No. 786,567.

PATENTED APR. 4, 1905.

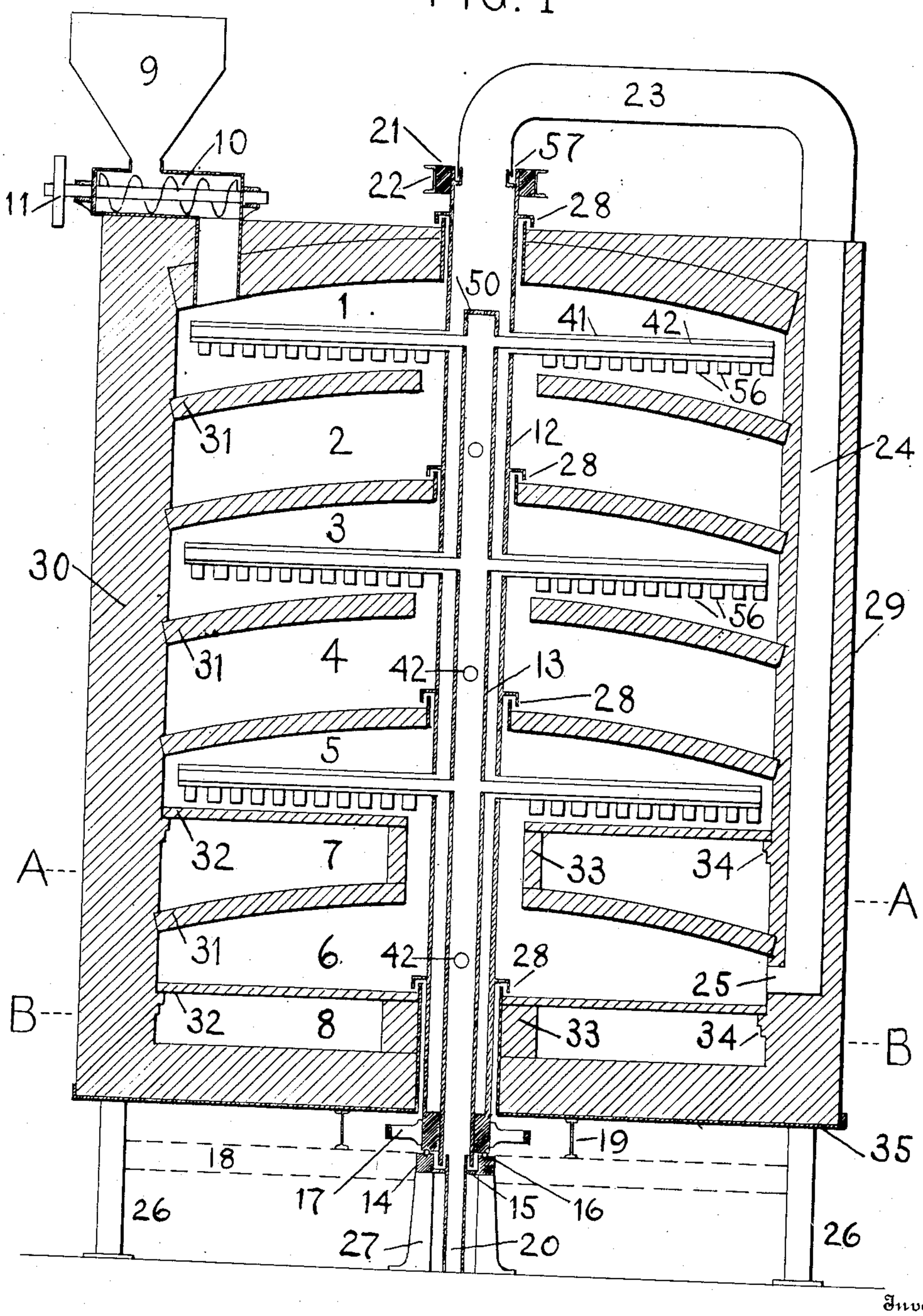
W. R. INGALLS.

ROASTING FURNACE.

APPLICATION FILED FEB. 15, 1904.

3 SHEETS—SHEET 1.

FIG. 1



Inventor

Walter Renton Ingalls

Witnesses

William W Lummus

Edward J Connell

No. 786,567. PATENTED APR. 4, 1905.

W. R. INGALLS.

ROASTING FURNACE.

