

April 11, 1933.

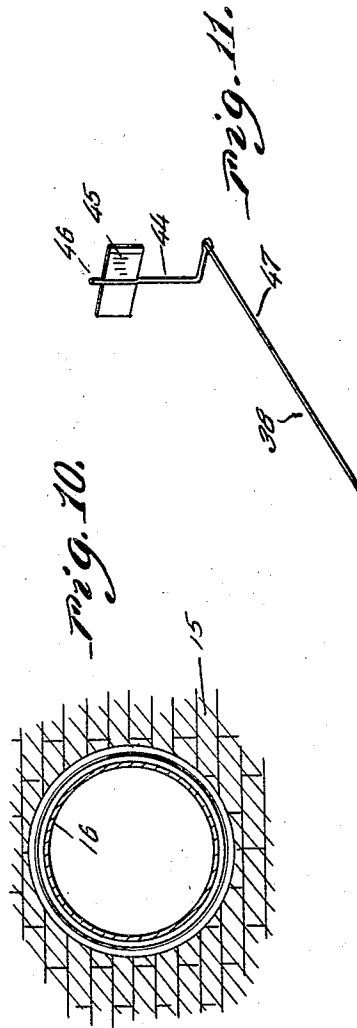
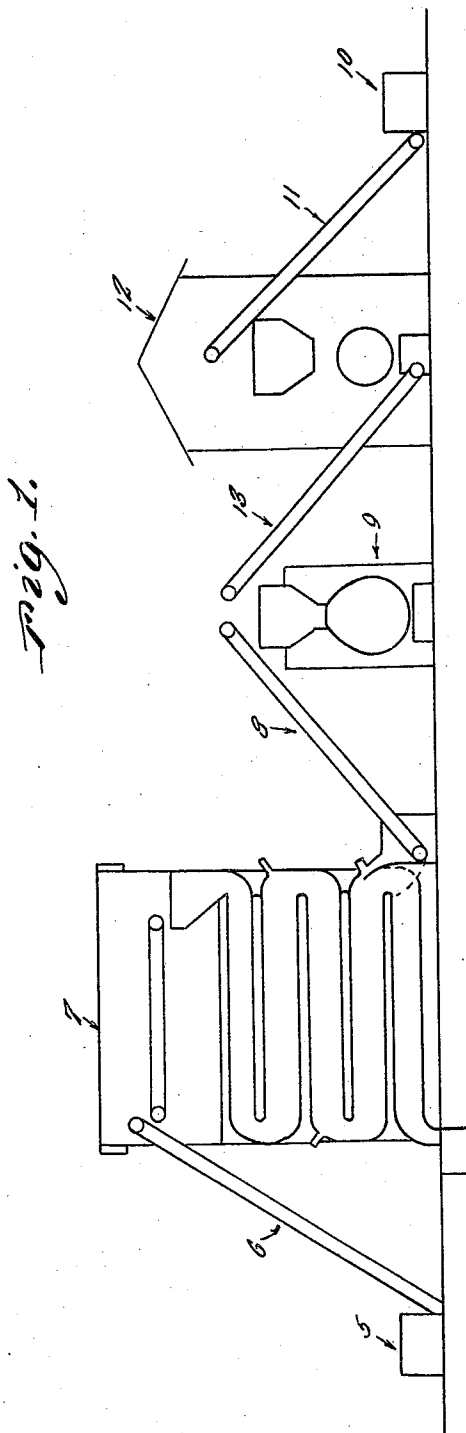
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1,903,733

