J. A. SINGMASTER.

MANUFACTURE OF ZINC OXID.

APPLICATION FILED JAN. 9, 1912.

1,112,853.

Patented Oct. 6, 1914.

10 SHEETS—SHEET 1.

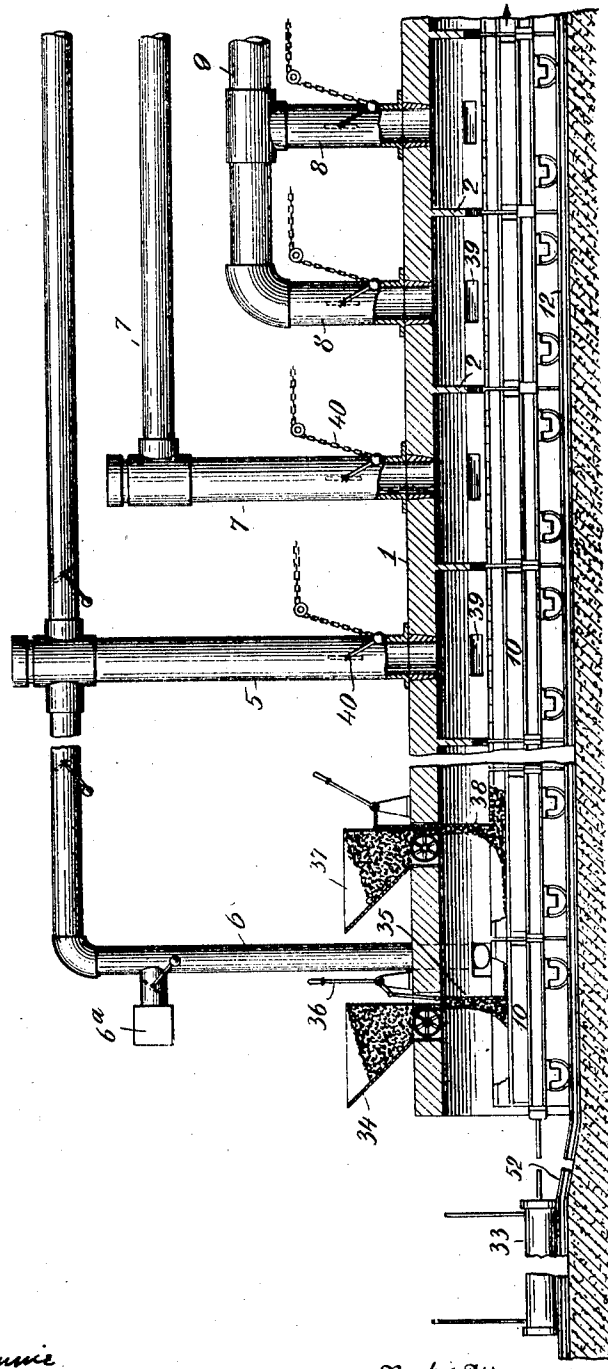


Fig. 1.

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MANUFACTURE OF ZINC OXID.

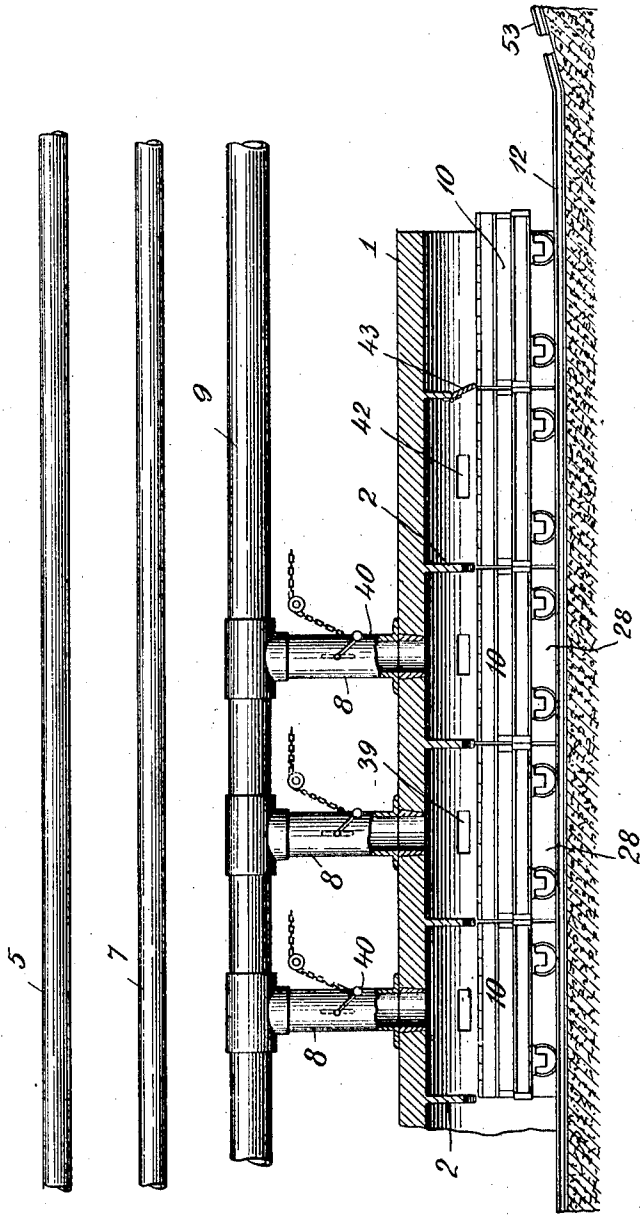
APPLICATION FILED JAN. 9, 1912.

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10 SHEETS—SHEET 2.

Fig. 1a



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10 SHEETS—SHEET 3.

