

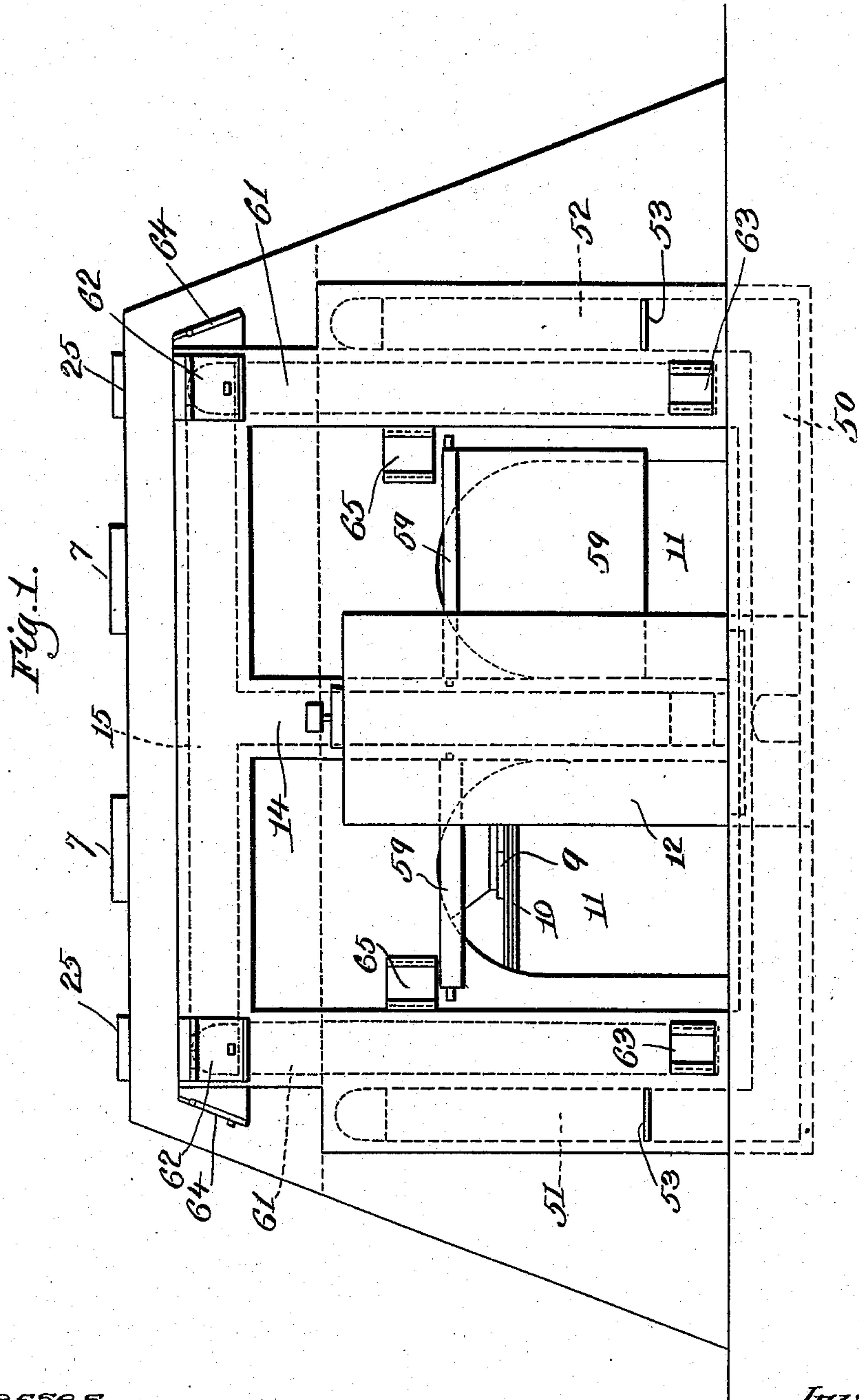
A. E. TRUESDELL.
KILN.

APPLICATION FILED AUG. 9, 1905.

930,506.

Patented Aug. 10, 1909.

7 SHEETS—SHEET 1.



Witnesses.
W. C. Lunsford
Bertrand Simonds.

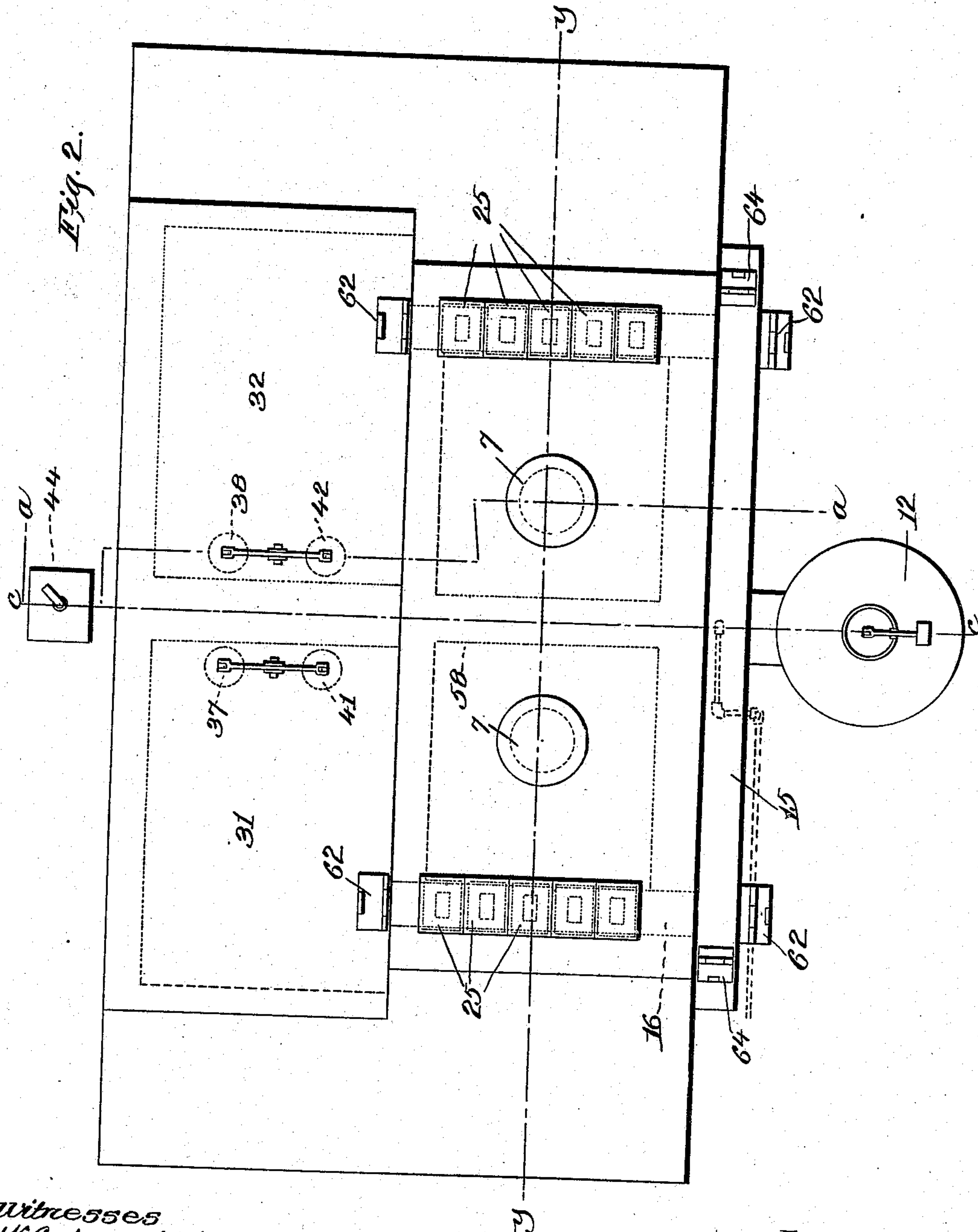
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7 SHEETS—SHEET 2.



