No. 830,904. PATENTED SEPT. 11, 1906.

A. V. LEGGO.

# FURNACE FOR ROASTING, CHLORIDIZING, OR DRYING ORES.

APPLICATION FILED OCT. 21, 1905.

3 SHEETS—SHEET 1.

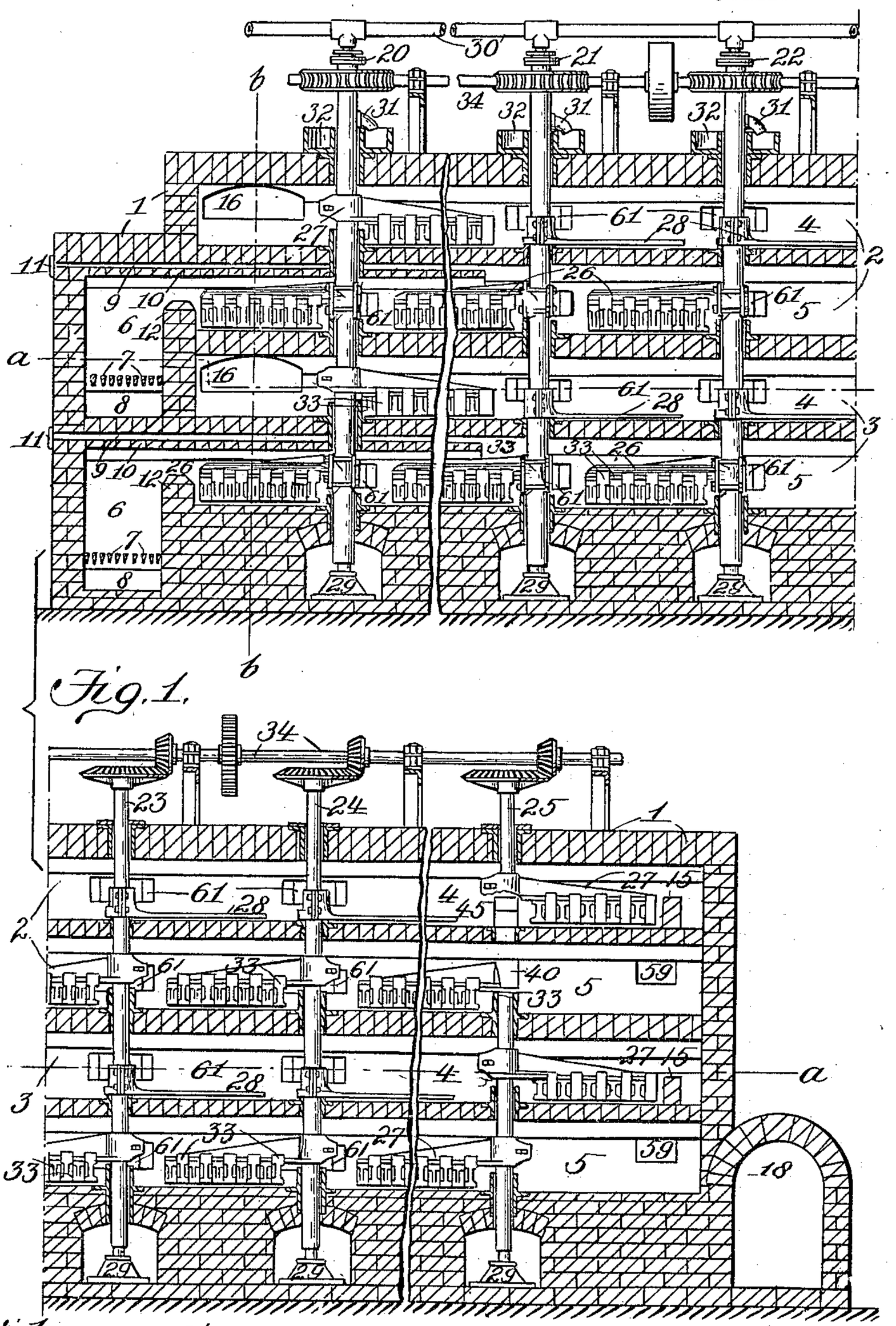


Fig. 1.

