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CONTINUOUS METALLURGICAL TREATMENT OF RAW MATERIALS

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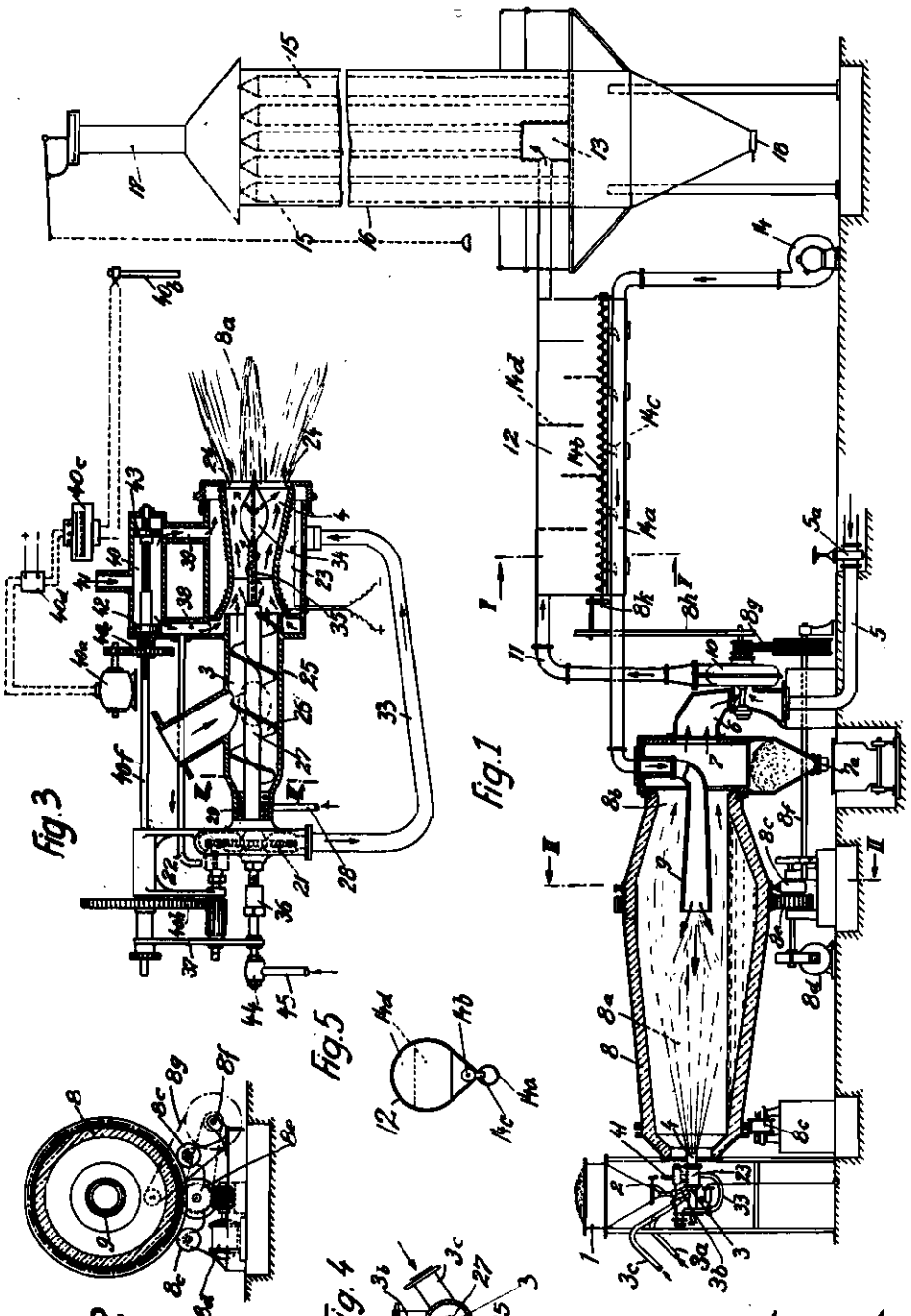

Fig. 1

Fig. 3

Fig. 2

Fig. 5

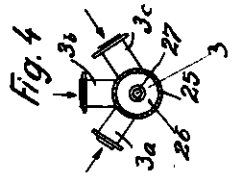

Fig. 4

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CONTINUOUS METALLURGICAL TREATMENT OF RAW MATERIALS

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Application filed July 12, 1941

My present application constitutes a division of my co-pending application Serial No. 361,314 filed October 15th, 1940, which is a continuation-in-part of my former application Serial No. 227,488 filed August 30th, 1938. The invention of my present application relates to a continuous metallurgical treatment of raw materials in a flame chamber, more particularly for the desulphurization, chlorination, roasting or drying of ores, concentrates or other minerals, and has for its object to provide improvements by which there is rendered possible a uniform dressing of the material in one operation, for example, in the case of roasting treatment even up to the extent of dead roasting, at the same time all manual operations together with any parts conducted through the material during the roasting operation and consequently subjected to considerable wear being avoided. Other advantages reside in the completely automatically regulable nature of the dressing treatment, which owing to a special returning means provided in accordance with the invention necessitates merely a short body or flame chamber and thus assists considerably to reduce the cost of the plant.