Witnesses
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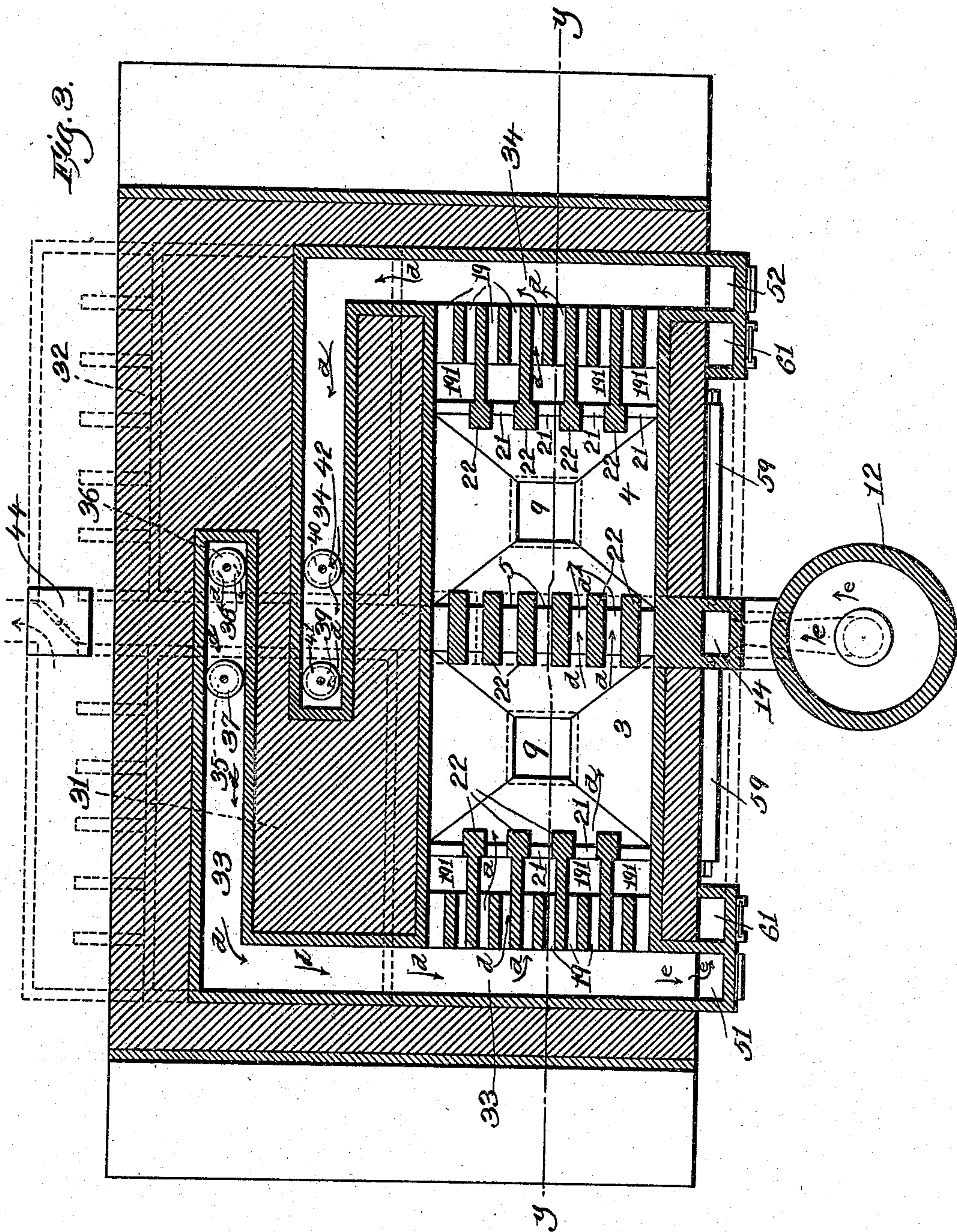
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7 SHEETS—SHEET 3.



Witnesses.