SMELTING PROCESS AND APPARATUS

Filed Aug. 1, 1931

7 Sheets-Sheet 1



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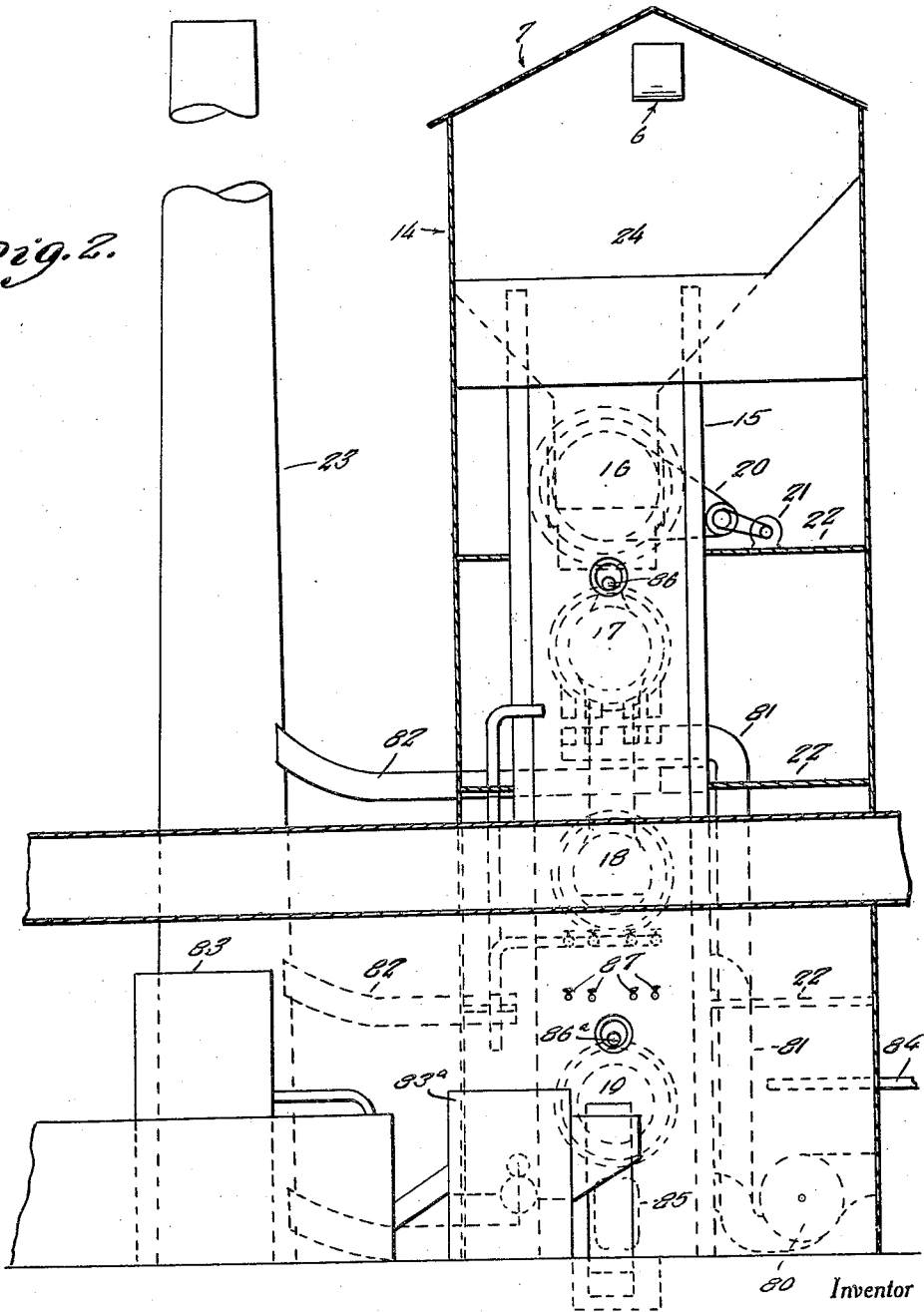
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SMELTING PROCESS AND APPARATUS

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Fig. 2.



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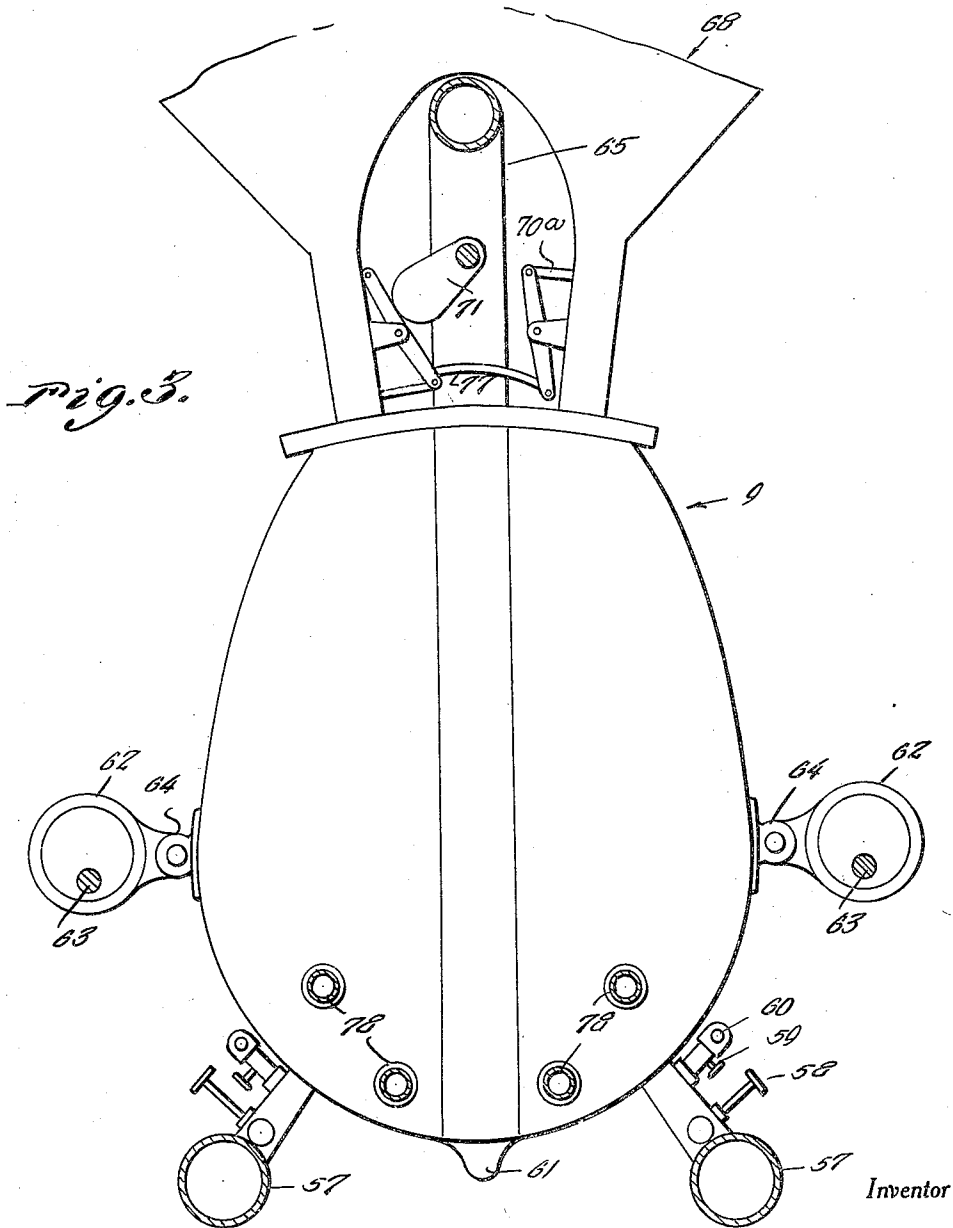
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SMELTING PROCESS AND APPARATUS