APPLICATION FILED FEB. 15, 1904.

3 SHEETS—SHEET 2.

FIG. 2

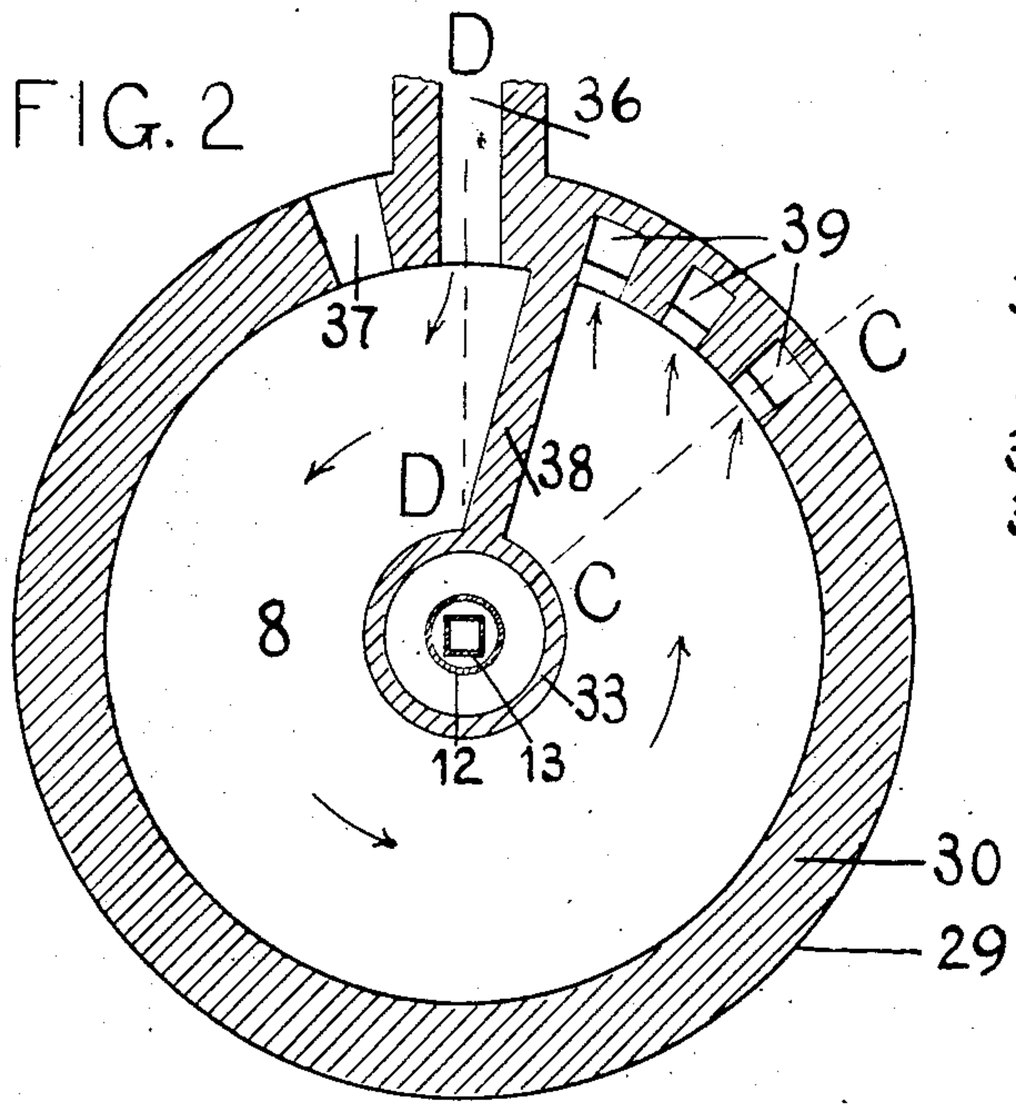


FIG. 4