Witnesses:

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H. B. Keesler

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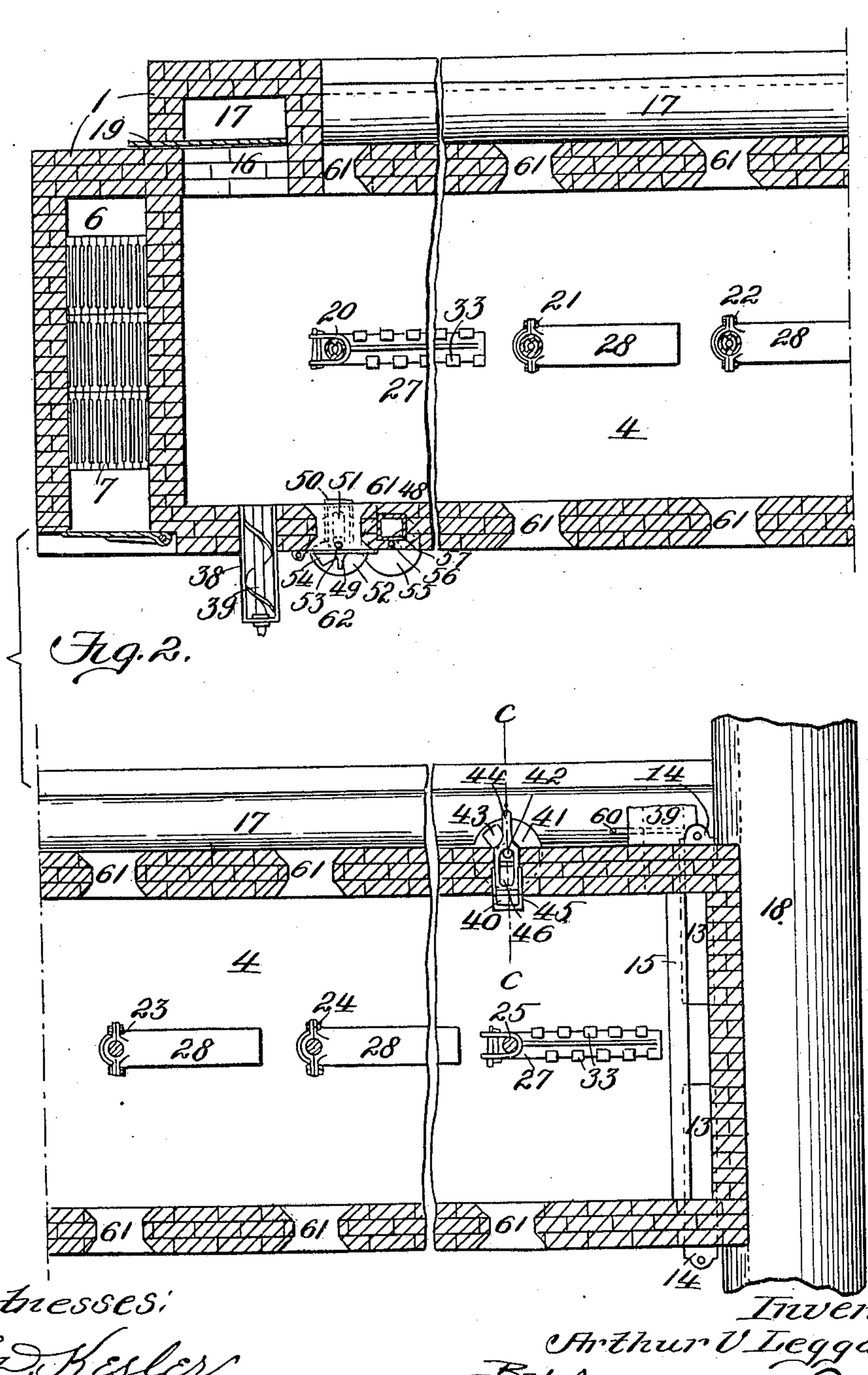


Fig. 2.