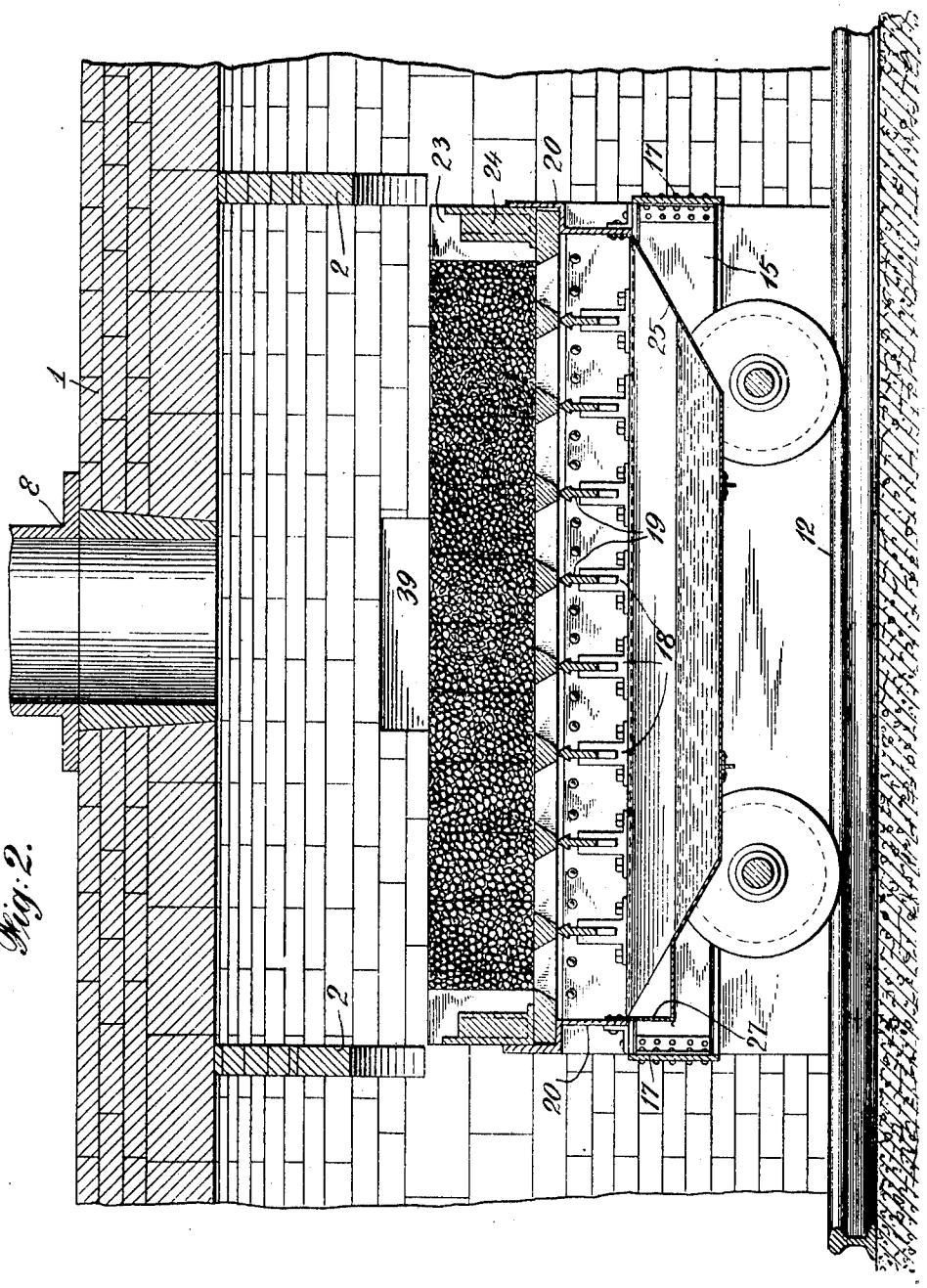


Fig. 2.

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10 SHEETS—SHEET 4.

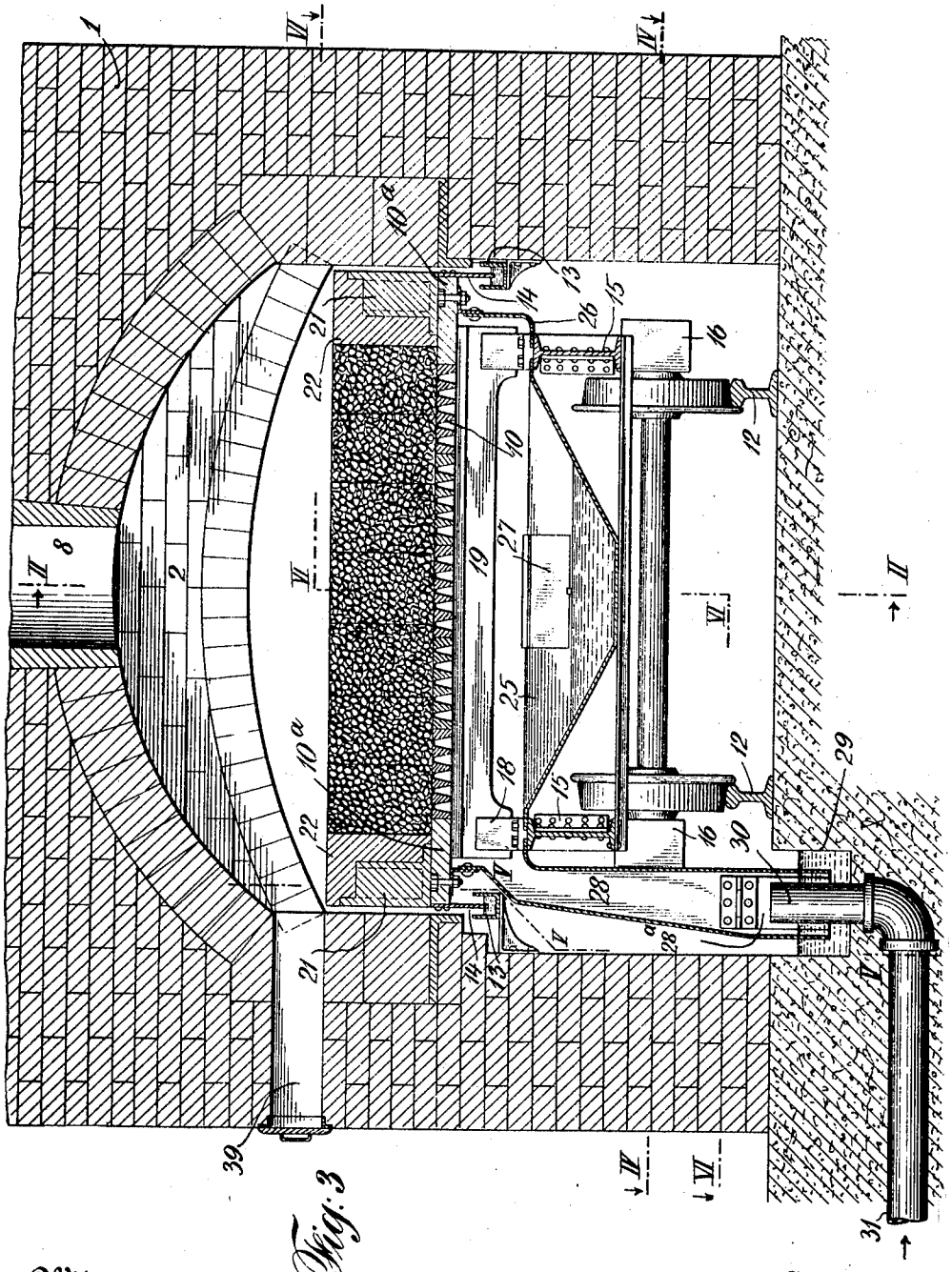


Fig. 3

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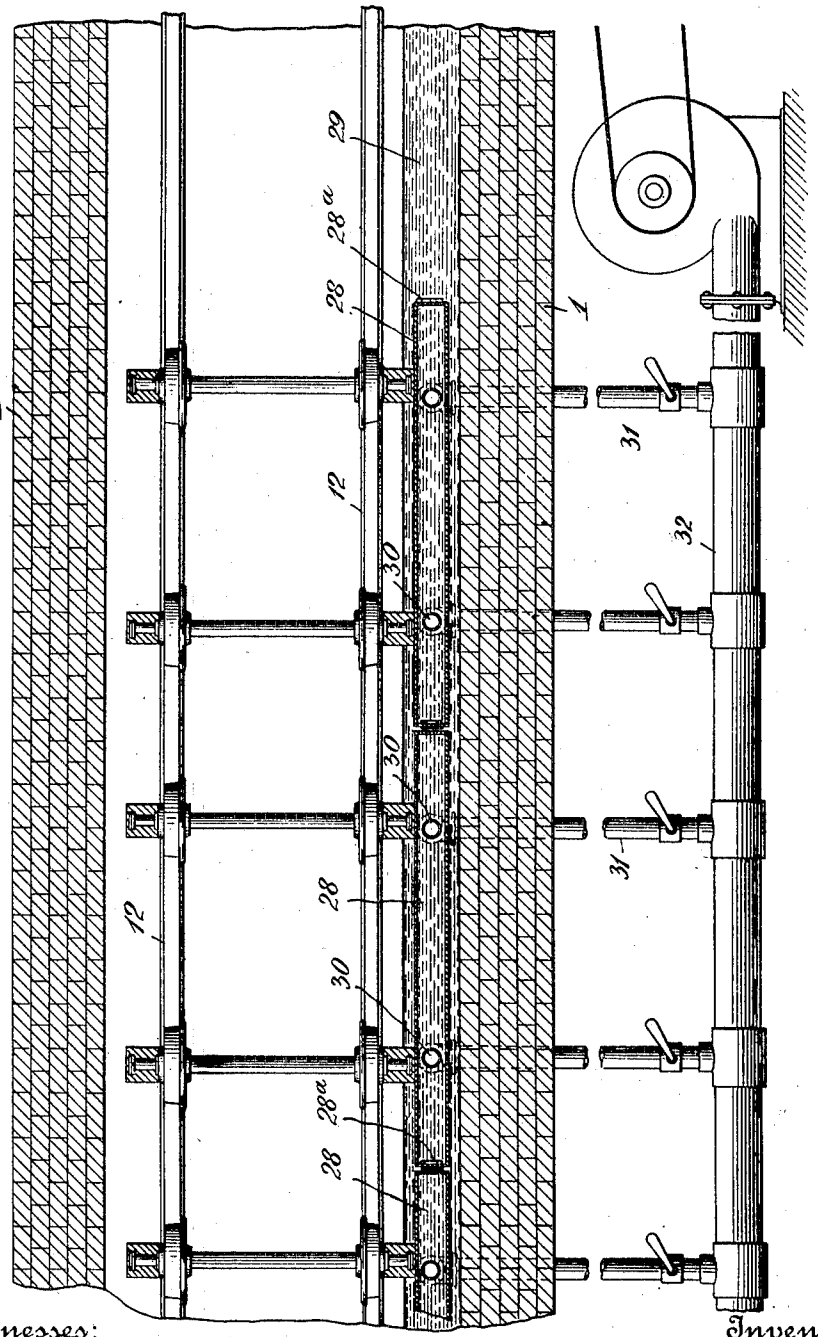


Fig. 4.