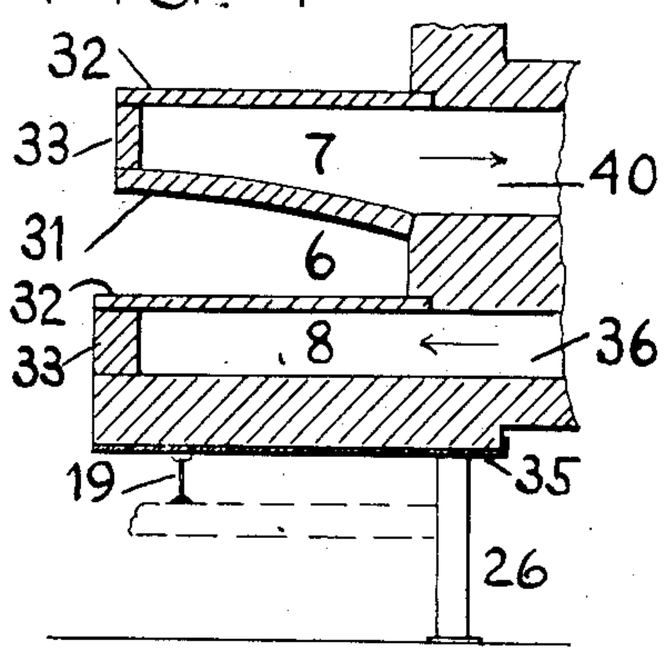


FIG. 5

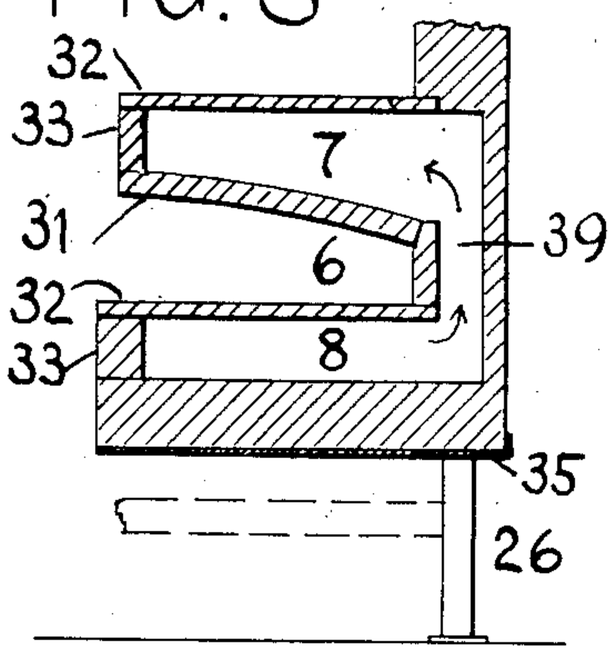
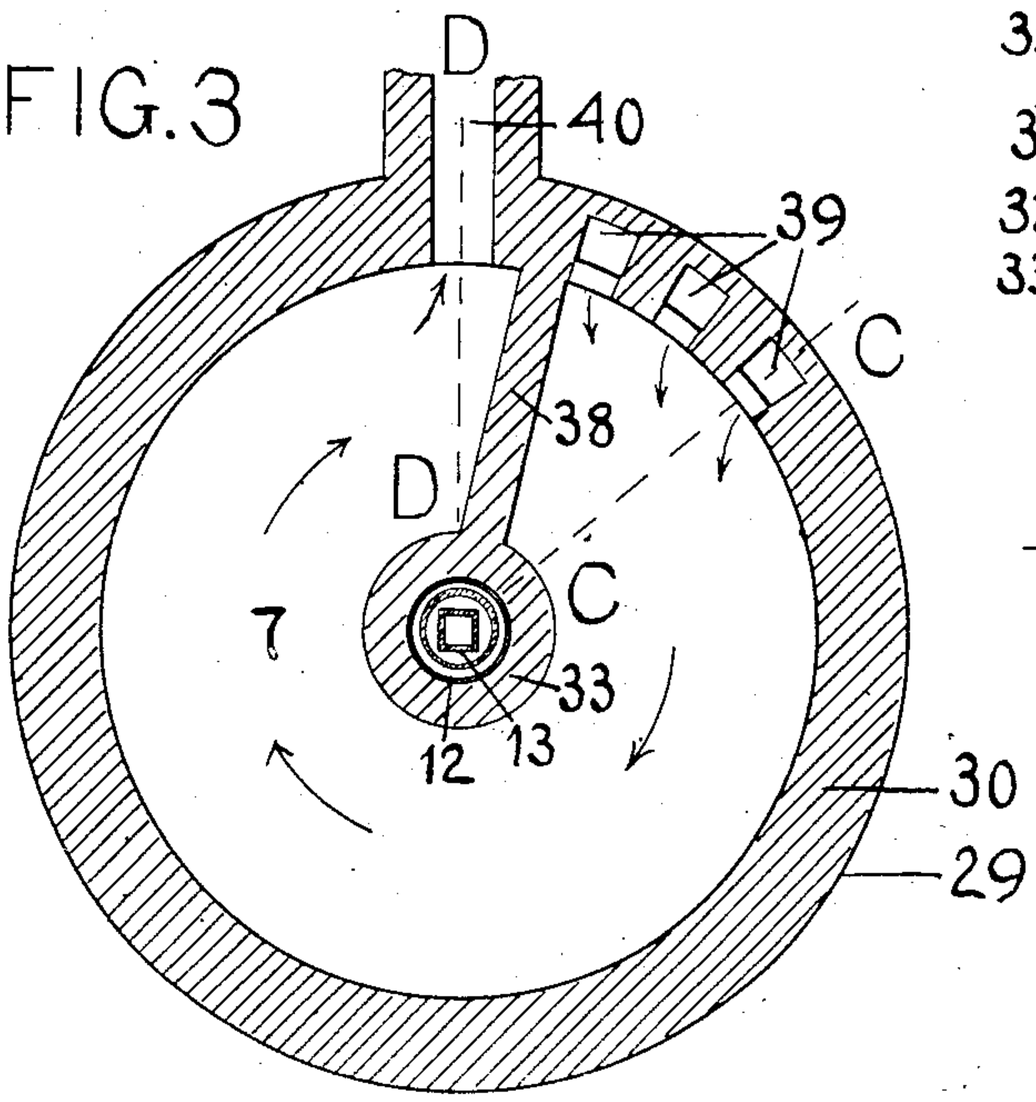