For the desulphurization and roasting of ores, concentrates or other products containing sulphur it has already been proposed, apart from the roasting processes previously usual in open kilns and stalls, to perform this roasting by hand in reverberatory furnaces of the material-advancing type with direct or indirect heating. It is also known to perform the manual operation by means of rakes suspended on chains, and on the other hand to make the arrangement of the furnace such that roasting is performed on the different levels of a circular shaft furnace.

In this connection it is also old in the art to disintegrate the ore or other product to be roasted, so that the rakes do not require to work through large lumps of ore but merely through a material ranging in size between a coarse granular and a powdery condition. In this way furrows are formed in the material in the direction of movement of the rakes, which present an increased surface area to the action of the roasting gases, as a result of which, by reason of the movement of the rakes, material not yet roasted is brought into action successively.

This disadvantage of apparatus operating with rakes consists on the one hand in the fact that the rakes are unable to convey the material down to the last grain, within range of the roasting action, so that a complete roasting of the material is only possible by continuous repetition of the roasting process and even then it is not of a regular kind. On the other hand the disintegrated material under the movement of the rakes, transfers its fine particles of dust to the current of heating gas and over-saturates this current, so that the roasting effect is obstructed.

It is also known, for the purpose of avoiding a dragging movement on the part of the rakes together with the disadvantages associated therewith, to supply the preliminarily disintegrated material to a revolving furnace, which passes the material in slow progressive movement through the flame chamber. To heat a revolving furnace of this kind it has been proposed to provide numerous air, gas and oil nozzles distributed along the length of the furnace, by means of which nozzles the roasting flames can be ignited at different points of the furnace and thus act on the material always with a new roasting effect.

Since the revolving furnace nozzles of this kind are of necessity covered successively by the material to be roasted and the burning of a roasting flame when covered by the material in direct fashion is not possible, extensive control means and control pipes are necessary along the complete furnace, which cause the flame to be ignited only at the moment when the nozzle in question is located above the charge. Despite the even movement of the material within the furnace there is nevertheless created in the furnace, as a result of slipping action and the whirling effect of the tuyeres and the gas nozzles a dust, which likewise chokes the atmosphere of the furnace, so that the roasting operation is considerably obstructed, whilst moreover in utilizing the waste gases extensive dust-filtering means must be provided, from which the incompletely roasted ore dust must be returned to the furnace for additional treatment.

Whilst the furnaces furnished with rakes exhibit a very appreciable wear of the rake arms and the rakes themselves, and the replacement of these cast iron parts is not only health-impairing and costly but also requires a certain amount of time, the revolving surfaces of the kind referred to, owing to the flames conducted radially in the interior thereof, also exhibit considerable wear of the brickwork and corrosion of the nozzles, which at times are covered by material and at times are exposed in the flame chamber. Repairing of the brickwork is a very complicated matter, even in the case of a single furnace, as the brickwork consists not merely of simple radial bricks but expensive shaped bricks of many different forms.

My present invention is based on the idea of employing as a carrier for the entire roasting operation the flame in conjunction with the ore dust which hitherto was considered during desulphurization and roasting as a great evil, but which according to my invention is introduced in such a way into the flame and preferably into the whirling flame that the large surfaces of the dust particles are continuously acted upon by the roasting agent. The problem with which the invention is primarily concerned consists in maintaining the dust and other ore particles during the roasting operation in intimate contact with the roasting agent and the solution to the problem resides in injecting the mixture for roasting into a hot chamber, preferably by charging them on to a whirling flame, whilst maintaining the current of roasting gas under pressure and performing the complete roasting operation in this hot current.

According to my invention, the ore, in a finely divided condition, is injected in common with the roasting agent under pressure into a hot chamber, floating in the current of roasting gas, and is again sucked off from this chamber whilst the current is maintained.