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3 SHEETS—SHEET 3.

Fig. 3.

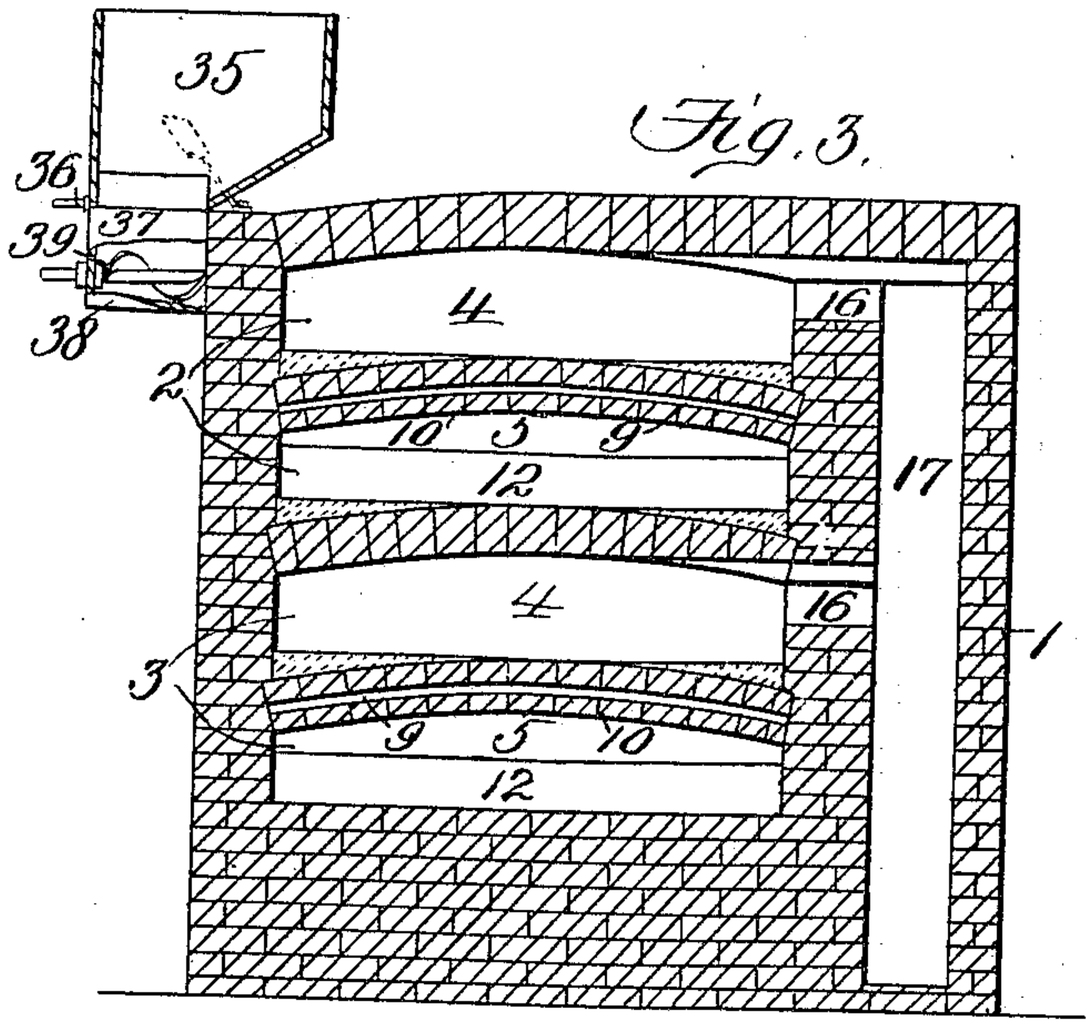


Fig. 4.