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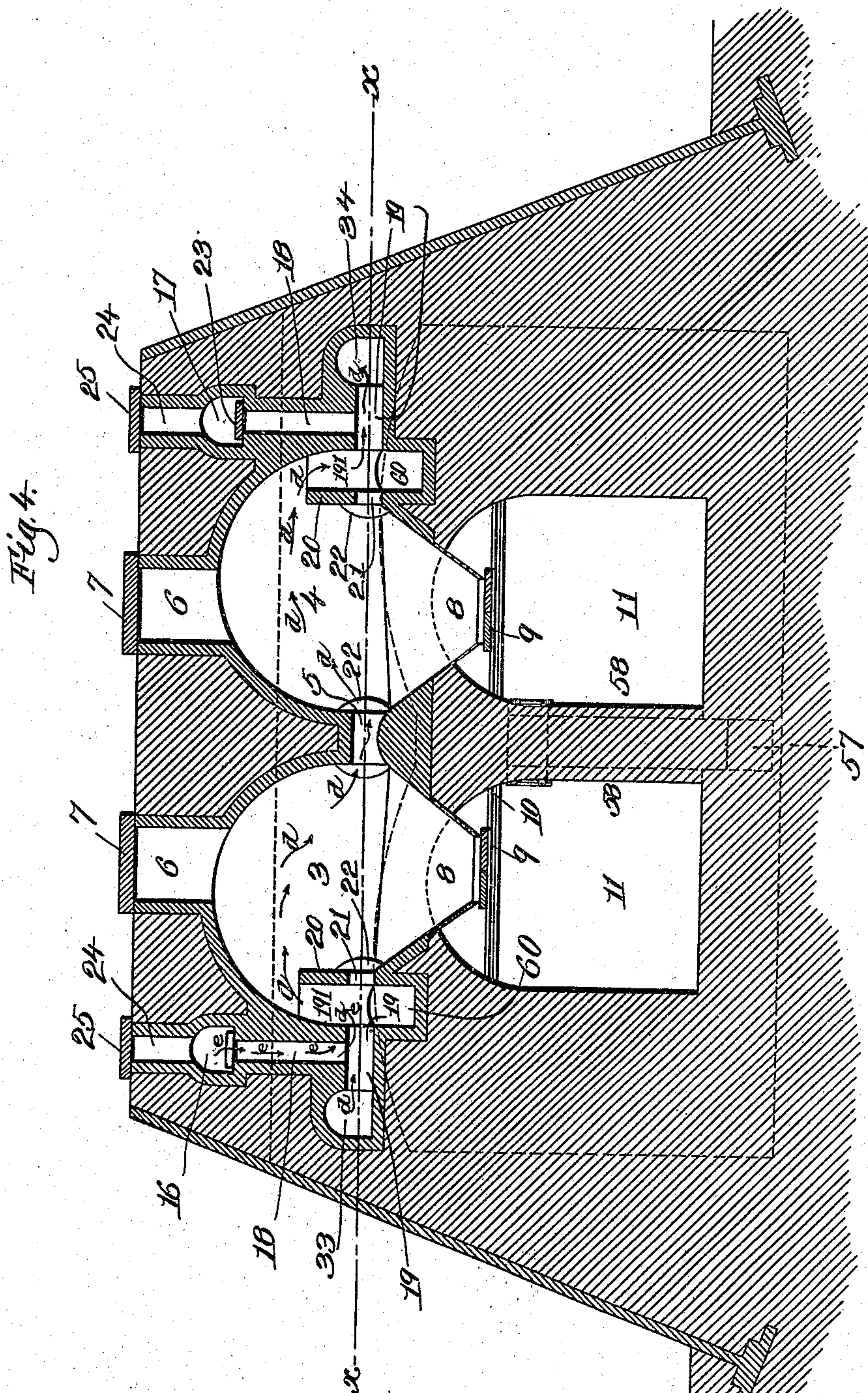
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7 SHEETS—SHEET 4.



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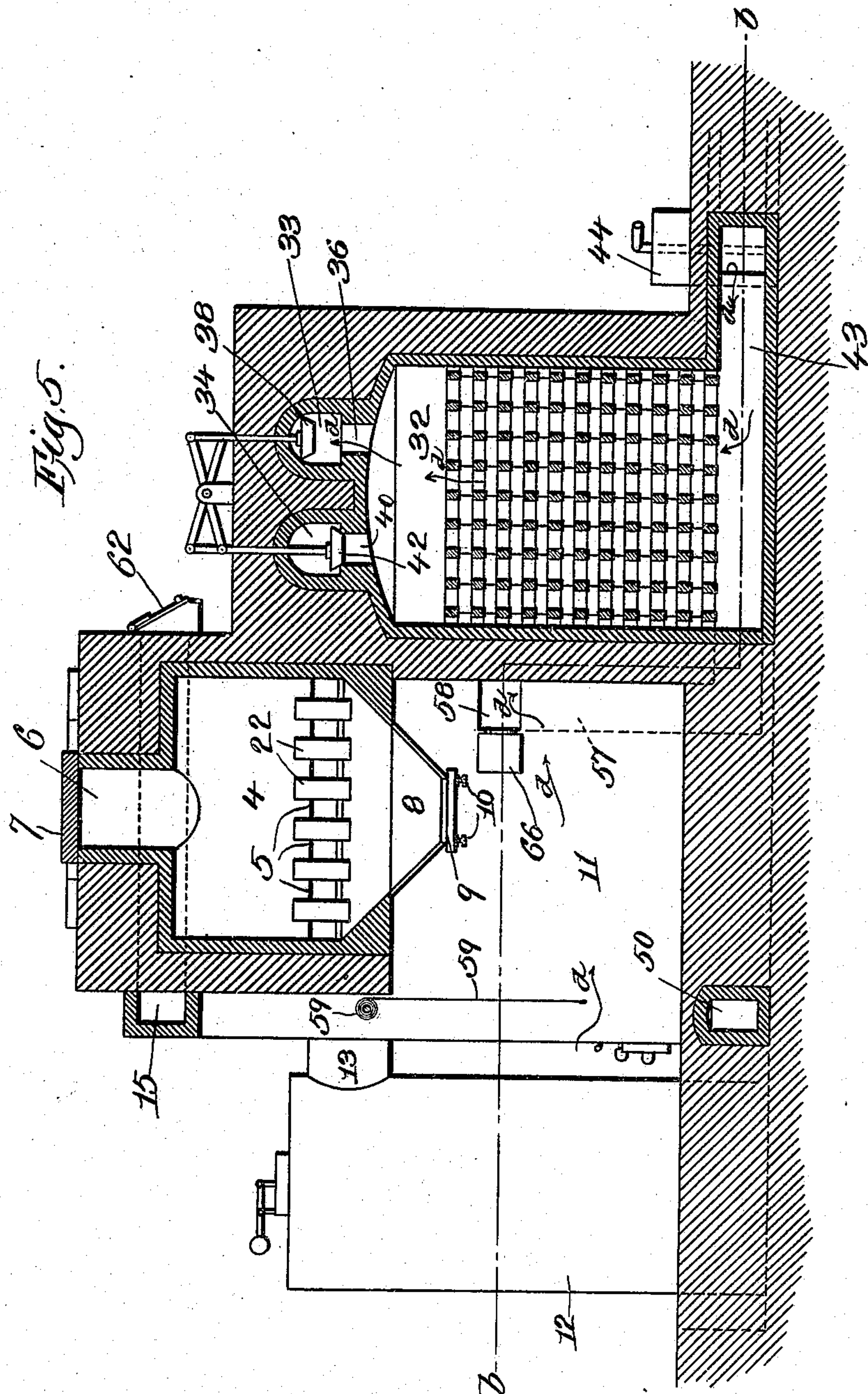
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7 SHEETS—SHEET 5.



