arched roof a separating the chamber from the shell of the boiler. Both of the combustion-chambers A open at the back into a flue B, leading the hot gases to the rear

ends of the tubes or flues. Two combustion-chambers are herein shown merely because the diameter of the cylindrical boiler is quite considerable. The present invention does not require two.

In front of the furnace is situated the fuel drying and feeding device, designated as a whole by C, and below the device C, at the front, is situated a portable igniter, designated as a whole by D.

The devices for supplying, drying, and feeding the powdered fuel *x* will now be described.

The fuel is supplied to a receiver or hopper 1, and the supply may be, as shown in Figs. 1 and 2, effected by an endless conveying device 2, which is not in itself novel. The fuel falls through a suitable chute or pipe 3 into the hopper 1, and falls onto the drier therein, this drier being formed, as herein shown, of coils 4 of steam-pipe arranged rather close together and inclined or V-shaped, as shown. Below the two inclined sets of coils are placed inclined plates 4^a, upon which the fuel falls after passing between the coils. These plates form the inclined bottom of the hopper. The fuel in drying may give off some vapor and other exhalations, and these may pass into the breeching Y by a pipe or flue 5. From the drier the fuel descends by gravity as a dust or powder into a laterally-extended flattened chute or trunk 6, which may be considered as a part of the hopper 1 or as a pendent continuation thereof. In this trunk 6 is the feed regulator or device for restricting the quantity of fuel fed, as well as feeding it in a sheet across the front of the combustion-chamber. This feed-regulator consists, as best seen in Figs. 3 and 3^a, of a plate 7, fixed to the back wall of the trunk 6 and having scallops $7^\times$ in its front edge, and a sliding plate 8, which plays through the front wall of the trunk 6 and rests on and slides over the plate 7 in such a manner as to gradually reduce the passages at the scallops for the flow of the fuel-dust when the plate 8 is pushed in. For convenience in operating the cut-off plate or slide 8 it may have collared in it, as seen in Fig. 3^a, at each end a screw 9, which screws through a bridge-nut 10, fixed to the outer face of the trunk 6. I may say here that the scallops or recesses in the front edge of the plate 7 will be, by preference, circular or curved, as seen in Fig. 3^a; but they may be with good results of other forms, as of the rectangular form seen in Fig. 4, for example. After passing the regulator just described the fuel-dust falls by gravity in a thin sheet or dust-cloud to the outlet 6^a of the trunk 6, where it emerges at the mouth 11 of the furnace. At this point there is a fixed inclined pan 12, on which the dust may fall in case it is not instantly drawn into the combustion-chamber by the draft.

When the fuel-dust is dried on the steam-pipes or coils 4, it may form in slightly cohesive flocculent masses, and in order to break or shatter such masses into dust or granules I prefer to provide the feeding apparatus C with agitators, which will now be described.

The apparatus C is hinged to the front of the furnace at 13, so that it may swing toward and from the furnace-front, and may indeed be swung out far enough to allow access to the breeching Y and to the front ends of the boiler-tubes by means of a door *y* in the front of the breeching.

In bearings on the furnace-front is mounted a rotatable shaft 14, on which are fixed one or more toes 14^a, adapted, as the shaft rotates, to engage or take behind a hook 15 on the trunk 6 and swing the device outward and then slip off and allow the whole to swing back on its hinge 13 and strike the furnace-front through the medium of a bumper 16 on the trunk, as seen in Fig. 1. This device may be operated by power or by hand, the shaft 14 being rotated through the medium of a sheave or pulley $16^\times$ on the shaft and a belt. (Not shown.) Of course the shaft 14 may be driven from any rotating shaft, as that which drives the fuel-conveyer 2, for example.

In the hopper 1 above the drying-coils is mounted a rock-shaft 17, which carries a number of curved arms 18, adapted to play back and forth through the fuel on the coils by the rocking of the shaft 17. On the outer end of the shaft 17 is an arm 17^a, which is coupled by a rod 19 to a crank 14^a on the shaft 14, whereby rotation of said shaft rocks the shaft 17 and causes the arms 17^a to agitate the fuel in the hopper and break up any flocculent masses or crusts that may be formed in drying. In Fig. 2 the hopper 1 is broken away to show this agitating device.