The fundamental idea of my invention resides not only in carrying out the roasting operation within an oxydizing flame zone, but also, owing to the large surface of the particles of dust and the favorable liberation of the affinitive forces of the roasting gases in relation to the material to be roasted, in making the roasting more spontaneous than has ever been possible heretofore in a flame chamber.

Additional to the above my invention also makes provision for the fact that, if necessary, the gases sucked off from the furnace and bearing the particles of ore floating therein are again mixed with fresh air and introduced into the furnace anew. The return of the sucked up gases takes place in opposition to and in such a manner and under such pressure as to distend the primary flame to a hollow cone.

Owing to the distension of the roasting flame in a flame chamber and by reason of fresh air added, the hot particles of ore give off within the flame in addition to their own heat, that of the sulphur or other additions included therein and thus exert an extremely favorably influence on the thermal economy of the complete treatment.

Owing to my invention of performing roasting in the hot current of a roasting flame and also by reason of the possibility of repeating the roasting operation one or more times in this current, it is possible to roast down the sulphur to small percentages, even to the extent of dead roasting, which result has not been attained with the apparatus previously in use.

According to my invention it is also proposed, after completion of the roasting operation, to conduct the current of gas with the particles of dust to a filtering device, whilst the large pieces precipitated in the furnace as a result of agglomerating are conducted by the rotary movement of the furnace into a collection hopper.

In addition to the stated advantages consisting in an increased roasting effect and the possibility of performing roasting even up to the extent of dead roasting the revolving furnace according to my invention is subject to much less wear than the apparatus previously in use, as a flame impinges on the brickwork of the furnace not radially, but at a tangent and also in whirling form, and a variation in temperature caused by the rotary movement with respect to those parts of the furnace, situated at one time above the charge in the flame chamber and at another time in cooling fashion beneath the charge, does not take place. There is also the advantage that the furnace can be bricked with simple radial bricks, the production of which is simpler and cheaper than that of shaped bricks. The total cost of a plant of the nature is accordingly very much less.

An additional advantage can be obtained according to my invention by providing the furnace with a regulable burner, which can be adjusted completely automatically by the use of known regulating means. By the use of a completely automatic device of this nature the roasting operation can be carried out independently to the skill of the man in charge, so that a certain roasting process having a certain roasting action can be adjusted once and for all solely on the basis of tests carried out in the laboratory.

My invention is illustrated by way of example in the accompanying drawings, in which

Fig. 1 shows diagrammatically in elevation and in partial section a plant in which roasting is performed in an open flame current.

Fig. 2 is a sectional view on the line II—II in Fig. 1.

Fig. 3 is a partly sectional view on a larger scale of the burner shown in Fig. 1 diagrammatically.

Fig. 4 is a section on the line IV—IV in Fig. 3 showing more clearly the distribution of the intake pipes of the burner.

Fig. 5 is a sectional view along the line V—V in Fig. 1.

In Fig. 1 the material is introduced together with the requisite coal into the hopper **1** in a disintegrated condition approximately equivalent to a screen mesh of 20—40. The ground material is blown through the pipe **2** to a worm in the burner **3**. In the burner nozzle **4** there is an intimate mixing of the materials employed, for example oil, gas, coal and sulphide ores with secondary and primary air, with simultaneous agitation, so that after ignition of the flame the latter whirls in the form of a long conical flame **8a** in the bricked conical jacket **8** of the furnace.

The burner structure comprises an air chamber **23** which encloses the nozzle structure **4**, and opens at its forward end into the furnace **8**, around the nozzle **4** at **24**. Extending through the rear end of the a chamber and into the rear of the nozzle **4** is a screw conveyor tube **25**, in which is a screw conveyor **26**, supported upon a tubular shaft **27**. Into the screw conveyor there open the three inlets **3a**, **3b** and **3c**, the inlet **3b** receiving the pulverized ores, while gas and coal dust are fed into the conveyor tube **25** by way of the inlets **3a** and **3c** respectively.

Fuel oil under pressure is fed through the pipe **28** to a suitable feed ring **29** surrounding the rear end of the tubular screw conveyor shaft **27** from which ring the fuel passes into the tubular shaft by way of apertures not especially marked. This fuel is discharged at the forward end of the shaft in the burner nozzle **4** where it mixes with the gas, powdered coal and minerals to be blown into the furnace.

The rear end of the screw shaft is connected with a rotor **21** which is driven by compressed air supplied through the pipe line **22** through a suitable nozzle against blades forming a part of the rotor **21**, and by this means the screw is turned to feed the several materials to the burner. The

air employed for driving the rotor 21 passes out of the rotor casing into the pipe line 33 and is discharged in the air chamber 23, as shown.