Witnesses.

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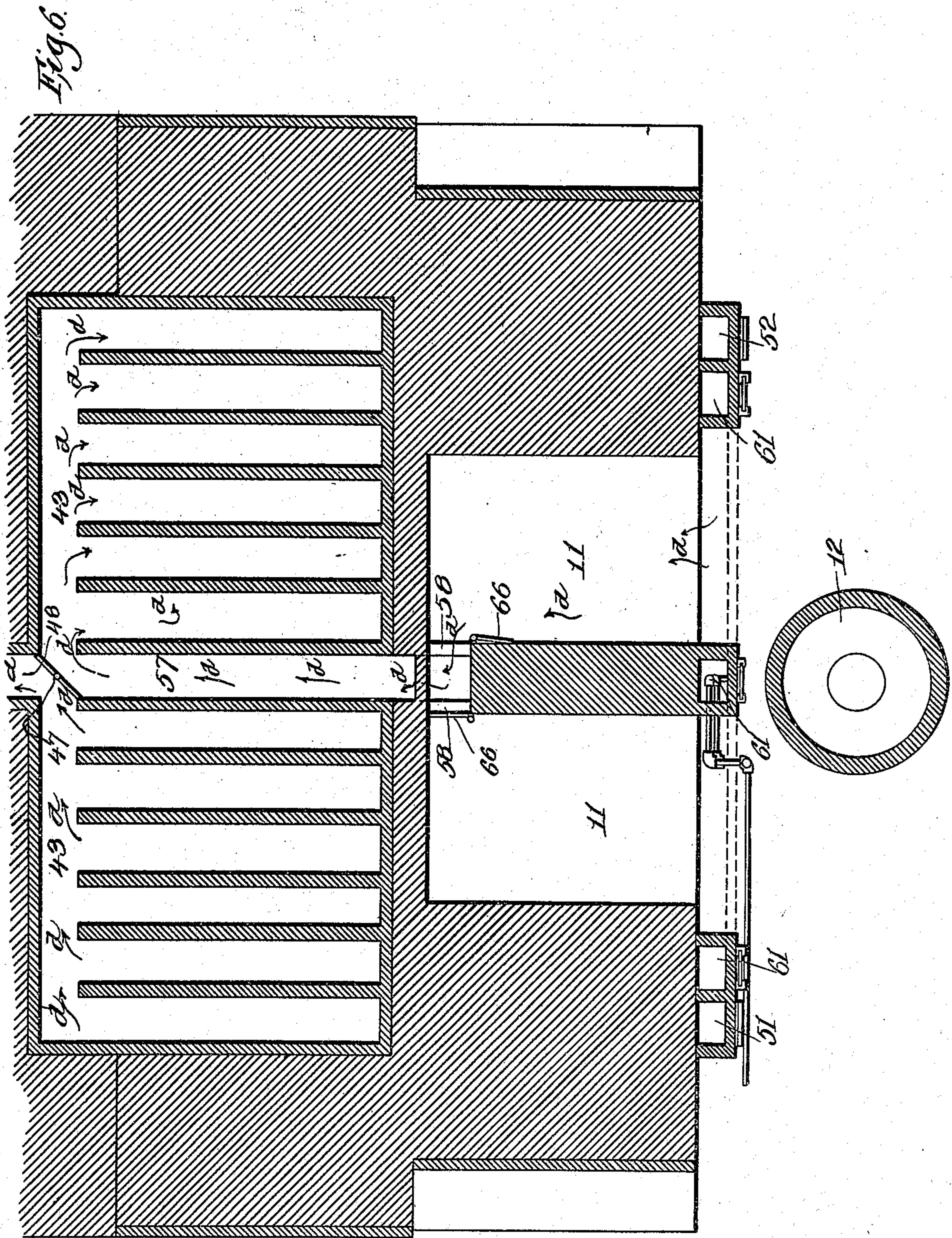
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7 SHEETS—SHEET 6.



Witnesses.
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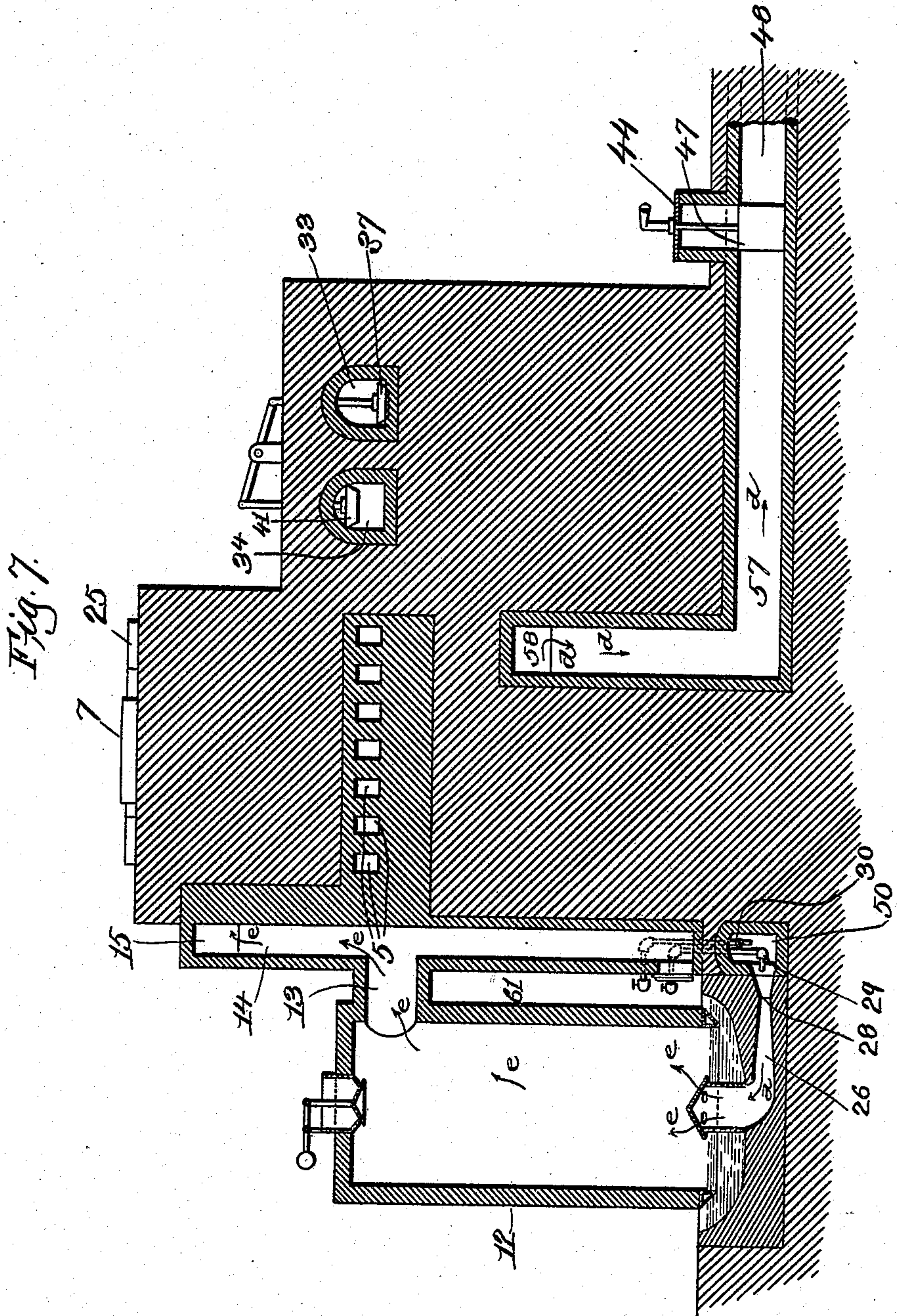
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Patented Aug. 10, 1909.