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7 Sheets-Sheet 3



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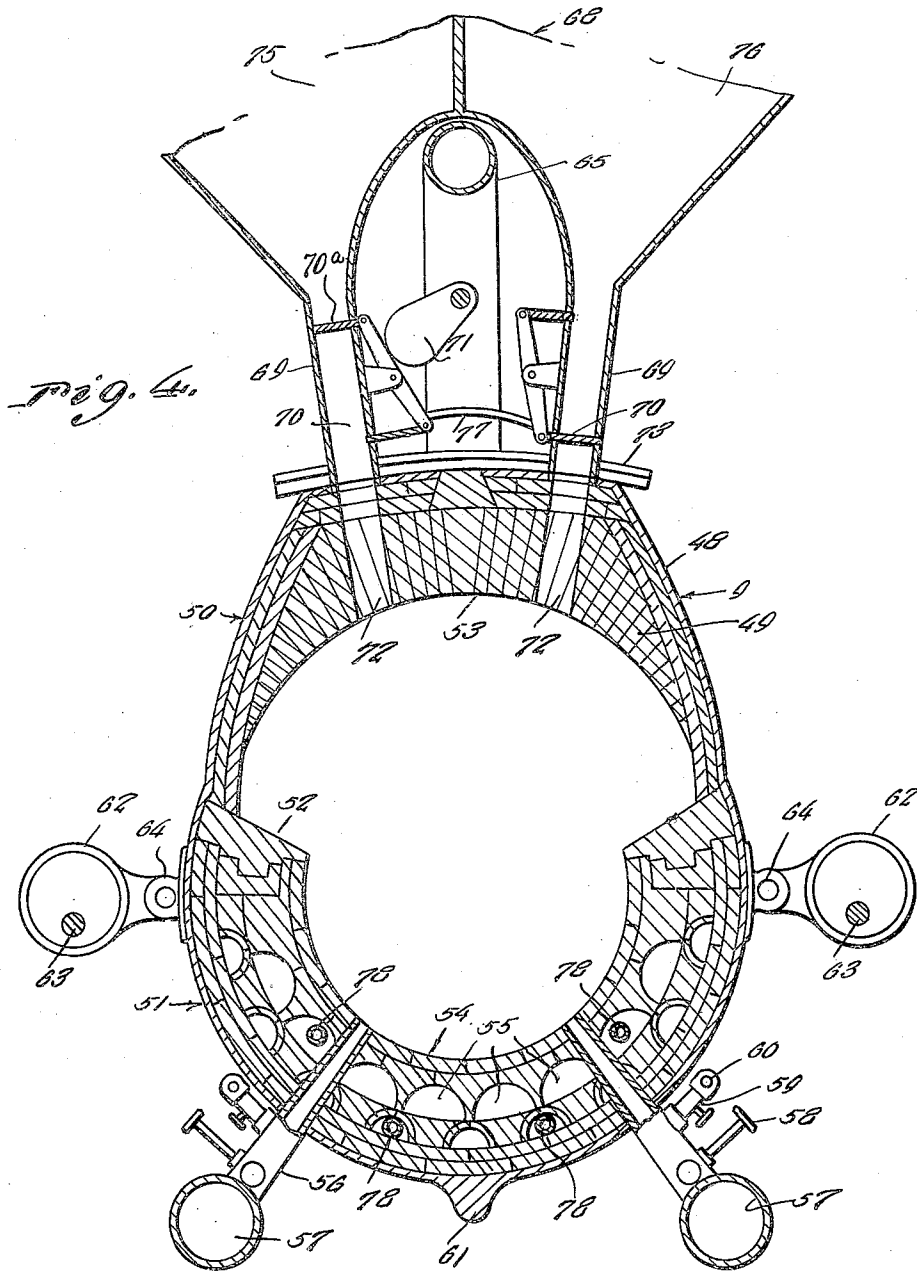
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SMELTING PROCESS AND APPARATUS