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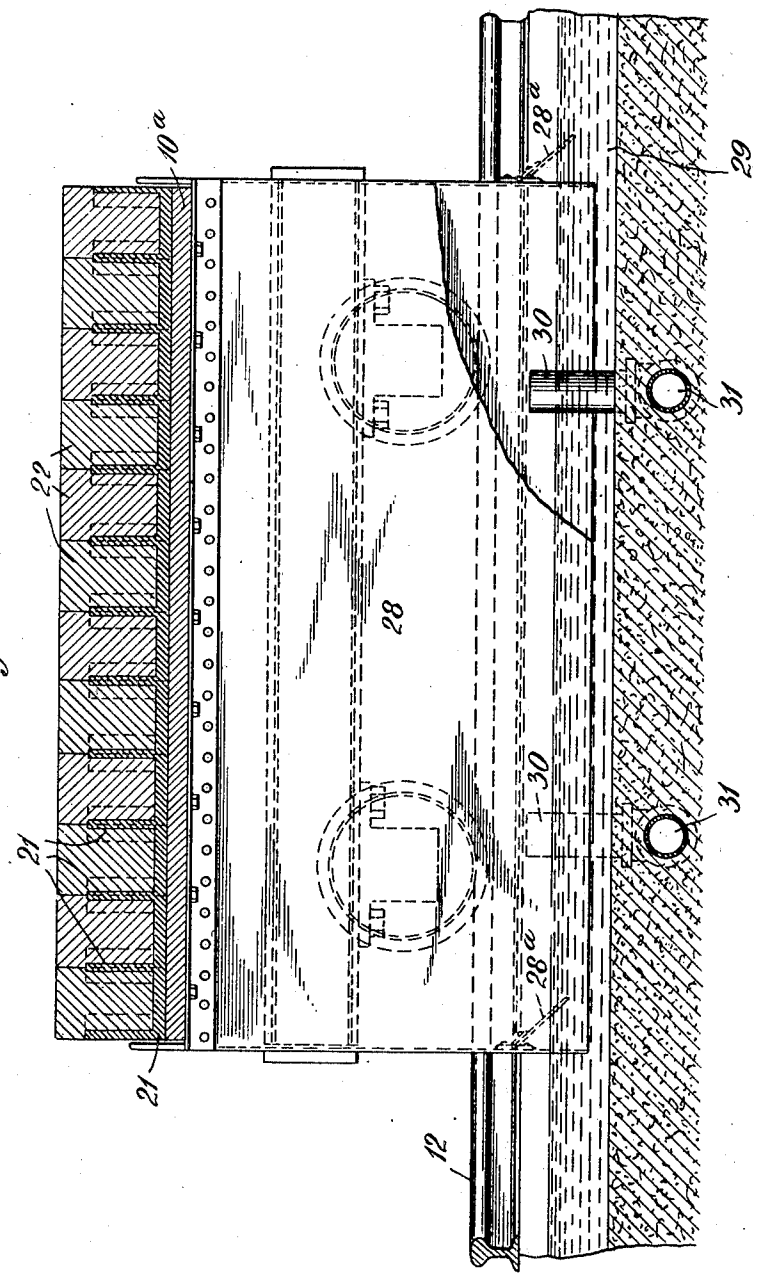


Fig. 5.

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10 SHEETS—SHEET 7.

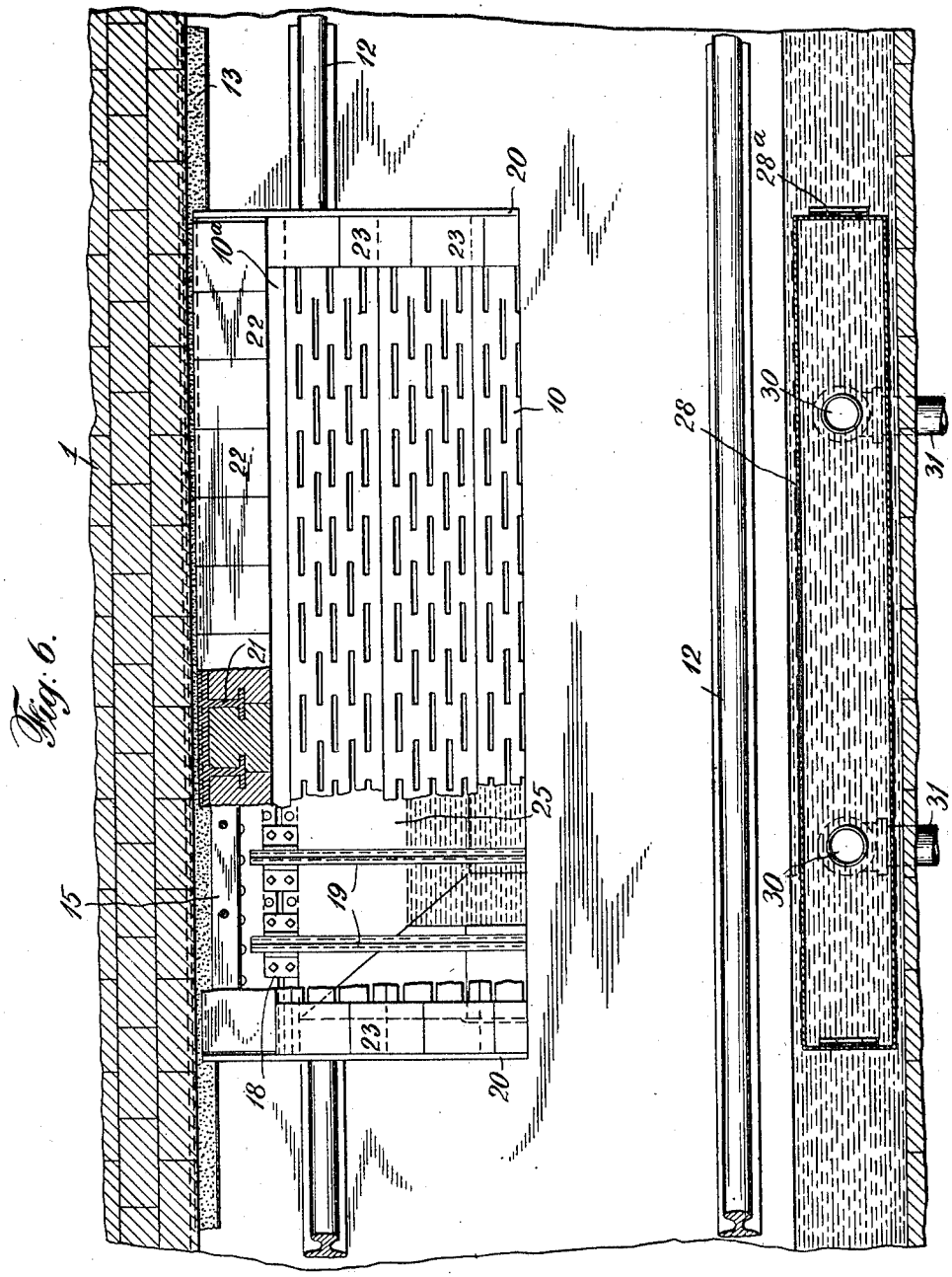


Fig. 6.

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10 SHEETS—SHEET 8.

Fig. 7.