7 SHEETS—SHEET 7.



Witnesses.
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UNITED STATES PATENT OFFICE.

ARTHUR E. TRUESDELL, OF PITTSFIELD, MASSACHUSETTS.

KILN.

No. 930,506.

Specification of Letters Patent.

Patented Aug. 10, 1909.

Application filed August 9, 1905. Serial No. 273,413.

To all whom it may concern:

Be it known that I, ARTHUR E. TRUESDELL, a citizen of the United States, residing at Pittsfield, county of Berkshire, and State of Massachusetts, have invented an Improvement in Kilns, of which the following description, in connection with the accompanying drawing, is a specification, like numerals on the drawings representing like parts.

This invention relates to that type of kiln wherein a moderate burning temperature is essential (a lime kiln being a good example of this type of kiln) and the principal object of my invention is to provide a novel kiln of this type in which gas can be successfully and economically used for burning the material in the kiln. Since a suitable gas may be derived from a large variety of carbonaceous material, such a kiln presents a great advantage over the ordinary type of kiln where only one class of fuel may be used.

In order to obtain the desirable moderate burning temperature I provide means for regulating the supply of air and gas to the kiln chamber, thereby producing a flame of the required temperature.

In order to obtain economy in the operation of the kiln I pass the heated products of combustion from the kiln chamber which is being fired through another kiln chamber which has been filled with fresh rock, thereby preheating the rock before burning, and I also pass these products of combustion through a heat conserving device before delivering them to the stack or other exhaust device, which heat conserving device arrests or extracts the heat units in the products of combustion whereby they may be carried back into the kiln and utilized.

When the gas used as fuel is produced in a suitable gas producer associated with the kiln, I propose to draw from the heat conserving device the air used in the gas producer for gasifying the fuel. In a kiln embodying my invention, therefore, the heat in the products of combustion after they are discharged from the kiln chamber being fired is utilized for preheating the rock, preheating the air delivered to the kiln chamber being fired, and also preheating the air delivered to the gas-producer. In this way a larger portion of the heat units in the fuel

being fired is utilized than in kilns of the usual forms.

In the embodiment of my invention herein shown there are two connected kiln chambers and the heat conserving device is in the form of two regenerators. In operation the air introduced in the kiln is heated by passing it through one regenerator, and part of such heated air is delivered to the kiln chamber to support combustion therein and the rest of said heated air is delivered to the gas producer. The products of combustion generated in the kiln chamber being fired pass through the other kiln chamber and thence into the other regenerator thereby heating the latter. Each regenerator is connected by valved ports to each kiln chamber, so that the products of combustion from either kiln chamber can be delivered to either regenerator. With this construction the currents of air through the regenerators may be reversed as often as need be to secure the most economical operation as will be more fully hereinafter described.

Other features of my invention will be more fully set forth in the following description and will be pointed out in the claims.

In the drawings, Figure 1 is a side elevation of a kiln embodying my invention; Fig. 2 is a top plan view; Fig. 3 is a horizontal section on substantially the lines $x-x$, Figs. 1 and 4; Fig. 4 is a vertical section through my improved kiln on substantially the lines $y-y$, Figs. 2 and 3; Fig. 5 is a vertical section on the line $a-a$, Figs. 2 and 3; Fig. 6 is a horizontal section on substantially the line $b-b$, Fig. 5; Fig. 7 is a vertical section on the line $c-c$.

In the present embodiment of my invention there are two kiln chambers designated by 3 and 4 respectively, said chambers being connected by means of ducts or passages 5. Each kiln chamber has at or near its top a charging opening through which the unburned material is delivered thereto, and at or near its bottom a discharging opening through which the burned material is discharged therefrom, both of said openings being closed or sealed during the process of burning.

The upper or charging opening of each kiln chamber is designated by 6 and it is closed during the burning operation by a suitable

cap-piece 7. Each charging opening may be made substantially air tight by packing or sealing the cap-piece with clay, sand or other suitable material.

5 The discharging opening of each kiln is designated by 8 and it is sealed during the burning operation by a suitable cover 9, which is herein shown as being supported on cross-pieces 10. If necessary the dis-
10 charging opening may be made air tight by sealing the cover or closure 9 with clay, sand or other suitable material. The cover 9 may be made in two parts and attached to rods so that the discharging opening may
15 be opened by separating the two parts of the cover.

Beneath each kiln chamber is a pit 11 into which the burned material is discharged, each pit being opened at one end,
20 as seen in Figs. 1, 4, 5 and 6.

By thus employing upper charging openings and lower discharging openings the action of gravity may be brought into use to assist in the operation of handling the
25 material to be burned, and the labor required for charging and discharging each kiln chamber is reduced to a minimum.