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7 Sheets-Sheet 4



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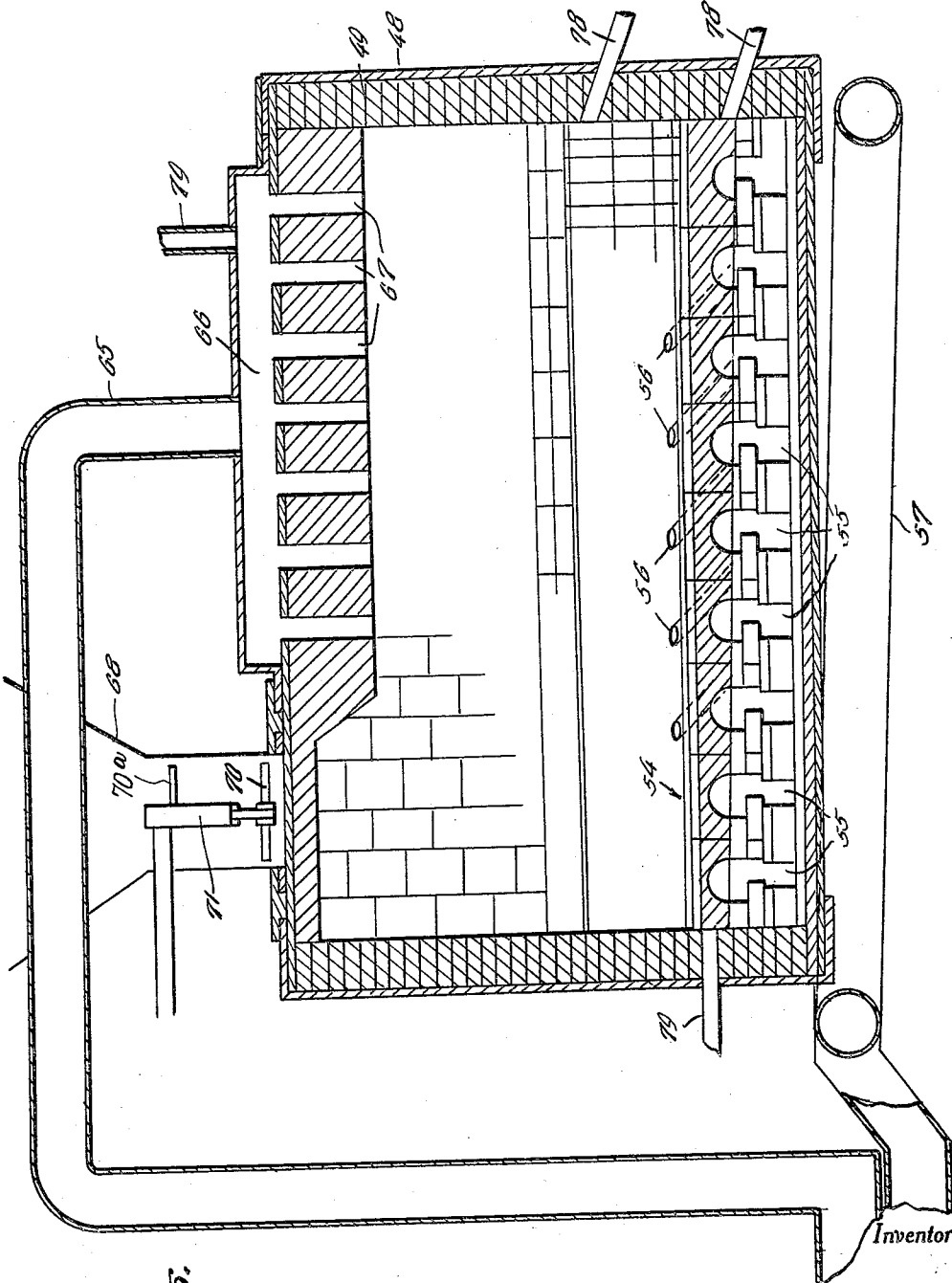


Fig. 5.