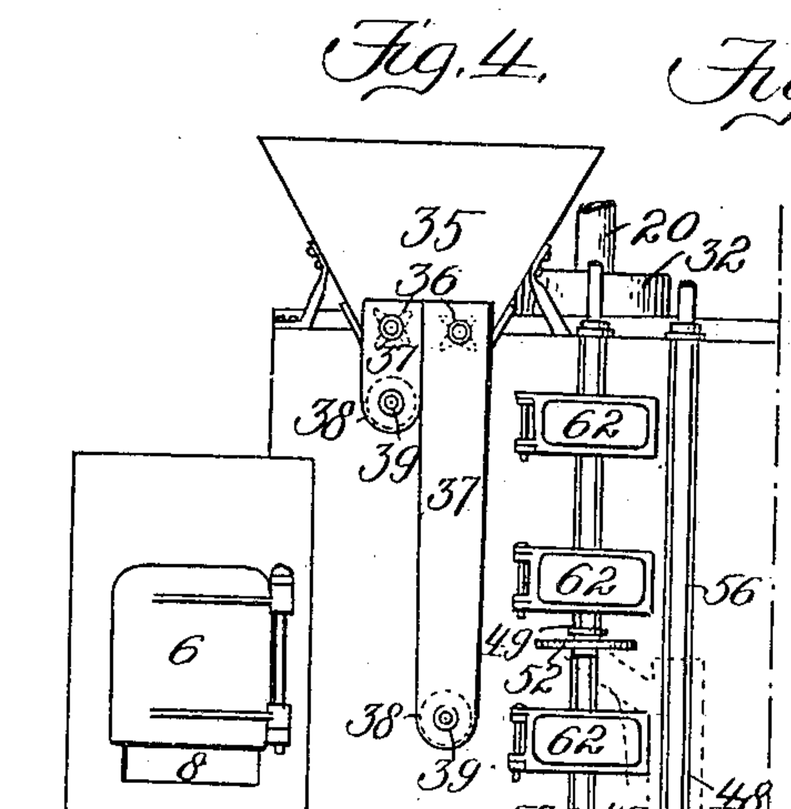


Fig. 6.

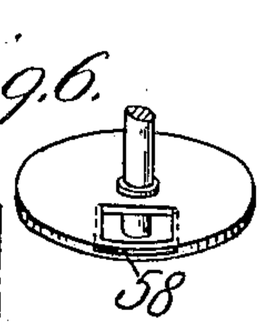


Fig. 5.




Witnesses:

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# UNITED STATES PATENT OFFICE.

ARTHUR VICTOR LEGGO, OF PENDEEN, VICTORIA, AUSTRALIA.

## FURNACE FOR ROASTING, CHLORIDIZING, OR DRYING ORES.

No. 830,904. Specification of Letters Patent. Patented Sept. 11, 1906.

Application filed October 21, 1905. Serial No. 283,841.

*To all whom it may concern:*

Be it known that I, ARTHUR VICTOR LEGGO, a subject of the King of Great Britain, residing at Pendeen, Dawson street, Ballarat, in the State of Victoria and Commonwealth of Australia, have invented certain new and useful Improvements in Furnaces for Roasting, Desulfurizing, Chloridizing, Dehydrating, or Drying Ores and other Substances, of which the following is a specification.

This invention consists of certain improvements upon an invention entitled an "Improved furnace for roasting, desulfurizing, chloridizing, dehydrating, or drying ores and other substances," for which I applied for Letters Patent in the United States on September 6, 1905, Serial No. 277,344, and has been devised in order to treat certain classes of ore and also where a furnace of very large capacity is not required.

A furnace constructed according to my invention can be more economically constructed and maintained than any other of a like character at present in use.

According to my invention the furnace consists of two or more superimposed series of roasting-chambers having horizontal or slightly-inclined hearths, each series being independent of one another and consisting of two or more superimposed roasting-chambers in communication with each other. Vertical rabble-shafts pass through the center of the hearths of all the series, and said rabble-shafts carry rabble-arms, which, on the rabble-shafts being rotated, convey the ore along the topmost hearth of each series in one direction and along the next hearth of each series in the opposite direction and then in the reverse direction—*i. e.*, the same direction as the topmost hearth—if three hearths constitute a series.