FIG. 3



Witnesses

William W. Lemmens

Edward J. Connell.

Inventor

Walter Renton Ingalls

No. 786,567. PATENTED APR. 4, 1905.

W. R. INGALLS.

ROASTING FURNACE.

APPLICATION FILED FEB. 15, 1904.

3 SHEETS—SHEET 3.

FIG. 6

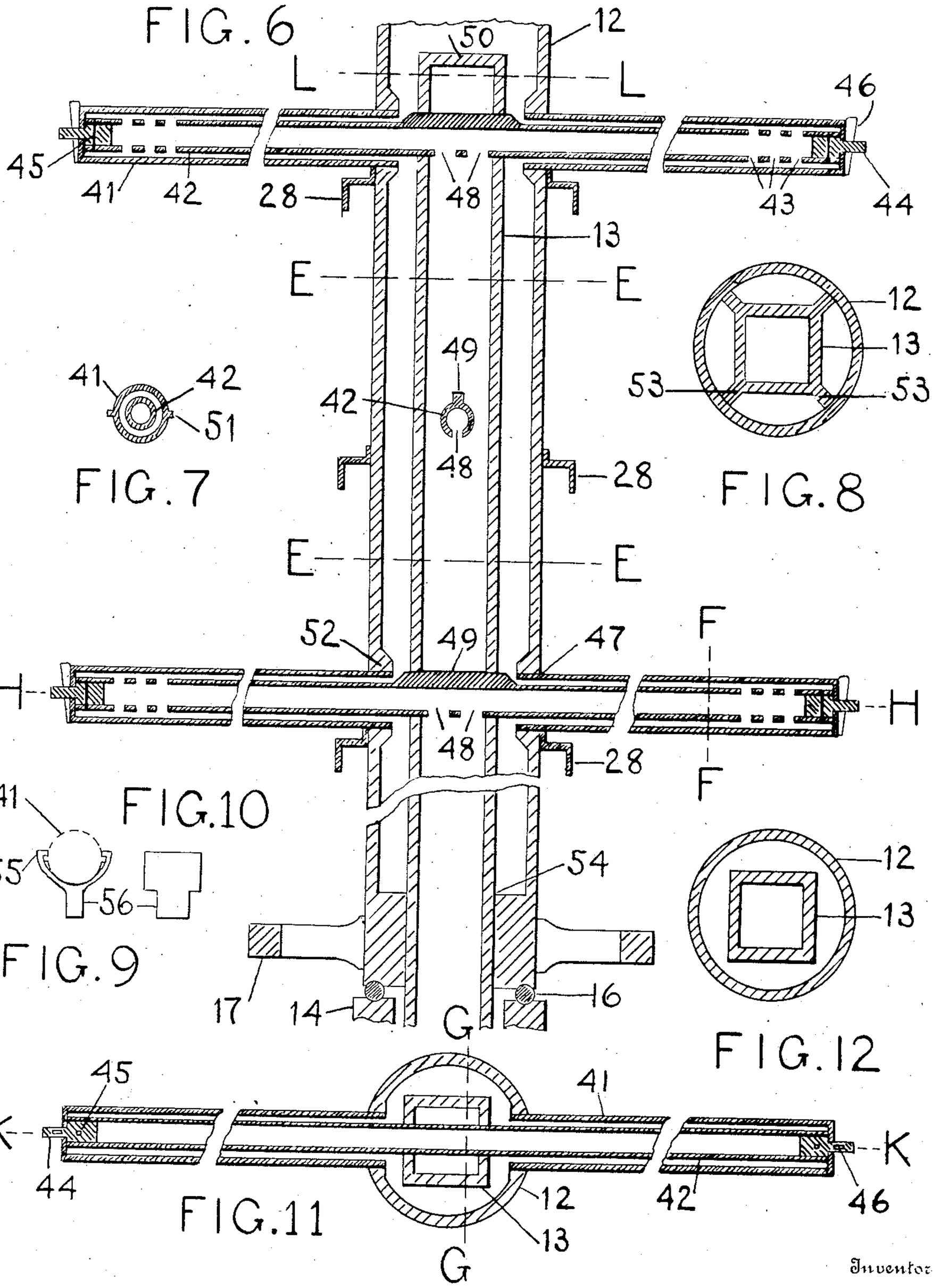


FIG. 7

FIG. 8

FIG. 9

FIG. 10

FIG. 12

FIG. 11

Witnesses

William W Lummus

Edward J. Connell.

Inventor

Walter Renton Ingalls

No. 786,567. Patented April 4, 1905.

UNITED STATES PATENT OFFICE.

WALTER RENTON INGALLS, OF LYNN, MASSACHUSETTS.

ROASTING-FURNACE.

SPECIFICATION forming part of Letters Patent No. 786,567, dated April 4, 1905.

Application filed February 15, 1904. Serial No. 193,622.

To all whom it may concern:

Be it known that I, WALTER RENTON INGALLS, a citizen of the United States, residing at Lynn, in the county of Essex, Commonwealth of Massachusetts, have invented new and useful Improvements in Roasting-Furnaces, of which the following is a specification.

My invention relates particularly to what is known as the "McDougall" type of furnace; and its objects are to provide an improved rotary stirrer for use in such furnaces and to adapt the furnace to a muffle form, whereby it may be used to produce a strong and uncontaminated sulfurous gas from ores which require the aid of extraneous fuel in their roasting.

Furnaces of the McDougall type consist of a vertical cylinder of brick, usually incased with a jacket of iron, with arched hearths having discharge-openings alternately near the center and periphery and a central revolving shaft with horizontal radial stirring-arms, which are provided with teeth or rabbles placed at an angle to the arm. The teeth of the arms on the even-numbered hearths are set in a direction opposite to that of the odd-numbered, so that on alternate hearths they act to push the ore toward the center or toward the side, respectively. The ore is thus worked through the furnace, dropping from hearth to hearth, and discharged finally from the lowest hearth. At the same time the air necessary for combustion of the ore passes upward in the reverse direction to the downward movement of the ore. The heat required in roasting certain ores is such that the central shaft, the arms, and the rabbles thereon have but a short life and are likely to be quickly disabled. For this reason the stirring-arms are commonly made removable, and in various furnaces of this type means are provided for cooling the arms by circulation of a current of air or water therein. In constructing muffle-furnaces of the McDougall type combustion-flues are interposed between the hearths, so that the latter will be heated by flames traversing the flues without coming in contact with the ore on the hearths. In furnaces of this type previously designed it has been commonly the practice to cause the flames to traverse the combustion-flues diametrically, rising from one flue to the next at alternate sides of the furnace, wherefore the flames have a comparatively short travel unless there be numerous combustion-flues.

My invention provides a furnace in which the course of the flames is prolonged and in which there are improved means for cooling the central shaft and stirring-arms, enabling a high temperature to be maintained in the furnace.