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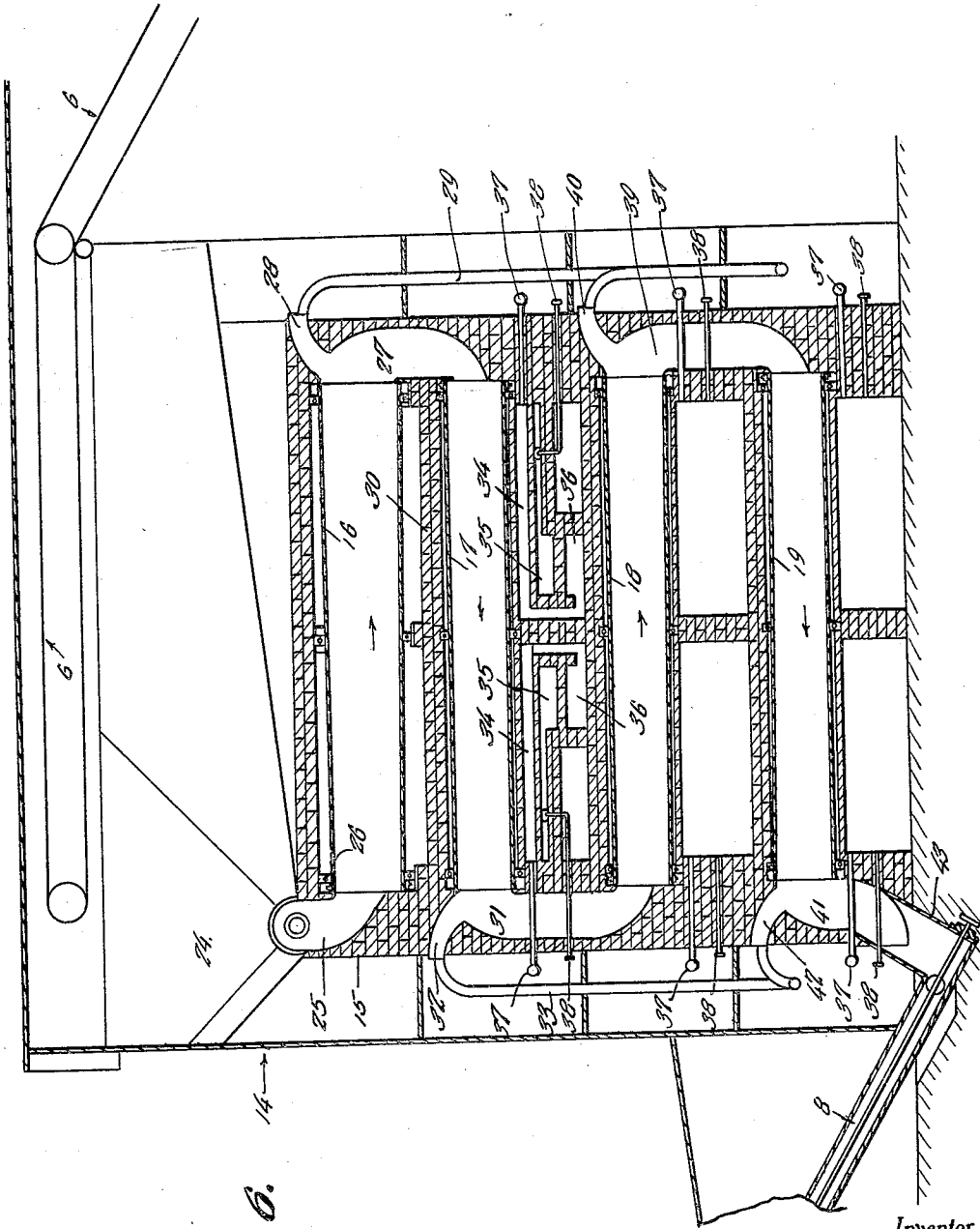


Fig. 6.

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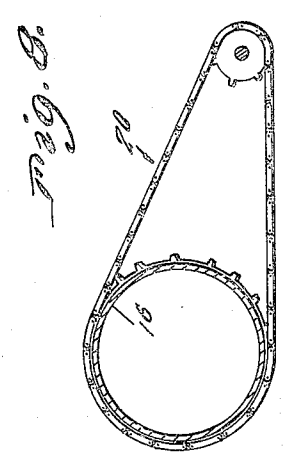
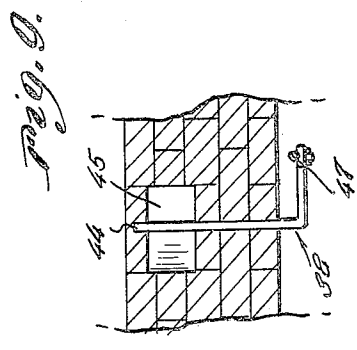
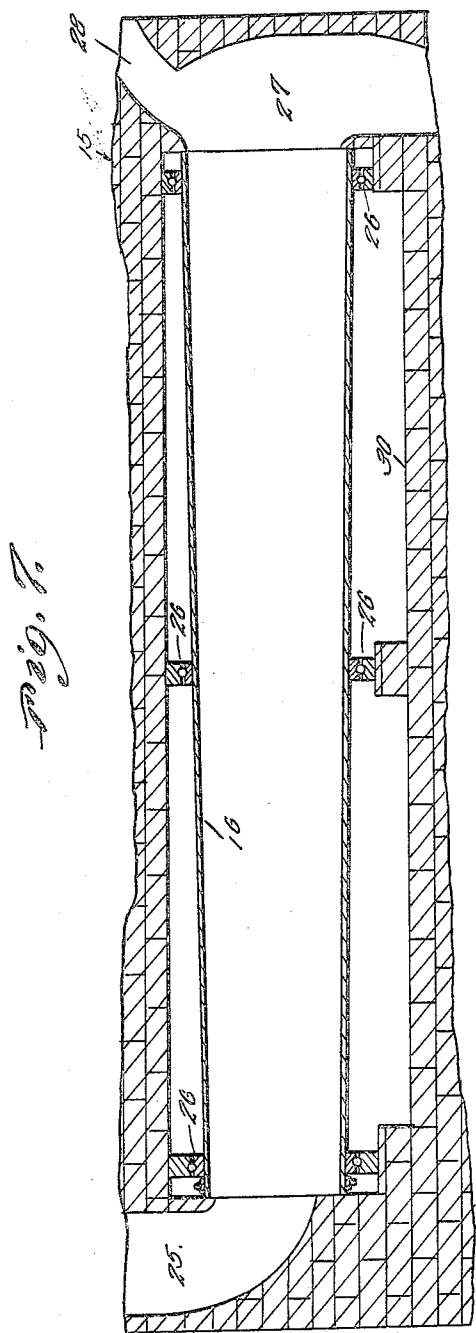
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SMELTING PROCESS AND APPARATUS

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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE

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SMELTING PROCESS AND APPARATUS

Application filed August 1, 1931. Serial No. 554,542.