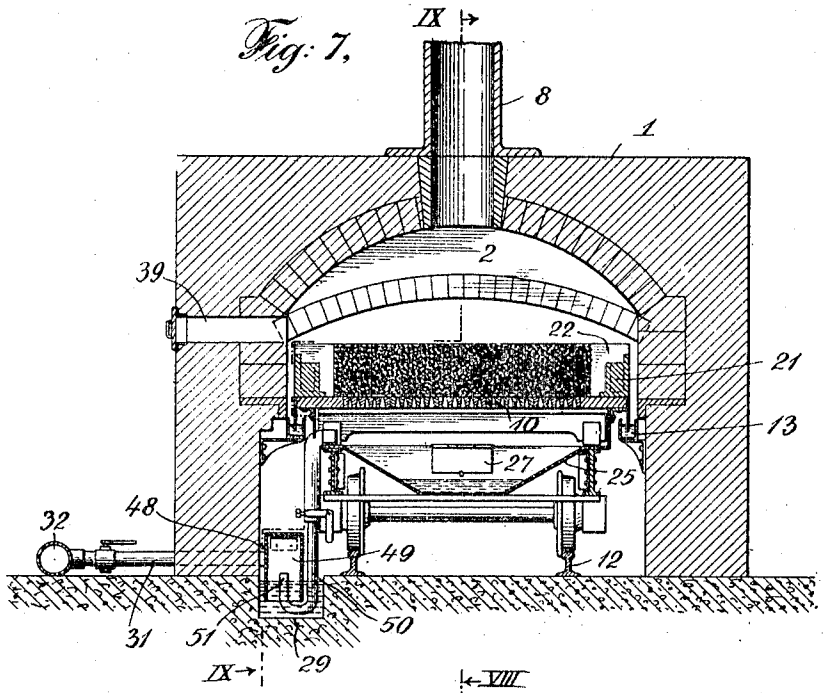
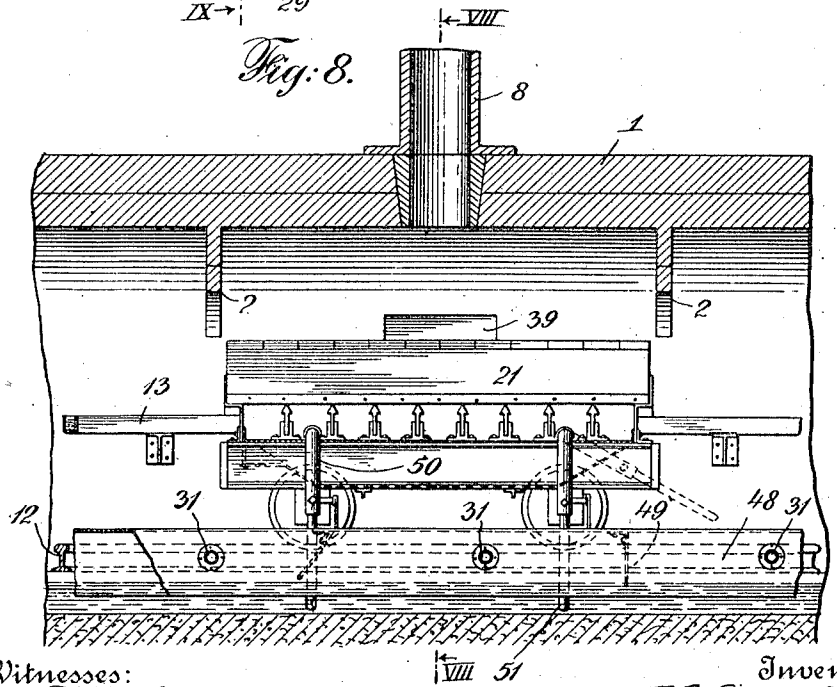


Fig. 8.



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APPLICATION FILED JAN. 9, 1912.

1,112,853.

Patented Oct. 6, 1914.

10 SHEETS—SHEET 9.

Fig. 9.

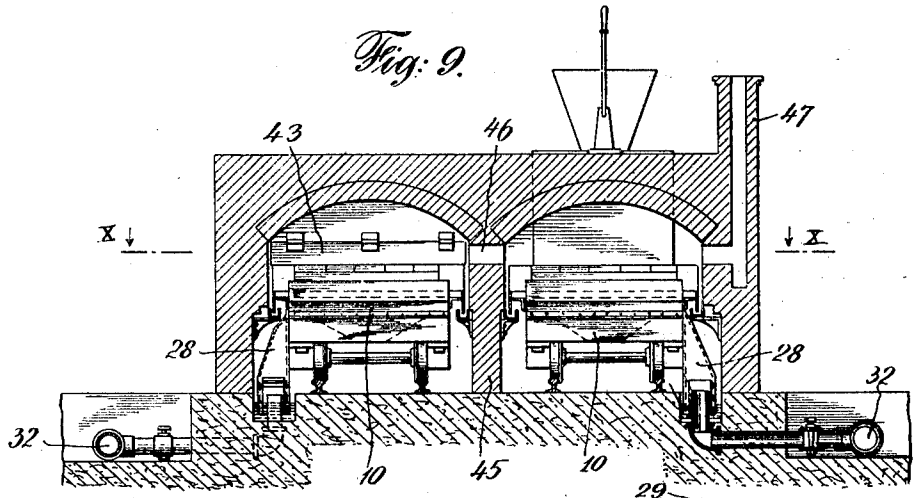
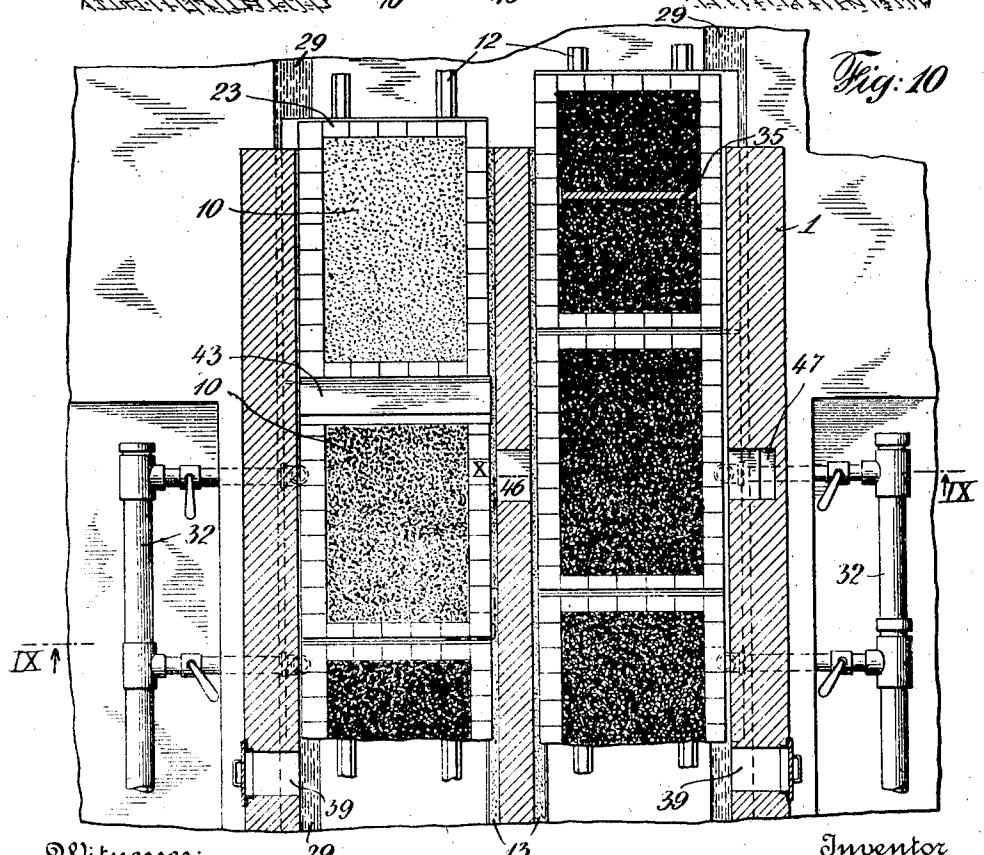


Fig. 10



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10 SHEETS—SHEET 10.