In the accompanying drawings, Figure 1 is a vertical section of the furnace through the center. Figs. 2 and 3 are respectively horizontal sections on the lines B B and A A of Fig. 1. Fig. 4 is a vertical half-section through the combustion-flues and sixth muffle on the line D D of Figs. 2 and 3. Fig. 5 is a vertical half-section through the combustion-flues and sixth muffle on the line C C of Figs. 2 and 3. Fig. 6 is a vertical section through the center of the revolving shaft and stirring-arms on the line K K of Fig. 11. Fig. 7 is a section on the line F F of Fig. 6. Fig. 8 is a section on the line L L of Fig. 6. Fig. 9 is an end view of a stirring-tooth, and Fig. 10 is a front view of the same. Fig. 11 is a horizontal section on the line H H of Fig. 6. Fig. 12 is a section on the lines E E of Fig. 6.

Like numerals refer to like parts throughout the several drawings.

Referring to the drawings, 30 represents the circular wall of the furnace, which stands on the cast-iron bottom 35, supported by the columns 26 and the beams 18 and 19. From the side walls the arches 31 are built in as shown, the shape of the cylinder being preserved by the iron casing 29. The lowest two hearths are formed of refractory tiles 32, laid on the ledges 34, and the fire-brick partitions 33. In this way the furnace shown is divided into six muffles or roasting-chambers 1, 2, 3, 4, 5, and 6 and two combustion-flues 7 and 8. The combustion-flues are shown only under the fifth and sixth hearths, which in view of the thick side walls 30 and the means for supplying preheated air, to be referred to subsequently, may be all that is necessary in fur-

naces for roasting certain ores; but flues may be arranged under the upper hearths in the same manner, if required.

The ore to be roasted is fed from the hopper 9 by a screw 10 to the topmost hearth. The central revolving shaft, supported by ball-bearings 16 on the pedestal 27 and revolved by the spur-wheel 17 and a worm-wheel or pinion, (not shown in the drawings,) works the ore inwardly on the uppermost hearth until it drops through the central hole to the second hearth, whereon it is worked outwardly, dropping through peripheral holes (not shown in the drawings, being outside of the planes thereof) to the third hearth, and so on, being finally discharged from the sixth hearth. The sulfurous gas arising from the burning ore passes upward in a direction opposite to the travel of the ore and is finally conveyed away through an opening in the top of the furnace (not shown in the drawings, being outside the planes thereof) in a manner quite familiar to those who are acquainted with the art. The fifth and sixth hearths are heated from below by flames in the flues 8 and 7. The flames may be produced from a fireplace or by the combustion of oil or gas in the flues. In the design shown in the accompanying drawings gas-firing is contemplated. Gas is admitted through the canal 36 into the flue 8, wherein it burns with air admitted through the port 37. The burning gas traverses the flue in the direction of the arrows in Fig. 2, making the circuit around the partition 33 until stopped by the partition 38, which deflects it into the ducts 39, communicating with the flue 7. In flue 7 the burning gas passes around the partition 33 in the direction shown by the arrows in Fig. 3 and escapes through the canal 40 to the chimney. The circular direction of the burning gas through the flues 8 and 7, which is affected by means of the partitions 38, gives it a longer course in which to impart its heat to the muffles 5 and 6 than if it merely passed diametrically through the flues 8 and 7. This, in connection with a correct design of the furnace in other respects, reduces the number of flues required for any specific ore, and thus the height of the furnace, and consequently its first cost. The dimensions of the flues 7 and 8 and the various canals, ports, and ducts 36, 37, 39, and 40 are of course proportioned to the volume of gas that must be burned and the combustion products thereof.