This invention relates generally to an ore and fuel treating process involving a continuity of steps and appropriate apparatus for carrying out these steps, whereby a final
5 quota of metal pig or ingots results, together with a number of valuable by-products, and wherein a remarkable degree of control of fuel consumption, heat, and smelting material is made possible, with consequent great
10 savings in labor, material and time.

The invention has specific reference to a new and useful process, and appropriate apparatus for carrying on the process, which involves the treating of mine run coal where-
15 by the coal is pulverized and by-products are produced, and the carbonized coal is advanced to the smelting furnace in a powdered form rather than in the usual lump form, and the ore to be smelted is likewise rendered
20 into powder form, and the powdered coal and the powdered ore introduced simultaneously into the smelting furnace of special type and novel construction. The process involves
25 steps and the use of apparatus described herein, in one single unified procedure, the chief value of which lies in its unification of the elements and the continuity and sequence of use thereof which will be described below.

It is also an object of this invention to
30 pulverize, and dry, the coal in a chamber heated by carbonizing ovens or retorts, and then pass the coal through successively hotter chambers wherein carbonization and distillation takes place, and free carbon residue as
35 well as by-products is produced.

It is also an object of this invention to provide for the treatment of the said carbon residue with superheated live steam to convert
40 the carbon in the carbon residue into water gas by-product.

It is also an object of this invention to conserve heat and hence fuel expense required to carbonize the mine run coal by employing for this purpose radiated heat from
45 the retorts.

It is also an object of my invention to provide means to control the gases and by-products in quantity and quality, and to provide additionally for enriching them with
50 oil gas while passing the coal through the

said chambers from a low to a high temperature.

It is also an object of this invention to provide means for drawing off the hot gases
55 from the retorts into distilling tanks from any or all of the retorts, whereby to take advantage of secondary cracking of the gas thus affording a close control of the by-products as to quantity, quality and nature, with obvious
60 savings in production costs and obvious enhancement of volume of production from a given quantity of materials.

It is also an object of this invention to provide means to pass the hot gases through
65 tar precipitators, whereby to remove primary tar, and then pass the gases through coolers and scrubbers where the ammonia and light oils are washed out, leaving the gas clean and properly conditioned for domestic and
70 industrial purposes.

It is also an object of this invention to provide a method or process and apparatus for carrying out the same wherein the raw
75 material is kept constantly in motion at the desired temperatures from the initial stage of raw material into the final product, and in this manner reduces the amount of power required as well as the amount of fuel and raw material and of time required for completion of the process.
80

It is also an object of this invention to provide a method and process and apparatus of the type described, wherein may be efficiently employed the lower grades of bituminous and lignite coals, through increase
85 in their efficiency of combustion, and wherein are utilized the carbonized coals of this type in pulverized, non-caked form as a metallurgical fuel in the smelting of ores.
90

It is also an object of this invention to provide a special coal feeding apparatus which is connected by a conveyor to a special
95 smelting furnace, and to provide a new and novel smelting furnace especially adapted to the steps of the process of this invention, and further to provide a new and novel type of ore conditioning apparatus also connected by a conveyor with the smelting furnace, whereby to produce a continuous, consecu-
100

tive sequence of steps, resulting in a final product and a plurality of by-products.

These and other objects of the invention, its nature, and its composition and arrangement and combination of parts, and the nature, duration and sequence of steps and operations, involved, will be readily understood by anyone acquainted with the art to which this invention relates upon consulting the following descriptions of the drawings, in which:—

Figure 1 is a diagrammatic view of the unified system of apparatus of my invention.

Figure 2 is a transverse vertical sectional view of the coal treating apparatus taken from one end thereof.

Figure 3 is an end elevational view partly in section of the special smelting furnace of my invention.

Figure 4 is a transverse vertical sectional view through the furnace shown in Figure 3.

Figure 5 is a longitudinal vertical sectional view through the smelting furnace.

Figure 6 is a longitudinal vertical sectional view through the coal treating apparatus.

Figure 7 is a sectional detail showing the construction of one of the rotary ovens.

Figure 8 indicates the type of drive for rotating the ovens.

Figure 9 is a detail of one of the flue gates.

Figure 10 is an end elevation of one of the ovens partly in section.

Figure 11 is a perspective view of one of the flue gates.

Referring in detail to the drawings the numeral 5 refers generally to a coal pulverizer which by means of the conveyor 6 delivers pulverized coal into the coal treating apparatus 7, where the coal is roasted at successively higher temperatures with the consequence of carbonization of the coal and throwing down of by-products. The coal enters the coal treating apparatus at the top and leaves at the bottom on a conveyor 8 which carries the conditioned coal to the hopper of the smelting furnace 9. Simultaneous with the action of the coal treating apparatus, there functions an ore crusher 10 connected by means of a conveyor 11 to the upper part of an ore roaster 12 from the lower end of which the pulverized and treated ore is carried on a conveyor 13 to be deposited in the smelting furnace 9.