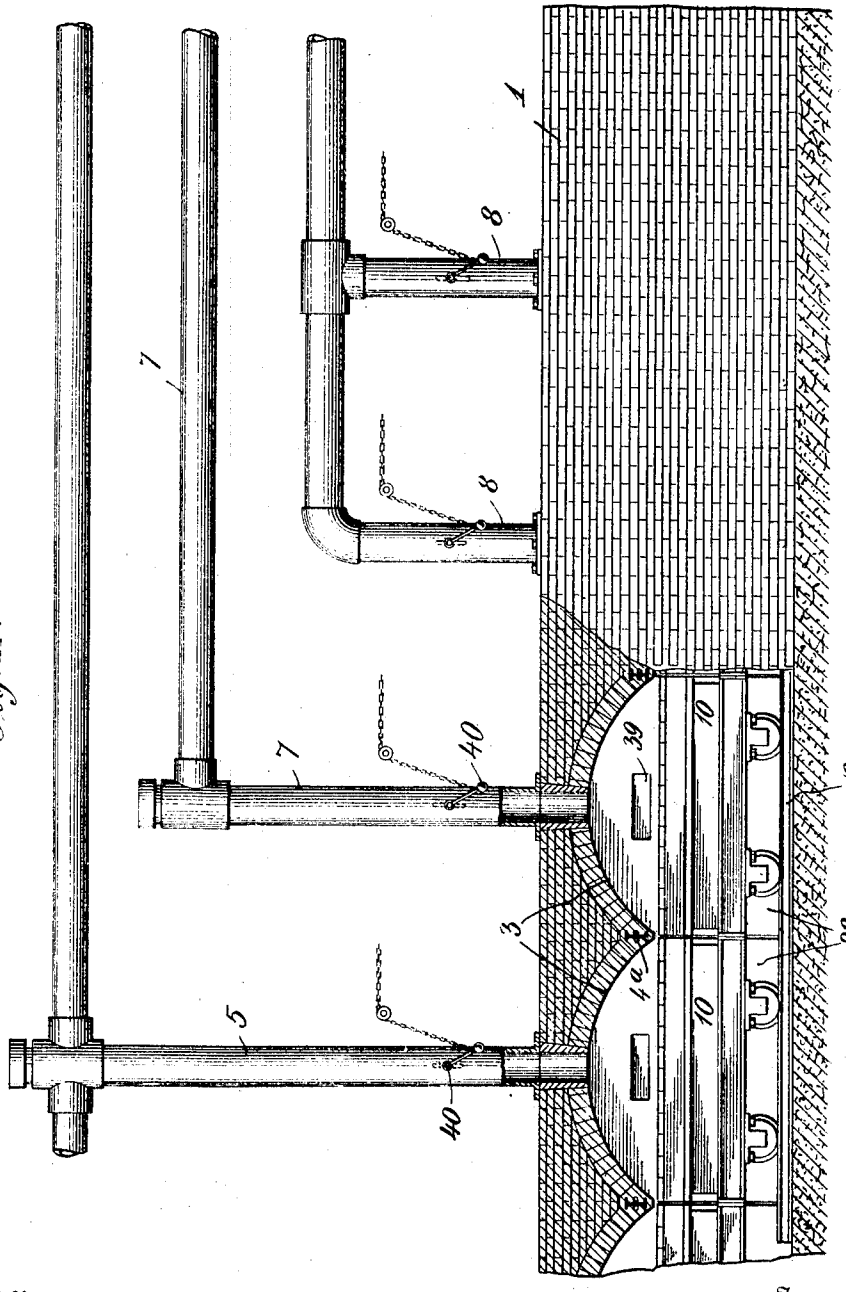


Fig. 11.

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UNITED STATES PATENT OFFICE.

JAMES ARTHUR SINGMASTER, OF PALMERTON, PENNSYLVANIA, ASSIGNOR TO NEW JERSEY ZINC COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

MANUFACTURE OF ZINC OXID.

1,112,853. Specification of Letters Patent. Patented Oct. 6, 1914.

Application filed January 9, 1912. Serial No. 670,264.

To all whom it may concern:

Be it known that I, JAMES ARTHUR SINGMASTER, a citizen of the United States, residing at Palmerton, county of Carbon, State of Pennsylvania, have invented certain new and useful Improvements in the Manufacture of Zinc Oxid; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The object of the invention is to provide a practical method of producing zinc-oxid by a continuous operation and in such a manner that the subliming reactions, so-called, will be effected with a higher degree of chemical and mechanical efficiency than is possible with the well-known form of Wetherill furnace.

More particularly, the object of the invention is to save fuel and labor, to increase the percentage of yield from the charge and improve the uniformity and purity of the product, to simplify the operations and apparatus required for handling the raw material and the residuum, and, further, to ameliorate the temperature conditions to which the workmen are subjected.

According to my invention, the charge is placed on a moving conveyance, specifically formed as a traveling grate-surface, and advanced through the combustion zone of the furnace apparatus, wherein the desired reactions take place with uniform and constant combustion and complete utilization of all the valuable elements of the charge. The workmen prepare the charge, consisting of fuel and ore, flue-dust, or other metallic compound to be treated, and place it on its conveyance outside of the furnace or at a point within it which is sufficiently removed from the active combustion zone to enable them to work carefully and without discomfort or danger. According to the nature of the material to be treated, the charge may be spread on a layer of bed coal, which has been ignited, or it may be deposited on the conveyance in any other suitable way, while the conveyance is advancing into or through the furnace, ignition of the fuel being produced either by special means to this end or spontaneously by the heat of the zone; and, coincidently with the advancing movement, a suitable combustion-supporting gas, such as air, is transmitted to or through the charge in controlled amounts to the end of properly generating the fume from the zinc or from the other volatile metal in the charge. After the fume generation has ceased, the conveyance moves out of the combustion zone, bearing a residuum of barren clinker and ash, which is given opportunity to cool before it emerges from the structure, and is required to be handled by the workmen. The effluent is drawn off during the passage of the charge and conducted to appropriate receivers. The preliminary effluent, being a gas of the general character of producer-gas, and having little or no metallic content, is or may be conducted to a point separate from the fume-collecting means, where its fuel value may be utilized, or it may be wasted if preferred; but in either case the receivers for the sublimed product are not burdened with the necessity of cooling and filtering this high temperature and non-metallic part of the effluent from the charge. The preliminary metallic-fume effluent, being the effluent evolved in the initial stages of the reaction, is usually more or less impure and off-color as a pigment, and for this reason is preferably conducted and recovered separate from the subsequently evolved fume. The fume rising from the charge after it has reached the stage of full combustion, is transmitted to bag-houses or other suitable screening system for collection in the usual way. It is important that the fume constituting the objective product of the process be taken away promptly from the subliming region and therefore the screening and collecting system is connected with such region through a plurality of suitable off-takes distributed at intervals along the path of travel of the fuming charge. These off-takes may all lead to the same receiver, if desired, with or without a suction fan to move the fume through them; but it will be obvious that they can be connected singly or in groups to separate receivers so that not only the fume containing sooty particles, if any such remain, can be kept separate from the white fume, but also fumes of different compositions can be separately collected from the same charge. It is by virtue of this method of removing the effluent from the traveling charge, that bituminous coal can be used as the fuel, as above stated. The preliminary non-metallic effluent will

contain the greater part of the sooty combustion products, and what remains thereafter will pass either into the first or second succeeding off-takes which are in this case, of course, connected with separate receivers.

The combustion or subliming zone above referred to, is preferably constituted by the middle part of a long, stationary, thick-walled chamber or tunnel which is raised to the necessary high temperature by the heat of the reactions taking place therein, and is maintained at that temperature by the continuing passage of the charge, without being allowed to cool down until the end of the run, thus establishing practically constant temperature condition and a consequent high degree of uniformity in the quality of the product pigment. The traveling rate surface on which the charge is carried, is divided into sections, as later described, each following the other and each provided with its own air supply connections which are subject to control by the operator so as to maintain a proper temperature of charge and furnace, and a sufficient excess of oxygen above the charge to oxidize the volatilized metal or metals. As in the established Wetherill practice, the air that is supplied to the charge is increased as combustion progresses and the charge advances. Further control of the generation of the fume can be had in the present invention by varying the suction in the off-takes and by varying the rate of movement of the charge, such movement being accelerated or retarded, as the case may be, in accordance with the conditions developing in the charge as observed through suitable openings in the tunnel side walls. The advancing movement may, of course, be continuous or intermittent according to circumstances, and it will be seen that by the exercise of proper judgment in the regulation of the controlling factors the conditions that are now known to be most productive of economy of operation and of high quality of product in Wetherill furnaces can obviously be reproduced by my present process in continuous form, and that such conditions can also be maintained with a high degree of reliability and precision.