The stirring mechanism consists of a cast-iron shaft composed of an outer tube 12 and an interior tube or flue 13, the latter being conveniently made of rectangular form, although not necessarily so. The interior tube 13 is made separately from the outer tube 12 and is inserted inside of the latter, being secured at the bottom by the tight joint 54 and held in proper position at the top by the fins 53. Through holes in the shaft are passed the main stirring-arms 42, while the outer arms 41 only connect with the shaft. In alternate hearth-chambers or muffles the arms are set at right angles to those next above and below. The arms 42, which are shown as tubular in form, but may be of any other suitable hollow shape, pass clear through the central shaft, making a tight joint with the inner portion 13 thereof. There are apertures 48 at the center and 43 near the ends of these arms. The ends are closed by the plugs 44, which are secured by the bolts 45. Over these arms are passed the hollow arms 41, which set into the holes 47 of the outer shell 12 of the central shaft, which is there thickened sufficiently to give a good bearing. In order to make a tight joint and for ease in insertion and removal, the hole 47 is made slightly tapering, and the end of the arm 41 is tapered to correspond. The arms 41 may be cast with fins 51, over which the stirring-teeth are slipped, as shown in Fig. 9; but several other simple ways of attaching the stirring-teeth are available. The arms 41 and the stirring-teeth strung on them are secured by the wedge 46, driven through the plug 44 in the ends of the arms 42. Instead of the wedge the end of the plug 44 may be threaded and the whole secured by a nut. Any tendency of the arm 42 to turn over is prevented by the fin 49 at the center, which also strengthens the arm at that point. In this way the stirring-teeth 56 are easily removable from the outer arm 41, the outer arm 41 is easily removable from the inner arm 42, and the inner arm 42 is easily removable from the central shaft. After all the arms have been removed and the collars 28 have been unbolted the central shaft itself may be removed from the furnace by simply lifting it out.

In operation a current of air from a canal under the furnace is forced through the tube 20 into the inner flue of the central shaft, from which it passes through the apertures 48 into the arms 42. Going to the ends of the arms the air passes through the apertures 43 into the space between the inner and outer arms, through which it returns to the central shaft, rising then through the outer flue of the latter or the space between the shells 12 and 13 and being thence conveyed through the pipe 23 to the duct 24 in the side wall of the furnace, whereby it is discharged through the port 25 into the lowest muffle. In this way air is constantly circulated through the parts of the stirring mechanism exposed to intense heat, and the arrangement is such that the main supporting parts—viz., the arms 42 and the inner portion 13 of the central shaft--are exposed to the current of cooling-air, both inside and outside, which it is conceived will greatly promote their durability. The air which becomes heated in cooling the stirring mechanism is returned to the furnace, wherefore there is no loss of heat, and, indeed, there

may be an increase in the efficiency of the furnace, since some surplus heat which may be developed in certain portions will be transferred in the form of hot air to the lowest muffle, where the most extraneous heat must be supplied. The furnace may be operated without this air-return and even with only a natural draft; but the arrangement shown in the accompanying drawings is preferable. Communication between the inner and outer flues of the central shaft except through the stirring-arms is prevented by means of the stop 50 and the tight joint 54. Connection with the external air is shut off by means of the liquid seals 15 and 57. The central shaft is supported at the top by the bearing 21, secured to the beams 22.

It will be observed that my invention provides a stirring mechanism which in addition to advantages above referred to has certain others of importance. The main stirring-arms being of one piece and counterbalanced, there are fewer strains on the central shaft and the arm itself can be made more rigid weight for weight. There are no projecting hubs on the central shaft, which is thereby simplified in construction. In removing either of the stirring-arms they can be pulled out horizontally, thereby saving so much height in the roasting-chambers as is necessary to lift the arms in order to unlock them in certain furnaces.

Obviously the stirring mechanism of my invention herein described may be used in connection with a furnace without the combustion-flues herein shown.

What I claim as my invention, and desire to secure by Letters Patent, is--

1. A roasting-furnace comprising two or more superimposed hearths, flues under two or more of said hearths, ducts connecting said flues, means to cause the gas burned in said flues to pass successively through them in a circular direction; and a rotary stirring mechanism with arms projecting over the hearths, said stirring mechanism consisting of a central vertical shaft with an interior flue, hollow horizontal arms passing entirely through said shaft and communicating with said interior flue by suitable apertures, the portions of said arms exterior to the central vertical shaft being inclosed by other hollow arms, so as to leave an open space between the inner and outer arms, and means for circulating a cooling medium through the shaft and arms.

2. A rotary stirring mechanism comprising a central vertical shaft with an interior flue, and a hollow horizontal arm, subdivided into flues, passing entirely through said shaft.

3. A rotary stirring mechanism comprising a central vertical shaft with an interior flue, hollow horizontal arms passing entirely through said shaft, the portions of said arms exterior to the central vertical shaft being inclosed by other hollow arms, so as to leave an open space between the inner and outer arms, said outer arms being supported by said inner arms, and means for circulating a cooling medium through the shaft and arms.

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

WALTER RENTON INGALLS.

Witnesses:

WILLIAM W. LUMMUS,

EDWARD J. CONNELL.