In the drawings hereto annexed I have illustrated a furnace which is suitable for roasting "cold ores"—that is, ores containing a low percentage of sulfur in which two hearths constitute a series.

For roasting ores containing a large percentage of sulfur I prefer that three roasting-chambers should constitute a series; but obviously a larger number may be used if the exigencies of the case require them. When three roasting-chambers are used in each series, the ore, instead of being fed to the topmost one, may be fed separately to each of the first and second roasting-chambers of a series and conveyed along the hearths of said chambers in the same direction and then delivered from each of them by means of a passage to the bottom roasting-chamber along the hearth of which the ore would be conveyed in the opposite direction.

In the drawings the hearths are shown horizontal, and generally they will be so constructed; but, if desired, they can be slightly inclined in the same direction as that in which the ore is to be conveyed, thereby assisting in the passage of the ore through the furnace.

At the discharge end of the lowermost chamber of each series a fire-box or combustion-chamber is provided, and when roasting ores containing only a small percentage of sulfur a fire-box can also be placed at the discharge end of the topmost roasting-chamber of each series.

When a high-percentage sulfur ore is to be roasted, to prevent said ore from being subjected to an excessively high temperature soon after its introduction into the furnace, a false arch is built over the said fire-box and below the hearth of the roasting-chamber above. This false arch is of the same width as the roasting-chamber and may be of any desired length. It is built quite independently of the arch, forming the hearth of the roasting-chamber above, and takes the wear and tear caused by the excessively high temperature of the fire-box and can itself be much more easily renewed than could the said arch forming the hearth above it. The space between the false arch and the hearth above it extends outwardly over the fire-box and is normally in communication with the atmosphere, the air passing through it being regulated by a damper or other means. When a cold ore is to be roasted, said false arch can with advantage be omitted altogether.

The furnace can be heated with either solid, liquid, or gaseous fuel, and, as will be well understood, when any fuel other than solid is used or when no fuel at all is required the fire-boxes can be dispensed with.

One of the advantages of my invention is that as the feeding, discharging, and firing thereof are closely located one attendant is enabled to do much more work than is possible with any other furnace at present in use, and, moreover, if it be desired to lengthen the furnace this can easily be effected.

When roasting an ore containing a high percentage of sulfur, I provide means where-

by the passages for the gases of combustion from the lower roasting-chambers to the upper roasting-chambers may be closed, and the gases of combustion drawn direct from the lower roasting-chambers through auxiliary flues in the side thereof to the stack. The upper roasting-chambers in this case are heated by the radiation of the heat in the lower roasting-chambers, and the sulfur gases of calcination can be drawn from them through suitable flues and be employed in the manufacture of sulfuric acid, sulfite-pulp, &c.

It will be obvious that a furnace constructed in the manner hereinafter described will permit of the use of more than one line of rabble shafts and arms.

Referring to the drawings hereto annexed, in which the same reference-numerals refer to similar parts throughout, Figure 1 is a longitudinal sectional elevation of the furnace. Fig. 2 is a horizontal cross-section on the line *a a*, Fig. 1. Fig. 3 is a vertical cross-section on the line *b b*, Fig. 1. Fig. 4 is a side elevation of portion of the furnace. Fig. 5 is a cross-section of the furnace on the line *c c*, Fig. 2. Fig. 6 is a perspective view of a disk which operates in the discharge-chutes of the furnace.

1 is the furnace, which is preferably of rectangular form and constructed of masonry strengthened and bound together by suitable stays, straps, and rods. Said furnace has two or more (two being shown in the drawings) superimposed series 2 and 3 of horizontal or slightly-inclined roasting-chambers which can be of any desired length. Each series may consist of two or more (two being shown in the drawings) superimposed and communicating roasting-chambers 4 and 5. At the discharge end of each of the lower chambers 5 of each series are separate fire-boxes 6. 7 represents fire-bars in said fire-boxes 6.