In the mixture constituting the metallic compound to be reduced and volatilized, the fuel ingredient (which may be either anthracite coal or bituminous coal) will necessarily be somewhat larger in my method than just sufficient for the generation of the necessary heat and the reduction of the metal, and my invention further contemplates the treatment of the charge after the volatile metal has been extracted to recover and utilize the energy of this excess. By continuing the air current through the charge and moving the latter to a point beyond the subliming zone, the fuel remaining therein is converted into gas which I conduct back to the furnace at an earlier point in the path of the charge, or utilize in some other manner, as will be later pointed out. This gas may, if desired, be mixed or used in conjunction with the preliminary, non-metallic effluent given off by the entering ignited charge as above explained before it reaches the point of generation of fume.

From the outline of the principal features of my invention, above given, it will be seen that the continuous process I have devised, readily leads itself to performance in duplicate or multiple apparatus, whereby the grate sections leaving one furnace tunnel can be immediately dumped or cleaned and again loaded and entered into another tunnel, and while they are still fairly hot, so that the ignition of the new charge thereon will be assisted and time as well as fuel saved.

The details of the preferred form of the method will be more fairly understood in connection with the description of the apparatus illustrated in the drawings and described below. It is the object of this apparatus to provide simple and effective means for transporting and advancing a charge and for maintaining its temperature and the control of the reactions, whereby uniformity can be obtained and whereby such manual labor as is required to be performed thereon can be done at a safe distance from the region of the intense heat. It should be noted, and will be apparent to those who are skilled in the art of subliming metals, that both the method and the apparatus constituting the invention herein disclosed, are also applicable to the manufacture of sublimed metallic products other than zinc-oxid.

Referring to the drawings: Figures 1 and 1ª together represent a vertical, central and longitudinal section of a tunnel structure embodying the present invention and adapted to the method I have above described: Fig. 2 is an enlarged detail in vertical section through the tunnel and one of the grate sections, on line II—II of Fig. 3: Fig. 3 a transverse vertical section of Fig. 2, the structure being here shown as a single tunnel structure: Fig. 4 a horizontal section on line IV—IV of Fig. 3. Fig. 5 a vertical longitudinal section on the staggered line V—V of Fig. 3. Fig. 6 a horizontal section on line VI—VI of Fig. 3. Figs. 7 and 8 are respectively transverse and longitudinal sections of the tunnel and one of the grate sections provided with a modified and preferred form of traveling air connecting means. Fig. 9 is a transverse section through a double tunnel furnace, also showing the means for utilizing the heat of the residual gases of one for igniting the charge in the

other, the section being taken on line IX—IX of Fig. 10. Fig. 10 is a horizontal section on line X—X of Fig. 9; and Fig. 11 is a side elevation, partly in section, of a modified form of furnace structure.

The tunnel structure 1, is built of masonry with a thick arched roof and preferably also with thick side walls, so as to be capable of confining and retaining the high degree of heat necessary for the subliming process. Its length may be about 150 feet and its internal dimensions about 7 by 6 feet, subject to variation, however, as circumstances may require. The length is determined with relation to the time required for complete volatilization and oxidation of all the zinc or volatile metal of the charge during the movement of the latter through the tunnel at a definite rate, a slower rate of movement requiring a longer tunnel, and vice versa. The tunnel is preferably somewhat longer than required to accommodate the traveling charge while in the actual process of combustion, so that its end portions may serve as vestibules, so to speak, of the actual combustion region, the entrance portion being adapted to protect the charge during its formation and ignition, and the exit portion to allow the exhausted charge to cool off before emerging, while the extension of the tunnel at either end, beyond the limits of the actual combustion zone, operates to conserve the heat developed by the reactions in the latter. In the drawings, the length of the tunnel is reduced for convenience, by breaking out intermediate parts, but the portion constituting the active combustion zone is indicated in a general way by the location of the off-takes which are for carrying away the gaseous product and fume. The interior of the tunnel is provided with a series of partitions 2, depending from the roof, with their lower edges extending as close as may be to the top of the charge moving thereunder. These partitions serve as baffles obstructing movement of gas between the combustion zone and the ends of the tunnel, and divide the upper part of the tunnel into a series of inverted pockets or collecting hoods into which the fume from the charge rises and from which it is collected. In Figs. 1 to 10, the partitions are formed by arched curtain-walls sprung from the sides of the tunnel, as shown more clearly in Fig. 3, but in the modified tunnel structure of Fig. 11 the same effect is produced by forming the tunnel roof of a series of successive arches 3 with their axes transverse to the direction of the tunnel and their springers rested on cross beams 4 spanning the side walls of the tunnel. The cross beams and their enveloping masonry, being situated just above the course of the charge, serve the same purpose as the baffle partitions 2 of the form first described. Water pipes, indicated in section at 4^a in Fig. 11, are laid alongside the beam 4 to guard against their overheating.

The partitions, formed in either way, are located at intervals throughout the length of the tunnel excepting at the entrance end where they may be omitted to provide space for charging. Throughout the portion of the tunnel where the charge is in combustion, they are spaced apart at substantially regular intervals of say about 12 feet, and from each of the intervening pockets leads an off-take for the effluent gas or fume. The first off-take 5, is adapted to conduct the preliminary non-metallic effluent which is given off by the charge after ignition but before volatilization of metal has begun. There may be several off-takes for this kind of effluent but only one is illustrated in the drawing. It or they may lead to any suitable collector or to a chimney stack, but as above mentioned the preferred method of operation contemplates the utilization of these gases for heating or igniting the bed-coal, and for this purpose a down-comer 6 is provided for the structure shown by Fig. 1 leading to the chamber or region of the tunnel where the charging operation takes place. The gas is directed toward the freshly-laid fuel bed together with the air necessary for its combustion, and the heat thus generated is made use of to ignite the fuel. In case this fuel supply should not be sufficient for this purpose, as may be the case in starting the apparatus in action, I have arranged an auxiliary furnace, indicated diagrammatically at 6^a in Fig. 1 which is adapted to provide sufficient heat to insure ignition of the fuel. The combustion gases of the ignition stage may be wasted in any suitable way. The second off-take 7, considering them with reference to the advancing movement of the charge, is intended to take away the preliminary metallic effluent, being for this reason entirely independent of the remaining off-takes. It may lead to a bag-house or any other suitable receiver not shown in the drawings. The next succeeding off-takes 8 lead off from the part of the tunnel where the subliming actions take place and are for the fume resulting from the perfect reactions of the charge. These off-takes may all be connected with a common pipe or flue 9 running to the bag-house or, where the material under treatment is capable of fractional subliming, the successive off-takes can be separately used for collecting the different fumes evolved. Dampers are diagrammatically indicated at 40 in each off-take for controlling the movement of the fume or gas therethrough.

Each of the charge-carrying grate-sections marked 10 in the drawings, is mounted on a wheeled truck-frame running on a track-