The embodiment of the invention herein shown is adapted for using for fuel coal, coke, or any other carbonaceous material
30 suitable for gasification, the burning of the material in the kiln being accomplished by the combustion of the gas generated in a suitable gas producer from the carbonaceous
35 material. For many reasons I prefer to place the gas producer outside of the kiln but as near to it as convenient so as to avoid any loss of the sensible heat of the gas due to the radiation of long flues.

40 The gas producer is designated by 12 and is situated just outside of the kiln, as shown in the drawings. Said producer may be of any suitable or usual construction, and it is connected to the kiln so as to deliver
45 the gas generated therein to either of the kiln chambers. As herein shown the outlet 13 from the gas producer communicates with a duct 14, which in turn communicates with a horizontal duct or flue 15 extending
50 along the side of the kiln. Said duct or flue 15 communicates at one end with a cross flue 16 adjacent one kiln chamber, and at the other end communicates with another cross flue 17 adjacent the other kiln cham-
55 ber. The flues 16 and 17 each communicate with downtakes 18 which open at their lower ends into the ports 19 at which point the gas meets the air which introduced into the kiln chamber and combustion of
60 the gas begins, the combustion continuing in the space in the kiln chamber above the material therein as the air and gas become mingled with each other. Additional space for the commingling of the air and gas is
65 provided at 191 by the walls 20, so that com-

plete combustion may take place. The walls 20 are provided with ports 21 and the flame generated by the combustion of the commingled air and gas enters the kiln chamber partly through the port 21 and partly over
70 the abutment 20, thereby causing a more even burning of the material than if the flame entered the material from above only. It will be seen from the drawings that there are several downtakes 18 arranged side by
75 side and several ports 19, so that the flame comes into the kiln chamber at various points along its entire side. The ports 21 are protected and the draft prevented from being clogged or choked by the material in
80 the kiln chamber by suitable abutments 22 which are built either side of said ports and which extend into the kiln chamber for a suitable distance. Each of the downtakes 18 may be closed by a suitable valve 23 in
85 the form of a brick or block, and said valves 23 are placed over the downtakes or removed therefrom through suitable apertures 24 in the top of the kiln, said apertures being closed while the kiln is in opera-
90 tion by covers 25. These valves are used to control the distribution of the gas to the chamber as well as its amount and are closed for one kiln chamber when the other is being fired.

95 The "primary" air which is introduced into the gas producer for supporting combustion therein is supplied through an inlet 26, and is previously heated by the products of combustion issuing from the kiln as will
100 be more fully hereinafter described. If desired a suitable steam blower may be used for forcing the primary air into the gas producer and a simple one is herein illustrated wherein the inlet 26 is made with the re-
105 duced portion 28 and a steam-jet pipe 29 is employed to force the air through said inlet, said steam-jet pipe being connected to any suitable source of steam supply. I find it
110 of advantage to commingle more or less steam with the primary air, because this not only reduces the temperature of the producer but also makes a richer gas, but if it is found that an insufficient amount of steam is thus admitted to the primary air through
115 the operation of the steam blower I propose to introduce an added quantity of steam through a suitable auxiliary steam pipe 30 which may be connected to any suitable source of steam supply. The air which is
120 delivered to the kiln chambers to commingle with the gas therein and to produce combustion, and the primary air which is delivered to the gas producer are both preheated by the products of combustion issuing from
125 the kiln chamber, thus securing the most economical use of the fuel. Abstracting the heat from the waste gases and returning it into the kiln by preheating the air admitted to the kiln.

My invention contemplates abstracting the heat from the waste gases and returning it to the kiln thereby saving much heat that is usually lost. This is accomplished by
 5 employing a heat conserving device through which the waste gases pass and which is so constructed that the heat in the waste gases is abstracted therefrom and is delivered to or absorbed by the air admitted to the kiln
 10 whereby said air is preheated. Any suitable heat conserving device, such for instance as a regenerator or a recuperator, may be used for thus conserving the heat and the waste gases. To illustrate the prin-
 15 ciple on which my invention operates, I have shown the heat conserving device as a regenerator, though my invention is not limited to a regenerator for this purpose. Two regenerators are shown in the drawing and
 20 each is of the usual checker work construction which is adapted to absorb and give up heat from and to a current of gas or air passing therethrough.

The regenerators are designated by 31 and
 25 32 respectively, and in the preferred form of my invention each is arranged so as to deliver the heated air therein to either kiln chamber. To accomplish this I have shown
 30 two flues 33 and 34, one of which communicates with the ports 19 of one kiln chamber and the other of which communicates with the ports 19 of the other kiln chamber. Both flues extend over both regenerators,
 35 and each flue is provided with two ports one leading to one regenerator and the other leading to the other. The ports in the flue 33 are designated by 35 and 36 respectively, and they are controlled by suitable valves
 37 and 38.

40 The ports connecting with the flue 34 are designated by 39 and 40 respectively, and they are controlled by suitable valves 41 and 42. The valves 42 and 38 are connected to move in unison but oppositely, and the
 45 valves 39 and 37 are similarly connected. When one of the valves leading to either regenerating chamber is closed the other valve must be opened, and hence one regenerator will be connected to one or the other only of
 50 the flues leading to the kiln chambers. Each regenerating chamber is connected by a port 43 which enters the bottom thereof with a suitable valve device 44 by means of which the direction of the current through the re-
 55 generating chamber may be reversed.

The valve device I have herein shown is best seen in Fig. 6 and consists merely of a pivoted valve 47 which is adapted to connect either port 43 with a passage way 48
 60 leading to the chimney or other exhaust apparatus and to similarly connect the other port 43 with the air inlet.

I prefer to utilize some of the heat in the waste gases to heat the primary air for the
 65 gas producer, and accordingly in this em-

bodiment of my invention I have shown the inlet 26 of the gas producer as being connected to the flues 33 and 34, so that part of the heated air in one of said flues may be
 70 utilized as the primary air of the gas producer. As shown the inlet 26 communicates with a flue 50 extending lengthwise of the kiln, and said flue 50 communicates at its ends with vertical flues 51 and 52 which, in
 75 turn, communicate at their upper ends with flues 33 and 34 respectively. Each of the flues 51 and 52 is controlled by a suitable valve 53 so that either or both flues may be opened or closed as desired. Where the air
 80 which is heated in the regenerator is being delivered to the kiln chamber 3 through the flue 33, the valve controlling the flue 52 will be closed so that part of the heated air in the
 85 flue 33 will be taken through the vertical flue 51, through the flue 50 to the inlet 26 of the gas producer.