8 represents ash-pits.

9 represents passages between false arches 10 over the top of the fire-boxes 6 and below the hearths of the roasting-chambers 4. One end of the passage is normally open to the atmosphere and the other opens into the roasting-chambers 5 at the end of false arch 10.

11 represents dampers at the outside ends of the passages 9.

12 represents bridge-pieces between the lower roasting-chambers 5 and the fire-boxes 6.

13 represents passages connecting the roasting-chambers 4 and 5. 14 represents dampers in said passages 13.

15 represents bridge-pieces extending from one side of the furnace to the other to prevent the ore passing down the passages 13.

16 represents throats or passages through which the products of combustion and calcination pass by way of flue 17 to the main flue 18, leading to the stack. (Not shown.) A damper (not shown) is placed in the horizontal part of flue 17 for the regulation of the draft through the furnace.

19 represents sliding dampers in the throats or passages 16 to distribute the required amount of draft through each roasting chamber or chambers for the proper oxidation of the ore being roasted in them.

Passing vertically through the center of the furnace 1 are a number of rabble-shafts, (six only of which are shown in the drawings, though any number may be used,) numbered, respectively, 20, 21, 22, 23, 24, and 25, fitted with rabble-arms 26, 27, and 28. The arms on each shaft overlap to a greater or less extent the paths of the arms on the shafts next adjacent. Said shafts 20, 21, 22, 23, 24, and 25 are supported in footsteps 29 (which can be adjusted both vertically and laterally) or in any other approved manner. Those shafts 20, 21, and 22, which are situated nearest the fire-boxes 6, and consequently in the hottest part of the furnace 1, are made hollow, and a continuous supply of cool water is fed to the top of the said shafts 20, 21, and 22 from the fixed supply-pipe 30 and circulates through said shafts. When it is more convenient, the water for cooling the rabble shafts and arms can be introduced and forced upward through the bottom of the rabble-shafts.

31 is an overflow-pipe through which the water escapes from the rabble-shafts.

32 is a trough to catch the water from the overflow-pipe 31. The rabble-arms 26 and 27, situated in the upper and lower roasting-chambers 4 and 5, are fitted with two rows of movable teeth 33, and those arms 26 attached to the hollow rabble-shafts 20, 21, and 22 in the lower roasting-chambers 5 situated nearest the fire-boxes 6 are hollow, and the water passing through the shafts 20, 21, and 22 circulates through the rabble-arm 26 also. The arms 27 and 28, situated in the upper roasting-chambers 4, are solid.

The holes in the hearth through which the rabble-shafts pass must be made of suitable size and shape to permit of their own particular shafts being introduced through them. Shafts 20, 21, and 22 can when desired be made in sections instead of in one piece, as shown.

The rabble-shafts 20, 21, 22, 23, 24, and 25 are operated through the intervention of worm or and bevel gearing from the main shaft 34, and they can work all in one direction or alternately in right and left hand directions, the latter being generally preferred. It is obvious that the rabble-shafts may be operated by gearing situated either under or over the furnace 1 and also that any number of hollow or solid rabble shafts can be used, or they may be all of either kind without any of the other.

35 is a feed-hopper.

36 represents fluted rollers to feed the raw

ore from the hopper 35 to the depending chutes 37 below.

38 represents horizontal chutes connected to the bottom of the depending chutes 37. Said horizontal chutes 38 can be attached to or built into the side wall of the furnace 1.

39 represents Archimedean screws which feed the ore from the chutes 38 to the feed ends of the upper roasting-chambers 4. The fluted rollers 36 can be operated separately and when necessary driven at different speeds to permit the required amount of ore being fed to each roasting-chamber. It is obvious that means other than that specified can be employed for feeding the ore to the respective roasting-chambers.

40 represents short chutes situated in the side wall of the furnace and preferably directly opposite the shaft 25 farthest from the fire-boxes 6. Said chutes 40 lead from the upper roasting-chambers 4 to the lower roasting-chambers 5.