way 12 laid on the floor of the tunnel, and is of a suitable width to extend from side-wall to side-wall of the tunnel with only a running clearance on either side. The successive grate-sections or their supporting frames are adapted to move in end-wise contact with each other, so that they will form a moving and substantially continuous horizontal deck or partition, dividing the upper from the lower part of the tunnel with no appreciable gap or opening between them. The clearance spaces at the sides of the traveling sections are preferably sealed by lutes. These may consist of troughs 13 carried on brackets on the side walls of the tunnel and filled with sand or other heavy and mobile material. The grate-sections have aprons 14 depending from their lateral margins and projecting into the sand so as to form a continuous closure, adapted to accommodate the movement of the sections without leakage. The particular mode of mounting and guiding the sections through the tunnel is not of special consequence, and various other means than the wheeled truck frame can manifestly be used with like effect, but the wheeled truck frame or buggy, such as shown, is preferred because of the length of the tunnel and the load which must be carried through it. The lower part of the tunnel is open to the circulation of the outside atmosphere and is therefore not so heated as to injure the running gear of these devices. Each truck frame is a rectangular frame about 12 feet long with a free space in the middle for the accommodation of the air supply apparatus and the water basin. The side sills, marked 15, are borne directly on the journal boxes 16 secured to them, and are joined at their ends by the cross-sills 17. On the top of each side sill, there is planted a series of slotted brackets 18, and across the rectangular frame there is laid a series of eight or more bearer-bars 19 rested with their ends in the slotted brackets, so that their top edges occupy substantially the same horizontal plane. A plurality of separate and removable grate bars, each about 9 inches wide and perforated, such as are at present used in zinc-oxid furnaces, are laid side by side upon the bearing bars with their ends supported in the angles of the Z-bars 20, of which there is one at each end of the frame, to hold the grate bars from longitudinal movement on the frame. The two grate bars located at the sides of the section, and marked 10^a, are preferably secured to the frame, so that they will hold the intermediate removable bars from separating laterally. The several bearer bars 19 support the grate bars against sagging when highly heated under the weight of the charge, and these bars are formed in simulation of knife edges, as shown, so that they will perform this function without unduly obstructing the grate perforations. These juxtaposed grate bars as thus supported constitute the grate section above referred to and the succession of these sections constitutes the grate of the furnace. Upright walls are preferably constructed on the margins of each section to confine the charge thereon. The fixed grate bars 10^a have placed upon them the bars 21, each of which is specially shaped to hold a row of refractory blocks 22 forming a side wall on each side of the grate; and end walls therefore are similarly provided by the bars 24 and the refractory blocks 23 held thereby, the four walls being preferably removable from the grate section so that they can be lifted off separately or all together, to allow the clinker to be removed and the grate bars to be cleaned. The walls assist in the production of uniform quality of product by the facility they provide for leveling the charge off with a uniform depth, equal to their height, over the surface of the grate and they also serve to retain and confine the heat as well as to avoid the erosion of the inner surface or lining of the furnace, which would otherwise take place if the stationary sides of the tunnel were relied on to keep the charge on the grate.

The grate bars form the roof or covering of an air chest 25 formed of sheets of iron in the present instance, with sloping side walls which are secured by their lateral upper margins to the side sills and by their end margins to the depending flanges of the two end Z-bars 20. The space between the side sills and the fixed grate bar 10^a on one side is closed in by the curved wall 26 (Fig. 3) while the corresponding space on the other side is left open for the admission of the air, which on entering the chamber passes thence upwardly through the perforations in the bars and through the charge thereon. A hand-hole, in the form of a flap-door 27, normally closed air-tight, is provided in the sloping wall at one end of the air chest, for cleaning it of ashes or portions of the charge that may fall through the grate; and the portion of the air chest that depends below the level of the cleaning door forms a basin wherein water is or may be contained, during the operation of the section, this being for the purpose of guarding against excessive temperature in the grate.

Admission of the air to the air chest 25 is accomplished by means of a device herein termed a traveling air connector, since its function is to form a connection between the charge conveyance with which it moves, and a stationary source of air supply, or a series of such sources, disposed along the path through the tunnel. This device is susceptible of embodiment in a variety of forms and may be used with forms of furnace apparatus varying considerably from the one under description.

In the form illustrated in Figs. 1 to 6 the connector consists of a depending box-like pipe or arm 28 equal in its horizontal dimension to the length of the frame, and connected at its top with the air admission space of the air chest. For this purpose its upper margins may be secured respectively to the fixed grate-bar 10^a and the top of the adjacent side-sill, as shown, and it may also be stayed to the journal boxes so that it will constitute a rigid structural part of the vehicle. Its lower end opens inside of a trough or gutter 29, which is filled with liquid such as water and extends the full length of the track-way through the tunnel and parallel therewith. This trough or gutter, though shown below the level of the track rails, could be equally as well placed above that level. At intervals less than the length of the grate sections, the trough 29 is provided with upright air pipes 30 connected from beneath with the valved branch-pipes 31 of a main air header 32 which is supplied with air under pressure from a fan or like device shown in Fig. 4. The upright pipes from a series of stationary air supply points throughout the length of the tunnel, one or more of which is adapted to project upwardly into the box-like pipe 28, of the grate section delivering air thereto, while the surrounding liquid furnishes a seal to the connection between the two. At its front and rear ends the box-like pipe is provided with hinged flap-doors or gates 28^a, partly or wholly submerged in the sealing liquid and adapted to ride over the tops of the upright air supply pipes as the vehicle advances, thus establishing air communication with the successive air pipes. It is desirable that the space between the adjacent supply pipes be such that there will be at least one communicating with each air connector at every point in the movement of the latter through the tunnel so that the air communication with the air-chest of each section will be continuous during the subliming process and under control.

It will be understood that all of the sections of the grate are similarly equipped with individual air supply connections of the kind described or the equivalent, so that as each is detailed to service it may move on the track-way through the tunnel with its air connector trailing through the water seal trough 29, each truck abutting closely against its adjacent trucks in front and rear, so that the successive grate sections of each truck form a continuous traveling charge-carrying device as above described. The air connector pipes of each truck also abut or nearly so, so that the escape of air through the interval between them when riding over a supply pipe will not be excessive. The trucks may be propelled by any means suitable for the propulsion of vehicles, as for instance by a cable, but I prefer a pushing device such as the ram 33 indicated in Fig. 1, because the successive sections can be thus more readily kept in close contact with each other with no appreciable gap between them, but with other modes of propulsion, means for positively closing the intervening spaces can be readily added when desired. Switching devices and suitable trackage, not shown herein, are intended to be provided for introducing the trucks in position in front of the pusher. The track through the tunnel is preferably on a lower level than that in the yard and approaches, so that the trucks will move down an incline, indicated at 52 (Fig. 1), as they enter the tunnel and thus bring their connectors and lute aprons 14 into the proper relation with the water and sand troughs, moving up a similar incline, at the exit, as shown at 53, to disengage these parts.

The grate sections are preferably loaded with their charge as they enter or while they are within the tunnel, and for this purpose I have shown two hoppers above the tunnel roof; the one nearest the entrance, marked 34, is supplied with the fuel to form the bed, which fuel passes, under control, through an inlet opening in the tunnel roof on to the grate surface of one of the sections 10, being spread thereon by means of a depressible spreader 35, manipulated by the lever diagrammatically shown at 36 or by any equivalent or suitable gearing, to cause the fuel to be spread in an even layer over the grate as the latter advances. As the grate surface thus covered with fuel comes under the second hopper 37, it receives therefrom a layer of mixed fuel and ore or such compound of zinc or of such other metal as may be the subject of the treatment. This hopper also is associated with a spreader 38, under the control of the operator, by which the charge is leveled off even with the tops of the side walls in the obvious manner.

In the drawings, the construction of the hoppers, their controlling devices and the spreaders, is indicated merely in a conventional way; it will be understood that any suitable mechanical appliances can be used for these purposes.

Being thus continuously loaded with a uniform layer of charge, the sections are continued in motion and pass toward and through the intermediate and highly heated part of the tunnel, heretofore designated as the active combustion zone. In starting the apparatus after a period of idleness it will be necessary to ignite the entering charge by means of the special heating means above described and shown at 6^a in Fig. 1, until the furnace is in full operation, after which the preliminary effluent from the downcomer 6 can be used for this purpose, or the gas from the residuary fuel, after completion of the fume generation as above stated.

By proper regulation of the valves in air pipes 31, the air supply to each moving grate section is controlled in accordance with the observed physical and thermal conditions of the charge, the supply being increased as the combustion progresses. It will be understood that the air for each section passes thereto through the successive supply pipes 30 in the water seal, one or more of these pipes being constantly in communication with the connector arm of each grate section. The controlling valves in the branch pipes 31 are located along the tunnel so as to be conveniently operable from a position adjacent the door-ways 39, through which the action of the charge is observable so that the adjustment of the air supply can be promptly effected. When the metal has become completely volatilized from the charge on a given grate section that section will have reached a point in the tunnel beyond the last off-take 8, and the effluent rising therefrom, resulting from the continuing combustion of the fuel still remaining in the charge, is allowed to pass through a lateral flue 42 in the side-wall of the tunnel, and thence either to a chimney stack or to some point where the heat therein can be utilized. At the point where the combustion of the remaining fuel has ceased or diminished and the air supply is discontinued, the grate sections pass under a pendent screen 43 hanging from the roof of the tunnel near the exit, which screen they push aside, as shown in the drawings. This screen and the two spreaders 35 and 38 all coöperate in closing in the ends of the tunnel structure above the level of the grate sections and they are each constructed with this end in view. The length of the tunnel beyond the pendent screen can of course be continued as far as desired, and at the terminal thereof suitable mechanism will be arranged for removing the now exhausted charge.