In order to still further utilize the heat in the fuel, and, therefore, to still further increase the economy in the operation of the
 90 kiln I propose to utilize the heat in the burned material which is discharged from the kiln chamber for partially heating the air which is subsequently introduced into the kiln and to the gas producer. To ac-
 95 accomplish this purpose I propose to provide means whereby the air which is introduced into either regenerator will first be passed over the heated lime or other material which
 100 has been burned and has been discharged from the kiln chamber. This is accomplished in the present embodiment of my invention by providing a duct 57 which leads
 105 to the valve device 44, and which also communicates with each of the pits 11 through ports 58, said ports preferably leading into
 110 said pits near their top, and being controlled by suitable valves 66. In this way the air which is delivered to either regenerator is drawn through the pits and over any heated material which has been discharged into
 115 them.

I may, if desired, employ suitable curtains or doors 59 which may be drawn over the openings to the pits thereby to partially
 120 close the same. These doors or curtains are preferably placed above the openings to the pit and may be drawn down to cover the upper part of said openings so that the air which is drawn through the pit is drawn
 125 into them near the ground and thus carried against and directly over any burned material within the pit.

I have herein shown auxiliary flues 60 extending transversely of each kiln chamber and located beneath the open end of the port
 130 19, said auxiliary flues being for the purpose of receiving stray material which might get thrown over the abutments 20 thereby further protecting the ports 19 from becoming
 135 clogged. These flues have sliding doors 65

through which such stray material may be removed. I have also provided my kiln with soot legs 61 which communicate with the ends of the flues 15, 16 and 17. The ends of the flues 16 and 17 are provided with suitable doors 62 through which they can be cleaned; and the soot legs 61 at their lower ends are provided with other doors or openings 63 through which the legs themselves can be cleaned. The ends of the flue 15 are also provided with doors or openings 64 through which said flue can be cleaned. In this way all the flues through which gas passes can be readily cleaned.

In practice I propose to always leave a quantity of burned lime or other material in the bottom of each kiln chamber, and, therefore, in discharging each chamber it will be emptied only to a point a little below the level of the ports 21. In charging each chamber the fresh or unburned material is delivered through the charging opening 6 on top of the bed of burned material which is left in the chamber, in this way a more uniform burning of the product can be obtained and the burned lime in the bottom of the chamber assists in sealing the discharge opening.

The valves of the kiln are shown in the drawings as they would be if the chamber 3 were being fired and the chamber 4 which had been previously fired had been discharged, its material falling into the pit below, and filled with unburned material. The arrows *d* indicate the course which the air takes with the valves arranged as shown in the drawings, and the arrows *e* indicate the course which the primary air delivered to the gas producer and the gas generated therein takes.

It will be seen that the fresh air is admitted to the pit 11 under the curtain 59 through the pit 58 and flue 57 to the regenerator 32 through its port 43, and that by passing over the hot material in pit 11 and through the regenerator becomes heated; from the regenerator 32 the air passes through the port 36 which is opened into the flue 33, and from said flue through the ports 19 where it meets the gas generated in the gas producer. The combined gas and air passes into the kiln chamber 3 and as they commingle combustion takes place, thus causing a burning of the material in said chamber. The hot products of combustion pass through the ducts 5 and into the kiln chamber 4 and through the unburned material therein, thereby preheating said material. From the chamber 4, the products of combustion which are still very hot pass through the ports 9 into the flue 34 and from said flue through the port 39 into the regenerator 31 thereby heating it. From said regenerator the products of combustion which are now fairly cool pass to the pas-

sage 48 and thence to the chimney or other exhaust apparatus. After the regenerator 32 becomes cooled somewhat and the regenerator 31 heated the valves 37, 41, 38, 42, are reversed and the valves 47 also reversed so that the fresh air may be admitted to the heated chamber 31 and the hot products of combustion will be delivered to the cooled regenerator 32. This alternation of the regenerator takes place without changing the direction of the current in the kiln chamber. By thus alternating the regenerators at appropriate intervals an increasing heat is given to the air blast during the burning of any kiln-chamber instead of a decreasing heat as would be the case if the regenerator could not be reversed or alternated during the burning of any kiln-chamber. While the preferred form of my invention embodies this feature of alternating the regenerators during the burning of any kiln chamber yet this is not essential to my invention.

When the material in the chamber 3 is completely burned, the draft through the exhaust device is taken off from the kiln, and the valves or blocks 23 in the flue 16 are moved to cut off the supply of gas from the kiln chamber 3, the discharge opening in said chamber is then opened, and part of the burned material is discharged, the amount of burned material retained in said chamber being sufficient to come about to the level of the ports 21. The said kiln chamber is then refilled with unburned material through the charging opening 6, and the cover 7 is closed and sealed. The valves 47 and the slide 53 are then reversed, the draft turned on to the kiln through the exhaust device, and the blocks or valves 23 for the kiln chamber 4 are adjusted, so as to permit the gas to enter said kiln chamber. The curtains 59 are reversed, as also are the doors or valves 66, so that the air which is drawn into the heat conserving device is taken over the hot burned material in the pit beneath the kiln chamber 3.

The material in kiln chamber 4 is now burned, the hot gases of combustion passing through the kiln chamber 3, and preheating the unburned material therein, and then passing to the heat-conserving device where the heat in them is abstracted, that it may be returned to the kiln. While the material in the chamber 4 is being burned, the cold material in the pit beneath said chamber may be removed.

The form of heat-conserving device herein illustrated is not essential to my invention, as any device which is adapted to reclaim from the waste products of combustion the heat units therein, and return the heat units to the kiln may be employed without departing from the invention.

From the above it will be seen that my improved kiln is so constructed as to utilize

as far as possible all the heat units in the fuel, those which pass out of the kiln chamber with the products of combustion being reclaimed by the manner in which the heat conserving device is used.

Various changes in the construction of the device may be made without departing from the invention.

Having fully described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a kiln, two separate kiln chambers communicating with each other, each chamber having an upper charging opening, and a lower discharging opening, means to normally close said openings, means to deliver air and gas to either kiln-chamber at will, and means to abstract from the waste products of combustion the heat therein, and return it to the kiln.

2. In a kiln, two separate kiln chambers communicating with each other, a gas producer connected to deliver gas to either chamber at will, air heating means, and ducts or flues to deliver part of the heated air to one of the kiln chambers and part to the gas producer.