41 represents disks keyed to the vertical shaft 42. Said disks 41 are free to rotate in the chutes 40. 43 is a hole in said disk 41.

44 represents adjustable slides fitting over the top of chutes 40. 45 represents vertical projections on the top of the said slides 44.

46 represents holes in the slides 44.

47 represents short inclined chutes at one side and opening into the discharge ends of the lower roasting-chambers 5, down which the treated ore passes to the main chute 48.

49 represents adjustable slides fitting over the inclined chutes 47.

50 represents projections standing upward at right angles to the slides 49.

51 represents holes in the slides 49.

52 represents disks keyed to the vertical shaft 53.

54 is a hole in each of the disks 52.

55 is a disk keyed to the vertical shaft 56.

57 is a hole in the disk 55.

The disks 41, operating in the chutes 40, and the disks 52 and 55, which operate in the inclined chutes 47 and main chute 48, can be provided with openings 58 (see Fig. 6) in their edges to receive a piece of thin metal plate (not shown) to adjustably close the holes 43, 54, and 57 in the said disks 41, 52, and 55, respectively. The vertical shafts 42, 53, and 56 may be operated by any mechanical means, and on their being rotated the disks they carry open and seal the respective chutes in which they work at predetermined periods, and thereby prevent dusting of the ore.

59 represents auxiliary flues, through which when necessary the waste gases of fuel combustion can be drawn from the lower roasting-chambers 5 direct to the stack. (Not shown.)

60 represents dampers in flue 59.

61 represents port-holes in the side walls of the furnace above the level of the hearths for the admission of air when required to assist in the roasting of the ore and through which observations can be made and any repairs effected to the rabbles or interior of the furnace that may be required.

62 represents doors over port-holes 61. Said doors 62 can be of any design.

The mode of operation is as follows: The fires are lighted in the fire-boxes 6, and the ore is fed from the hopper 35 down the depending chutes 37 to the horizontal chutes 38, from which it is fed, by means of the Archimedean screws 39 to the feed ends of the upper roasting-chambers 4 nearest the waste-heat passages or throats 16. Motion at the same time is given to the rabble-shafts 20, 21, 22, 23, 24, and 25, carrying the rabble-arms 26, 27, and 28 and vertical shafts 42, 53, and 56, rotating the disks 41, 52, and 55 in the chutes 40, 47, and 48, respectively. The rotation of the rabble-arms 26, 27, and 28 on the said rabble-shafts 20, 21, 22, 23, 24, and 25 causes the ore to pass along the upper roasting-chambers 4 toward that end farthest from the fire-boxes 6 where it is rabbled over the projections 45 on the top of and through the holes 46 in the adjustable slides 44 to the chutes 40, when it falls onto the disks 41, rotating in the said chutes 40. When the holes 43 in the disks 41 are in line with the chutes 40, the ore in said chutes 40 passes to the lower roasting-chambers 5, along which it is rabbled toward the fire-boxes 6. After traversing the whole length of the lower chambers 5 it passes over the projections 50 on the top of and through the holes 51 in the adjustable slides 49 to the inclined chutes 47, where it falls on the disks 52, rotating therein, and when the holes 54 in the disks 52 are in line with the chutes 47 the ore passes to the main chute 48 and falls on the disk 55, rotating near the bottom thereof. When the hole 57 in the said disk 55 is in line with the main chute 48, the ore passes direct to the outside of the furnace or, when necessary, to a finishing-chamber or cooling-chamber. (Not shown.) When a more rapid discharge is desired, the adjustable slides 44 over the chutes 40 and the adjustable slides 49 over the inclined chutes 47 are withdrawn, and the ore then passes direct to the chutes 40 and 47. The air assisting in the combustion of the fuel in the fire-boxes 6 and the oxidation of the ore in the roasting-chambers 4 and 5 passes under and through the fire-bars 7. The gases of combustion pass over and heat the ore in the lower roasting-chambers 5 of each series, and after traversing the whole length of the said chambers 5 the said gases pass upward through passages 13 to the upper roasting-chambers 4, heating the ore therein. From said chambers 4 the gases are drawn through the throats 16, flue 17, and main flue 18 direct to the stack. (Not shown.) When the