The fuel, reaching the laterally-extended mouth 11 of the furnace in the form of a thin sheet or filmy cloud, is drawn into the combustion-chamber by the natural draft.

The combustion-chamber A has an air flue or flues *b* underneath its floor *a'*, the air entering at the front of the furnace through openings controlled by doors *b'*. Near the front of the combustion-chamber A on its floor is an ignition-wall *c*, having in it passages *c'*. This wall faces the mouth 11 of the furnace. Primary ignition of the fuel is effected by heating the ignition-wall, which will be of refractory material, up to a high temperature by means of the igniting apparatus D. Respecting this apparatus it will only be necessary to say that, as here shown, it is a form of burner for liquid hydrocarbon comprising a reservoir or holder 20 for the oil, into which air is compressed, which forces the oil out through a series of jet devices 21, constructed on the Bunsen principle, and from which the oil is ejected through a needle-like aperture. The flame from these jets impinges on the ignition-wall and the adjacent refractory surfaces, heating them to a high temperature, whereby the cloud of dust-

like fuel entering with the air caused by the draft is ignited in a very perfect manner. The solid fuel must be reduced practically to a gaseous form before perfect combustion can be attained, and at the point of ignition some of the carbon of the fuel will be combined to form carbon dioxid, while a considerable portion will unite with oxygen to form carbon monoxid, and this will be supplied with oxygen at points farther on, as will now be explained.

In the arched roof *a* of the combustion-chamber are shown, in Fig. 1, inlets *d* for air drawn in by the natural draft. Preferably one of these inlet-points will be situated over or nearly over the igniting-wall and the others placed at intervals farther back and the inlet-passages will be inclined downward toward the rear. In the bottom *a'* of the combustion-chamber are formed upright walls facing to the rear, in which are formed air-inlets *d'*, open to the bottom air-flue *b*.

It may be well to state here that as there are really two like combustion-chambers A, placed side by side under the boiler, and two mouths 11, one for each furnace, the single hopper 1 of the fuel-feeding apparatus C is conveniently branched or forked below, there being two trunks 6, each provided with a feed-regulating device.

Figs. 5 and 6 show a construction somewhat different from that last described, but not differing therefrom in principle. In this form the hopper of the feeder is adapted to be filled by hand and the agitator $18^{\times}$ therein to be operated by hand. The igniting apparatus D is the same; but in lieu of an igniting-bridge in the combustion-chamber A the mouth 11 of the furnace is inclined downward and is formed in the thick refractory front wall of the furnace. The jets from the igniting apparatus impinge directly on the inclined upper wall 11^{a} of the mouth 11 and heat it to a high temperature. Air for primary ignition enters at inlets *e* in the front wall and inlets *f* in the floor. The current of gases from the front part of the combustion-chamber is divided by an upright hollow partition a^{2}, and air-inlets *g* are formed in it and in the hollow side walls to provide air to complete the combustion.

Figs. 7 and 8 illustrate an adaptation of the invention to a locomotive-boiler. In this adaptation the drying and feeding devices for the fuel and the igniter D are substantially the same as described, and shown in Figs. 5 and 6. X' is the locomotive-boiler, and A' is the fire-box. Above the arched roof or crown $a^{\times}$ of the fire-box is a chamber or space W, to which air has access from an air-flue *h*, open at the front end $h^{\times}$ to receive air when the locomotive is running. The air enters the combustion-chamber through air-inlets *i* in the crown $a^{\times}$. The amount of air admitted to the flue *h* is regulated by a valve *h'*. Below the fire-box is another air-flue *j*, also open at the front end $j^{\times}$, and air entering thereat passes into the fire-box through inlets *k* in the bottom thereof. Air to promote primary ignition enters the mouth of the furnace at an inlet *m* below the lower plate of the furnace-mouth. Access may be had to the rear tube-sheet of the boiler through a door *n* in the front wall of the chamber W. A door *o* regulates the influx of air to the lower air-flue *j*.

The fuel-feeding apparatus C is shown in Fig. 1 as hinged to the front of the furnace, and it may be loosely hinged or suspended therefrom, so that it can be lifted off if desired.