3. In a kiln, two separate kiln chambers communicating with each other, two regenerators, means to cause a current of air to pass through one regenerator then through the kiln chambers in succession and to cause the products of combustion to pass through the other regenerator, a gas producer, means to deliver the gas produced thereby to either kiln chamber at will, and means to deliver to the gas producer part of the air heated in the regenerator that delivers air to the kiln chambers.

4. In a kiln, two kiln chambers arranged side by side and having permanent communication with each other, said kiln having flues connected to each kiln chamber on the outer side thereof, an exhaust device adapted to be connected to the flue leading to either kiln chamber, and means to deliver air and gas to the flue leading to the other kiln chamber.

5. In a kiln, two separate kiln chambers arranged side by side and having permanent communication with each other through their adjacent sides, a flue leading to each kiln chamber on the opposite side, an exhaust device, means to connect the exhaust device with either of said flues, and means to deliver air and gas to the other flue.

6. In a kiln, two separate kiln-chambers communicating with each other, a gas producer, means to deliver the gas produced thereby to either kiln chamber, a heat conserving device to abstract heat from the products of combustion issuing from the kiln chambers means to pass a current of air through said heat conserving device, whereby said air is heated, and means to deliver

part of said heated air to the gas producer and part to the kiln chamber.

7. In a kiln, two connected kiln chambers, means to deliver gas and air to either kiln chamber, and a regenerator communicating with each kiln chamber whereby the air admitted to one kiln chamber is drawn through one regenerator and the products of combustion are passed through the other kiln chamber and the other regenerator.

8. In a kiln, two connected kiln chambers, a gas producer, means to connect the gas producer to either kiln chamber, two regenerators, and means to connect each regenerator to either kiln chamber.

9. In a kiln, two connected kiln-chambers, means to deliver gas and air to either kiln-chamber, two regenerators, each connected to both kiln chambers, and means to reverse the direction of the current through each regenerator without reversing the direction of current through the kiln chambers.

10. In a kiln, two separate kiln chambers communicating with each other, a heat-conserving device, means to connect said heat conserving device to either kiln chamber, and means to reverse the current through said heat-conserving device without reversing the current through the kiln chambers.

11. In a kiln, two separate kiln chambers communicating with each other, each kiln chamber having a flue communicating therewith, a heat-conserving device, and a valved passage connecting each flue and said heat-conserving device whereby the current can be reversed in the heat-conserving device without reversing it in the kiln chamber.

12. In a kiln, two separate kiln chambers communicating with each other, a gas producer, means to connect said producer to either kiln chamber, each kiln chamber having a flue connected thereto, a heat-conserving device connected to both flues, and means to reverse the direction of the current in the heat-conserving device without reversing the direction of the current in the kiln chamber.

13. In a kiln, two separate kiln chambers communicating with each other, two regenerators, means to connect each regenerator to either kiln chamber without reversing the direction of current through the kiln chambers.

14. In a kiln, two separate kiln chambers communicating with each other, each kiln chamber having a flue communicating therewith, two regenerators, and means to connect each regenerator with either flue without reversing the direction of current through the kiln chamber.

15. In a kiln, two separate kiln chambers communicating with each other, a gas producer, means to connect said gas producer to either kiln chamber, each kiln chamber having a flue connected thereto, two regenerators, and means to connect each regen-

erator to either flue without changing the direction of the current through the kiln chambers.

16. In a kiln, a plurality of separate kiln chambers communicating with each other, each chamber having an upper charging opening and a lower discharging opening, means to maintain said openings closed while the kiln is in operation, means to supply gaseous fuel to one chamber, and means to withdraw the products of combustion from another of said chambers.

17. In a kiln, a kiln chamber, ports communicating therewith through which gas or air may be delivered thereto, and an auxiliary flue or chamber beneath the open end of said ports to catch stray material and prevent the ports from being clogged.

18. In a kiln, a kiln chamber, a gas producer, a flue connecting the gas producer with the kiln chamber, and a soot leg connecting with the said flue.

19. In a kiln, a kiln chamber having a pit beneath the same into which the burned material may be discharged, a flue connecting with said kiln chamber to deliver air thereto, said flue communicating with the pit whereby the air delivered to the kiln chamber is drawn through the pit.

20. In a kiln, a kiln chamber, having a pit beneath said kiln chamber into which the burned material may be discharged, a regenerator connected to said kiln chamber, and a flue connecting the regenerator with the pit whereby the air delivered to the kiln chamber is drawn through the pit and regenerator.

21. In a kiln, a kiln chamber, a gas producer communicating therewith to deliver gas thereto, means to deliver air to said chamber, means to utilize the waste heat issuing from said kiln to heat said air, and means to commingle with the heated air regulated quantities of steam.

22. In a kiln, two connected kiln chambers, a gas producer, means to deliver gas produced therein to either kiln chamber, means to deliver heated air to either kiln

chamber, and means to commingle regulated quantities of steam with the air prior to its delivery to the kiln chamber. 50

23. In a kiln, a kiln chamber provided with draft-ports, and baffle-blocks or abutments between said ports to prevent their being clogged. 55

24. In a kiln, two connected kiln chambers each having in its side ports through which the gaseous fuel is admitted and from which the products of combustion escape, and a baffle-block or abutment at the side of each port to protect it. 60

25. In a kiln, a kiln chamber provided with draft-ports having sloping bottoms, and baffle-blocks or abutments adjacent said ports to prevent their being clogged. 65

26. In a kiln, a kiln chamber, a pit into which burned material from said chamber may be discharged, a flue connecting with the kiln chamber to admit air thereto, said flue communicating with the pit, whereby the air which is admitted to the kiln chamber is drawn through the pit and heated by the hot burned material therein. 70

27. In a kiln, a kiln chamber, a pit into which the burned material in the kiln chamber may be discharged, a flue to admit air to said chamber, a heat-conserving device connected with the flue and also connected with the pit, whereby the air which is admitted to the kiln chamber is taken from the pit and through the heat conserving device. 75

28. In a kiln, a kiln chamber, a pit arranged to receive material therefrom, a curtain for partially closing the door of the pit, said pit having communication by means of a flue with the kiln chamber, whereby the air which is admitted to the kiln chamber is drawn through the pit. 80

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses. 85

ARTHUR E. TRUESDELL.

Witnesses:

E. G. TRUESDELL,
A. W. FLINT.