Reference to Figure 2 will aid an understanding of the construction of the coal treating apparatus which consists of a metal building designated 14 which encases a frame 15 which supports in vertical spaced relation between backing walls associated with the frame 15, rotary kilns 16, 17, 18, and 19, adapted to be rotated by sprocket chains 20 driven by motors 21 supported on floors or gratings 22. The conveyor 6 appears at the top in Figure 2. Associated with the coal treating apparatus 7 is a steel stack 43 having

connections with the interior of the building 14 of a type to be described.

Referring to Figure 6, the position of the terminus of the conveyor 6 is seen to be above a funnel formation 24 which converges to a passage 25 in the brick work frame 15 which leads directly into the end of one of the rotary kilns or the top kiln 16. Description of one of the rotary kilns will suffice for all. Each is composed of a tapered barrel supported at each end and at intermediate points by roller bearings or the like 26. The taper is given the barrels in order to convey the material deposited at one end toward and from the other end. The said other end of the kiln 16 communicates with a hot well 27 which has a gas outlet 28 communicating with a gas header 29. The hot well 27 communicates with the next lower kiln 17. Between the kiln 17 and the kiln 16 there is a brick work 30. The end of the kiln 17 opposite the hot well 27 communicates with another hot well 31 which has a gas outlet 32 in communication with a gas header 33. The hot well 31 communicates with another rotary kiln 18. Between the kilns 17 and 18 there is a system of flues and combustion chambers, the combustion chambers being designated 34, the air chambers 35 and the extra gas passages to the stack 36. The combustion chamber is controlled by a valve 37 and the air chamber is controlled by a gate valve 38 projecting through the brick work of the frame 15 as shown.

Below the system of flues and chambers just described, the rotary kiln 18 is disposed, and below the rotary kiln 18 is another system of flues and chambers similar to those just described, and below this is another rotary kiln 19 below which is another system of flues and chambers similar to those already described. The topmost kiln is known as the drier, and the remaining kilns are referred to as retorts. The end of the kiln 18 opposite the hot well 31 communicates with the hot well 39 having a gas outlet 40 connected to the gas header 29 and the lower end of the hot well is connected with an end of the rotary kiln 19 which has its other end in communication with a well 41 having a gas outlet 42 communicated with the gas header 33. The lower end of the well 41 connects with a chute or hopper 43, otherwise known as a conveyor pit, where the conveyor 8 picks up the carbonized and treated coal for delivery to the smelting furnace 9.

Reference to Figure 10 will give an idea of the relation of the brick work frame 15 and the rotary kilns, and reference to Figure 11 will disclose the character of the gate valve air control 38, which is composed of an upright 44 carrying at a central point a rectangular valve 45. The upper end of the upright 44 projects at 46 into the ceiling of the flue and the upright 44 is suitably mounted

through the base of the flue and extends into one of the gas chambers and is connected to an operating rod 47.

The special smelting furnace of my invention consists of an elongated horizontal tubular body as seen in Figures 4 and 5 wherein the furnace skin is designated 48, the brick lining 49. It is obvious that the smelting furnace is composed of an upper half 50 of semi-circular cross section and a lower half 51 approximately two-thirds of a circle in cross section, the upper ends of which carry a cast iron rim 52 which supports the upper portion 50 within the skin 48. The interior of the brick lining 49 presents a dome formation 53, and a two-thirds circular system of gas burners 54 protrudes inwardly as seen in Figure 4. Hot air pipes and gas conveyors 55 are formed in the blocks of burners 54 and tuyères 56 penetrate through the burner section from the outside of the furnace and communicate with the fire pot thereof, being fed by gas conveyor pipes 57. Tuyère dampers 58 are placed at the point of connection of the tuyères with the hot gas supply pipes 57, and upwardly of the dampers 58 there is provided water valves 59 connected with a water supply 60 for a well known purpose.

The bottom of the furnace is provided with a downward projection 61 adapted to rest in a suitable base whereby to permit the vibration of the furnace by means of eccentrics 62 mounted on actuating shafts 63 and connected pivotally to the sides of the furnace as indicated at 64. Of course, it will be understood that all gas and fluid connections to the furnace are provided so as not to be disturbed by the vibration of the furnace. A gas chamber 66 at the top of the furnace communicates with the interior of the furnace through a series of longitudinally spaced passages 67, and exhausts to an exhaust pipe 65 disposed as shown. At one end of the furnace there is disposed a divided hopper generally designated 68, each side of which is in the form of a funnel having a restricted delivery chute 69 which is provided with a lever actuated gate 70 moved by the action of a weighted cam 71, which upon vibration of the furnace alternately moves one of the gates 70 so as to permit either coal or ore to enter the furnace by means of the passages 72. The mechanism is so adjusted as to permit the delivery into the furnace of just the proper proportions of coal and ore according to the nature of the final product desired. A slide cover 73 is provided adjacent and surrounding the divided hopper 68. Suitable ports and bleeders may also be provided. The left hand section of the hopper 68 is designated 75 and the right hand 76. The left hand section is the ore hopper and the right hand the coal or fuel hopper, viewed in Figure 4. A connecting link 77 provides for simultaneous operation of the gates 70 whereby to properly

and in a synchronized manner deliver predetermined amounts of fuel and ore in the interior of the furnace. The ports referred to are designated 78 in Figure 5 wherein also the placing of the tuyères may be seen, the bleeder pipes being designated 79. The hot air pipes connecting the tuyères are also seen in Figure 5. Also in Figure 5 the numeral 79 refers to the gas burner connection. The hopper 68 is stationary and the furnace rocks relatively thereto.