air passing through the fire-boxes 6 is not sufficient to thoroughly oxidize the ore being roasted in the furnace, air may be admitted to the lower roasting-chambers 5 through passages 9 over the fire-boxes 6 and to both the upper chamber 4 and the lower chamber 5 through the port-holes 61. When an ore containing a very high percentage of sulfur is being treated and the sulfur-gases of calcination generated in the upper roasting-chambers 4 are required for the manufacture of sulfuric acid, sulfite-pulp, &c., the passages 13 from the lower chambers 5 to the upper chambers 4 are closed by dampers 14, and the gases of combustion passing through the lower roasting-chambers 5 are drawn direct to a stack (not shown) through auxiliary flues 59. The ore in its passage through the upper chambers 4 is heated by the radiation of heat from the lower chambers 5, and the undiluted sulfur-gases of calcination produced in the said chambers 4 are drawn therefrom through throats 16. The ore then passes through chutes 40 to the lower roasting-chambers 5, where the last remaining percentages of sulfur are eliminated from and a perfectly "sweet" roast of the ore is obtained. The treated ore is discharged from the lower roasting-chambers 5 in the manner hereinbefore described.

It is obvious that any means other than those shown can be employed for transferring the ore from the upper roasting-chambers 4 to the lower roasting-chambers 5 and also for discharging the roasted ore from the roasting-chambers 5.

Having now fully described and ascertained my said invention and the manner in which it is to be performed, I declare that what I claim is—

1. The combination with two or more superimposed series of roasting-chambers, having horizontal or slightly-inclined hearths, each series being independent of one another, and consisting of two or more superimposed roasting-chambers in communication with each other, of means for supplying ore to each series, rabble-shafts passing through all of the hearths, said rabble-shafts carrying rabble-arms to convey the ore through each series, and means for discharging said ore from each series.

2. The combination with two or more superimposed series of roasting-chambers, having horizontal or slightly-inclined hearths, each series being independent of one another, and consisting of two or more superimposed roasting-chambers in communication with each other, of means for supplying ore to each series, rabble-shafts passing through all of the hearths, said rabble-shafts carrying arms to convey the ore through each series in the same direction and preferably at the same rate of speed on the corresponding hearths of each series, and means for discharging said ore from preferably the lowermost hearth of each series.

3. The combination with two or more superimposed series of roasting-chambers, having horizontal or slightly-inclined hearths, each series being independent of one another, each series of the lowermost roasting-chambers being provided with a separate fire-box at its discharge end, of a hopper having at its bottom fluted rollers which can be driven separately and at different speeds, chutes leading from said hopper to supply the ore direct to the upper roasting-chamber of each series, and rabble-shafts passing through all of the hearths and carrying rabble-arms to convey the ore through each series to a discharge-chute, substantially as described.

4. In an ore-roasting furnace, the combination with superimposed roasting-chambers, of hollow rabble-shafts passing through all of the said chambers and carrying hollow rabble-arms in the lowermost roasting-chamber, and solid-rabble arms in the upper roasting-chamber.

5. The combination with an ore-roasting furnace having superimposed roasting-chambers, of a chute in the side wall of the furnace and leading from the upper to the lower roasting-chamber, disks operating horizontally in said chute, a vertical shaft at the side of the furnace, said disk being keyed to the said shaft and having a hole therein, substantially as described.

6. In an ore-roasting furnace, the combination with two or more superimposed independent series of roasting-chambers, of inclined chutes in the side wall of the furnace, main chutes in communication with the first-mentioned chutes, a shaft having disks each provided with a hole and extending into the inclined chutes, and a vertical shaft having a disk keyed thereto provided with an opening, said latter disk extending into the main chute, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

ARTHUR VICTOR LEGGO.

Witnesses:
WALTER SMYTHE BAYSTON,
FRANK BAYSTON.