It will be noted that in all of these forms of furnaces the fuel-feeding devices are in substance the same, the dry dust-like fuel being fed by gravity down to the flame in a thin cloud or sheet. The heat of the flame from the igniter D under the heavy pressure of the air on the liquid hydrocarbon is very intense and acts in the manner of a blower or blow-pipe; but the several jets 21 are under perfect control and are arranged to ignite the powdered fuel in a complete and perfect manner. The jets 21 may be placed quite close together; but as it is hardly feasible to make them coalesce into one sheet of flame it is contemplated to so shape the lower end of the trunk 6, where the fuel emerges, that the latter will issue in thin streams, each stream being directly in front of one of the jets of the igniter. This will insure that each particle of the fuel shall be brought into direct contact with the intensely-hot flame. This form of the delivery end of the trunk 6 will be understood from the fragmentary view Fig. 9, wherein 6^{b} represents the several outlet-chutes for the fuel, arranged in line with a jet 21 of the igniter.

Having thus described my invention, I claim—

1. In means for feeding fuel in the form of dust to a furnace and igniting same, the combination with a receiver for the powdered fuel situated above the furnace-mouth, of a pendent chute extending down from said receiver to lead the fuel by gravity to the furnace-mouth, means for regulating the quantity of fuel fed, and an igniter having a flame-jet directed into the mouth of the furnace, whereby the falling fuel is ignited and carried into the said mouth, substantially as set forth.

2. In means for feeding fuel in the form of dust to a furnace, the combination with a fuel-receiver situated above the furnace-mouth, an upright flattened chute extending from said receiver down to the furnace-mouth, and a feed-regulator in said chute, of a drier for the fuel in and forming the bottom of said fuel-receiver, substantially as set forth.

3. The combination to form a means for feeding powdered or dust-like fuel to a furnace, of the receiver to contain the fuel, the drier for the fuel consisting of the steam-pipes 4, and the plates 4^{a} situated beneath said pipes, the chute or trunk 6, which leads the dried fuel by gravity down to the furnace-mouth, and an adjustable regulator in the

said chute for the feed, substantially as set forth.

4. The combination, in a means for feeding powdered or dust-like fuel to a furnace, of a receiver for the fuel, a drier therein for the fuel, a flattened chute or trunk to lead the dried fuel down by gravity to the furnace-mouth, and means for agitating the dried fuel to break up any flocculent or crust-like masses thereof formed in drying, substantially as set forth.

5. In a furnace for burning powdered or dust-like fuel, the combination with a feeder which feeds the dust down in a thin sheet to the furnace-mouth so that the draft may take it in, of an igniter which heats the refractory material at the furnace-mouth up to a high temperature, substantially as set forth.

6. The combination with the fuel-receiver and the chute or trunk 6 extending down therefrom, of a feed-regulator consisting of a scalloped plate 7, in the said chute or trunk, and the movable plate 8, which may be shifted in or out over the plate 7, to regulate the size of the opening through which the fuel must pass in its descent to the furnace-mouth, substantially as set forth.

7. A fuel feeding and drying device suspended and hinged at the front of the furnace, and means, substantially as described for swinging it out from its normal suspended position and releasing it, whereby the fuel therein is shaken and agitated, substantially as set forth.

8. A fuel feeding and drying device, comprising a receiver 1, a V-shaped drier therein consisting of the steam-pipes 4, and the plates 4^a situated beneath and near to said pipes, the agitator in said receiver above the drier, the chute 6 adapted to lead the powdered fuel by gravity down to the furnace-mouth, and the feed-regulator in said chute, substantially as set forth.

9. In a furnace for burning powdered or dust-like fuel, the combination with a feeder for feeding the fuel by gravity in a thin sheet to the mouth of the furnace, and an igniting-wall near the furnace-mouth, of an igniter for heating the said igniting-wall, substantially as set forth.

10. The combination with a furnace, of a feeder for feeding dust-like fuel by gravity down to the mouth of the furnace, and an igniter having a flame-jet directed into the furnace-mouth and across the path of the descending fuel, substantially as and for the purposes set forth.

In witness whereof I have hereunto signed my name, this 31st day of March, 1898, in the presence of two subscribing witnesses.

WILLIAM WESTLAKE.

Witnesses:

PETER A. ROSS,

HENRY CONNETT.