Disposed within the forward end of the burner nozzle 4 is a needle 34 which is adjustable in the opening of the burner nozzle 4 to regulate the size of the same, and this needle is supported upon a stem 35 which passes through the tubular shaft 27 and through the rotor 21 where it is threadably connected in a suitable supporting nut 36 so that the opening being turned as by means of a control belt 37 which encircles the rear end of this stem 35, it may be fed forwardly or retracted in the burner nozzle if desired.

The numerals 38 and 39 designate air feed channels which lead from a compressed air chest 40 respectively to the rear end of the burner nozzle 4 and the air chamber 23. The numeral 41 designates the air inlet for the air chest. The afore mentioned air pipe 22 is branched off the channel 38. Within the air chest 40 are valves 42 and 43 which are under the control of suitable automatic regulating mechanism for governing the flow of air through the feed channels 38 and 39. Such regulating mechanism comprising, for instance, a pair of gear wheels 40*e* and a motor 40*a*, controlled from a pyrometer 40*b* arranged within the chamber wall 8, with indicator 40c, over an impulse producer 40*d*, and may incidentally be used for also regulating in accordance with the air admission into the nozzle 4, the air admission to the rotor 21, by means of an extended shaft 40*b* and a gearing 40*h*, and the position of the needle 34 by actuating the belt 37, whereby the stem 35 is advanced or retracted.

The stem 35 carrying the needle 34 is tubular and means is provided, as indicated at 44, for carrying thereinto through a pipe line 45 connected with a suitable source of supply, any gases which it may be found desirable to introduce such as oxydizing or chlorinating gases.

At the opposite end of the furnace there is a discharge section 8*b*, into which projects a refractory blast pipe 9 extending approximately to the base of the two cones of the double-conical revolving furnace 8. This blast pipe has compressed fresh air supplied to the same by the fan 14 through pipe 14*a*. Another fan is connected, by means of pipe 6, centrally to a chamber 7, into which the discharge section 8*b* of the rotating furnace 8 projects and out of which the fan 10 sucks the sulphurous acid-gas formed during the roasting action, and a part of the furnace gas laden with particles of ore, which are returned and injected through the pipe 9 into the flame corona (funnel) to be again subjected to the hottest region of the spontaneous preliminary treatment in the long whirling flame. At 7*a* lumps, cakes and coarser particles can be discharged into trucks, the material in the discharge funnel of chamber 7 always forming an airtight and gastight seal. The recycling of the ore particles withdrawn by means of fan 10 is performed by a special apparatus, comprising a pipe 11 and an oval shaped chamber 12 (Fig. 5), provided with filter curtains 14*d* which cause the coarser particles to settle above the bottom where a conveyor 14*b* moves them into a series of discharge pipes 14c projecting into the above mentioned blast pipe 14*a*. The air blast therein set up by the fan 14 returns the discharged coarse and fine ore particles into pipe 9 as described. The revolving movement of the conveyor screw 14*b* is derived from the shaft of the fan 10 over a belting 8*h* and speed lowering gear 8*k*. The chamber 12 precedes a filtering tower 16 which may be of any approved construction and is provided at its lower end with a centrifugal device or a fine bronze jacket screen 13 through which the fan 10 forces the current of sulphurous acid-gas and air through bag filters 15. The bronze screen retains the coarser material and accumulates it in the lower funnel portion of the tower 16 along with the dust falling from the bags, which bags can be subjected to a mechanical shaking operation to assist the separation of the dust.

The filtering gas can be sucked up at its lower end by an exhauster for treatment in a sulphuric acid plant not shown. The tower 16, in which the filter bags 15 are suspended, possesses above the bags a comparatively large empty space which during the operation is filled with the combustion gases, which are lighter than sulphur trioxide, so that nitrogen, carbon monoxide or carbon dioxide, are able to escape into the air through a pipe 17. This arrangement within the tower 16 permits of a preliminary separation of the flue gases, as carbon monoxide with a specific weight of 0.967, nitrogen with a specific weight of 0.971 and carbon dioxide with a specific weight of 1.525 will always be displaced upwards in relation to sulphur dioxide and sulphur trioxide having specific weights of 2.214 and 2.765 respectively. At the finest material such as copper, iron oxide, ferric oxide, zinc oxide, etc., is preferably sucked off with preclusion of the air and discharged for example into trucks.

It is shown in Fig. 1 that the chamber 8 rotates upon rollers 6c (Fig. 2). The movement is derived from a motor 8*d* over gearing 8*e*. This motor also actuates, over a shaft 8*f* and a belting 6*g*, the fan 10.

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