Referring again to Figure 2, it will be seen that there is provided an air fan or blower 80 which connects with the air chambers by means of ducts 81. Flues 82 connect the chambers with the stack 23. The numeral 83 and the numeral 84 refer to by-products outlets and the numeral 85 to a discharge opening. The numeral 86 refers to an outlet for the initially liberated by-products in conjunction with the drying kiln. Air valves are collectively indicated by the numeral 87.

It is deemed unnecessary to describe the apparatus in further detail other than to say that the kilns may be interiorly provided with means to move the material in the direction of discharge as shown by the arrows in the drawings, and suitable connections are provided between the kilns at the various stages to communicate with the collection receptacles for separating the by-products.

The ore conditioning apparatus is constructed in very much the same way as the coal conditioning apparatus, and for this reason it is not deemed necessary to describe the ore treating apparatus in detail other than to say that it operates in synchronism with the coal and fuel conditioning apparatus and the vibratory furnace described.

As the pulverized coal is introduced into the drier kiln 16 and dried by means of the heat and gases and air arising from the lower and more highly heated kilns, and passes into the kiln 17 and through the well 27 the initial stage of carbonization and distillation will take place, liberating a certain characteristic by-product which is carried off and conveyed to the vats provided therefor, an example of which is indicated at 83a. Each successively lower kiln is maintained at a greater heat, and the carbon residue is passed out through a cooler at the desired temperature and then conveyed by means of the conveyor 8 to the furnace hopper. The by-product of water gas is obtained by operatively associating a device for treating the carbonized material with superheated live steam, and the water gas is conveyed then to storage means. The gas produced in the coal treating apparatus may also be passed through precipitators where the primary tar is liberated and is conveyed to the vats 83, thence to coolers and scrubbers where the ammonia and light oils are washed out.

It will be observed that the heat and air

and gas are continually utilized in an obviously economical manner and that the continuous motion of the material and the continual utilization of the available heat also results in considerable saving of fuel and increases the production of useful products from the raw materials. By means of the arrangement shown in the coal treating apparatus the low grades of coal such as mine run coal are utilized with a greater efficiency than is possible in the use of ordinary or selected coal as usually employed for this purpose.

It should be stated for the sake of clarity that as the carbon residue comes through the hot well 41 it may be disposed of or may be utilized in any one of the following ways: (a) It may be made to flow into a cooling chamber. (b) It may be conveyed into a device for treatment with superheated live steam for converting the carbon into water gas. (c) It may be conveyed into a heated hopper above the furnace or smelter and then introduced, thus properly conditioned into the furnace simultaneously with the prepared ore for the smelting operation.

It is to be definitely understood that I do not desire to limit the application of this invention to the particular modification or example thereof set forth herein, but any change or changes may be made in material and structure and in the duration and sequence of steps and operation within the spirit and scope of the invention.

What is claimed is:—

1. A smelting furnace, comprising, an elongated horizontally disposed furnace structure having by-products outlets, a hopper on its upper side at one end, a partition in the hopper defining separate fuel and ore receiving chambers, valve means for controlling the introduction into the furnace of the fuel and ore introduced into the hopper, rocking support means for the said furnace, said furnace being adapted to be rocked on its longitudinal axis, from side to side.

2. A smelting furnace comprising an elongated horizontally disposed furnace structure having by-products outlets, and a discharge, a hopper at one end of the structure, a partition dividing the hopper into fuel receiving and ore receiving chambers, a separate conduit leading from each chamber to the interior of the furnace structure, valve means for each of the conduits operating, means for operating the valves alternately to feed fuel and ore alternately into the furnace structure, rocking support means for supporting the structure for rocking on its longitudinal axis, and a power means for rocking the furnace.

3. A smelting furnace comprising an elongated horizontally disposed furnace structure having by-products outlets, and a discharge, a hopper at one end of the structure,

a partition dividing the hopper into fuel receiving and ore receiving chambers, a separate conduit leading from each chamber to the interior of the furnace structure, valve means for each of the conduits operating, means for operating the valves alternately to feed fuel and ore alternately into the furnace structure, rocking support means for supporting the structure for rocking on its longitudinal axis, and a power means for rocking the furnace, said valve operating means being operable in coordination with the rocking of the furnace.

4. A smelting and byproduct process comprising simultaneously and separately preparing pulverized coal and pulverized ore by heating successively in zones of successively higher temperatures to dry the same and drive off volatile matter but not to fuse, ignite or cake the same or change its pulverized form, then introducing the treated pulverized coal matter and ore matter simultaneously and separately into a furnace at the same temperature and smelting the same therein, while agitating the same.

5. An ore reducing and by-product recovering process comprising preheating separately and simultaneously pulverized coal and pulverized ore to a temperature high enough to drive off by-products but not high enough to cause caking, igniting or fusing into lumps, then smelting the treated pulverized coal and pulverized ore by passing them separately, and alternately into a smelting furnace and rocking the furnace to agitate the resultant mixture of pulverized ore and coal while smelting to prevent caking and massing of the same.

In testimony whereof I affix my signature.
JAMES MADISON LIVELY.

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