The duplication of the tunnel apparatus referred to above is illustrated by Figs. 9 and 10 and its construction will be obvious from a consideration of these figures, both tunnels being exactly alike except as to the reversal of their direction. Having a common dividing wall 45, the two adjacent tunnels are, of course, more economical of heat than either would be if built separate. The formation and arrangement of the grate sections and their truck frames and the air connectors of each frame may be the same as already described, but the propelling means of whatever kind employed, is arranged to move them in opposite directions through their respective tunnels so that the unloaded trucks of one tunnel can be immediately recharged and turned into the adjacent entrance of the other with the least loss of time and heat and the minimum of trackage and appliances. A loop of track or a turntable, not shown, may be used for shifting the trucks from one tunnel to the other.

The portion of each of the adjacent tunnels, between the last fume off-take and the pendent screen, is connected, by a lateral flue here marked 46, leading through the dividing wall 45 into the entering portion of the adjacent tunnel, where the grate sections are receiving their bed-coal, or where they pass after having received it, and this latter portion of tunnel is connected with a stack or chimney 47. The fuel remaining in the charge after volatilization of the metal, is caused to burn while moving in the portion of the tunnel above referred to by continuing the supply of air through the traveling air-connector, and the products of combustion escape through the lateral opening 46 into contact with the freshly laid fuel in entrance portion of the adjacent tunnel, where they may mingle with the preliminary non-mteallic effluent if the same is used for igniting the fuel. The escape from this part of the tunnel is through a chimney 47.

The modification of Figs. 7 and 8 concerns only the form of air-connecting means, the construction of the tunnel and the truck frames and their grate surfaces and air chest being otherwise the same as above described. The air supply disposed along the track through the tunnel, comprises an inverted trough-like box or hood 48, co-extensive in length with the trough 29 which, as above described, runs the length of the tunnel. The open side of the hood is immersed in the water in trough and its interior is divided into compartments by a series of flap-doors 49 hinged therein so that the effect of gravity will maintain them in closed position. Each compartment is connected through its side wall with one of the valved branch pipes 31 of the main air header 32, so that the pressure in each of the compartments or the volume of air passing thereto can be varied at will and each independently of the others. The air connector for this form of air supply consists of a goose-neck pipe 50 connected by its upper end with the air chest 25 and terminating at its lower end in an upward extension 51 projecting within the hood 48 and reaching the space therein above the water level, so that it can receive the air from the respective branch pipes 31 while the surrounding water forms the seal to the connection. As the grate section travels along the track, the lower end of the goose-neck pipe will push upon and open the successive compartment doors 49, which will close behind it, and preserve the isolation of each compartment, except for the momentary interruption when the pipe passes from

one compartment to the next. The traveling grate sections will be maintained in constant communication with the air source, and in each of them the air will be under control by the manipulation of the air valves, so that it can be made to increase as the charge advances or as desired. Ordinarily the supply to several compartments will be permanently set or adjusted to provide the appropriate increase in the supply to the trucks as they advance and without attention by the operator. The compartments of the inverted hood would then contain air at differential pressures properly coördinated to the advance of the charge. The goose-neck form of traveling air-connector is preferably hinged and telescopic, so as to be capable of being removed or turned back out of the way when the truck is being shifted about the yard, and it is hence more convenient than the form first described. One of the said pipes is sufficient to maintain constant communication with the fixed air source, but two or more of such pipes can be used with each truck frame, as indicated in the figures referred to. It is desirable, however, that the air boxes of the successive frames, when supplied with more than one air connector pipe, be arranged so that they will not put more than two of the compartments in the hood 48 in communication at the same time. This is accomplished by the proportioning of the spaces between the flap-doors 49 with reference to the spaces between the air connectors.

It will be understood by those skilled in this art that the apparatus above described is not limited with respect to the size or proportion of the tunnel structure, or its grate-sections, nor to the details of their mechanical assemblage or construction, nor to the number of air boxes supplied to the section of the grate surface that is borne by each truck-frame, and that various omissions, substitutions, and alterations in the form and in the operation of the apparatus may be made without departing from the invention.

I do not claim herein, the apparatus shown, for the reason that I have filed a separate application for Letters Patent of the United States, in which I have claimed said apparatus, the application therefor bearing date of January 18, 1912, Ser. No. 671821.

Having thus described my invention, what I claim is:

1. The process of producing sublimed zinc oxid and analogous products, which consists in forming a bed or layer comprising a reducible compound of the zinc or other relatively volatile metal and combustible material, igniting such bed, advancing the same during its combustion through a suitable chamber, simultaneously transmitting a combustion-supporting draft-current through the bed, and collecting the effluent from such bed at successive points along its path of movement.

2. The process of producing sublimed zinc oxid and analogous products, which consists in forming a bed or layer comprising a reducible compound of a relatively volatile metal and combustible material, advancing the same through an inclosing tunnel, previously heated to cause ignition and combustion of said bed or layer, simultaneously transmitting through said layer a combustion-supporting draft-current during its travel through said tunnel and collecting the effluent from said bed or layer.

3. The process of producing sublimed zinc oxid and analogous products, which consists in forming a bed or layer comprising a reducible compound of a relatively volatile metal and combustible material, igniting and advancing the same through a suitable combustion region; simultaneously with such movement transmitting an air current through said bed or layer, increasing such air supply coincidently with the advance of said bed or layer and collecting the effluent from the latter.

4. The process of producing sublimed zinc oxid and analogous products, which consists in forming a bed or layer comprising a compound of a relatively volatile metal, advancing the same through a heated zone, simultaneously with such advancing motion supplying a suitable gas to the said bed or layer, and collecting the effluent therefrom at a plurality of separated points along the path of movement of said bed or layer.

5. The process of producing sublimed metallic products, which consists in forming a bed or layer comprising a reducible compound of a relatively volatile metal and combustible material, igniting said bed or layer and collecting the non-metallic effluent arising in the early stages of the ensuing combustion, advancing such bed or layer during its combustion and separately collecting the metallic effluent.

6. The process of manufacturing zinc oxid, comprising producing an ignited bed of a compound of zinc and a fuel, advancing such bed through a suitable inclosing fume-collecting chamber, supplying a combustion supporting draft-current through said bed during its movement therethrough, increasing the pressure of such current as the movement progresses, conducting away the preliminary effluent from such bed, and separately conducting and collecting the subsequent metallic effluents.

7. The process of manufacturing zinc oxid, which consists in producing an ignited bed or layer of fuel and a reducible compound of zinc, advancing and simultaneously driving off metallic fume from said

compound, continuing the advancing movement beyond the point where the evolution of fume ceases and there separately collecting the residuary effluent.

8. The process of manufacturing zinc-oxid or like product which consists in producing a continuous bed or layer of a compound of zinc, advancing and simultaneously driving off zinc fume therefrom, and collecting such fume, collecting the residuary effluent from said bed and conducting the latter into contact with a similar freshly prepared continuous bed or layer of zinc compound to assist in igniting the same.

9. The process of manufacturing sublimed zinc pigment, consisting in forming a charge comprised of a bed or layer of fuel and a superposed layer containing a compound of a relatively volatile metal, igniting and advancing such charge through a suitable combustion zone, simultaneously supplying the same with a combustion-supporting draft-current and collecting the metallic fume from the advancing charge.

10. The process of manufacturing sublimed zinc pigment, which consists in maintaining a tunnel of refractory material in a highly heated state, advancing a charge comprising zinc ore and fuel through said heated tunnel, simultaneously transmitting to a portion of said advancing charge as it becomes poorer in its volatile constituents a progressively increasing supply of gas, comprising oxygen, and collecting the effluent driven off from said charge during its said advancing movement.

In testimony whereof I affix my signature in presence of two witnesses.

JAMES ARTHUR SINGMASTER.

Witnesses:
JOHN C. PENNIE,
M. A. BILL.