

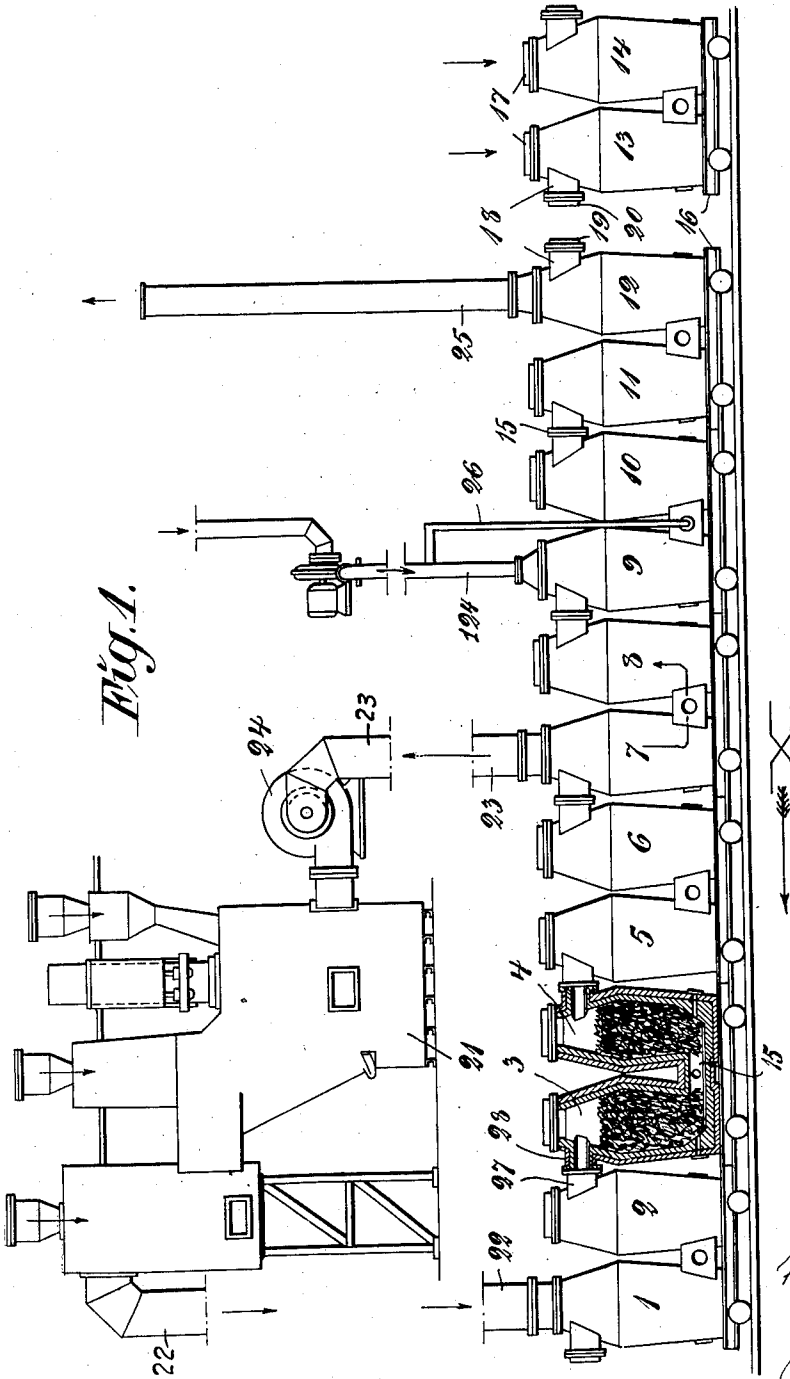
March 15, 1932.

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1,849,561

METHOD OF TREATING SOLID MATERIALS WITH GASES

Filed Sept. 18, 1929 2 Sheets-Sheet 1



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Fig. 2.

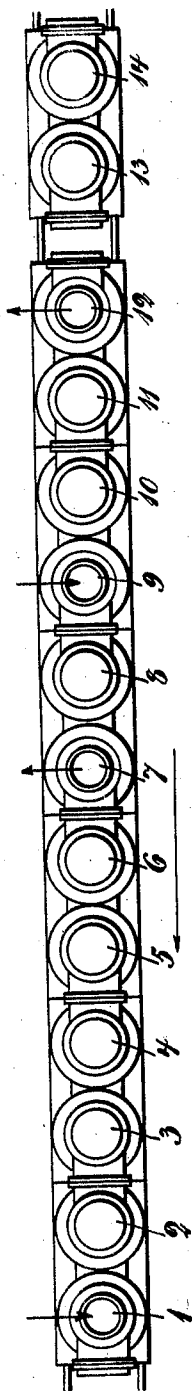
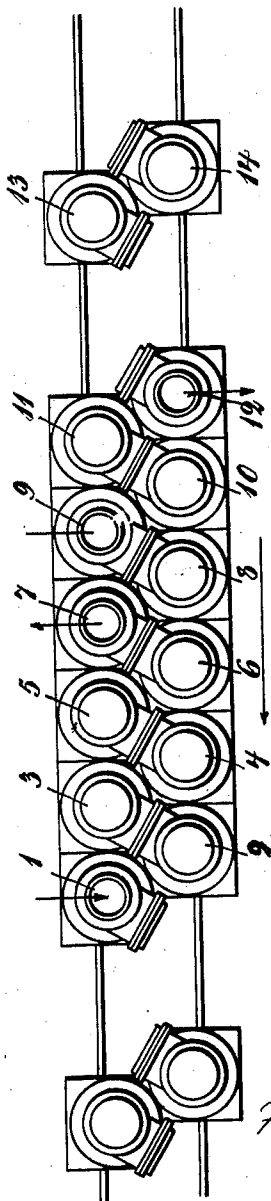


Fig. 3.



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METHOD OF TREATING SOLID MATERIALS WITH GASES

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When treating solid materials with gases in shaft furnaces there will often arise some difficulties. First and foremost the pieces of solid substance may crumble so as to form a dust owing to the friction of the pieces against each other and against the shaft walls in moving downwards through the shaft thereby forming so much dust that the gas either is prevented from passing through the material or will pass through the same in uneven currents. Moreover, the solid pieces of the material in the lower part of the shaft may be crushed on account of the pressure of the whole relatively high stock column in the shaft and finally the stock column may be hanging on the shaft walls thereby causing inconvenient interruptions in working or uneven downwards movement of the material.

The present invention relates to a process for treating solid materials with gases whereby the above inconveniences can be avoided while at the same time as intimate a contact is obtained between the gas and the solid material as in an ordinary shaft furnace.

The process is chiefly characterized by enclosing the material to be treated in a series of receptacles or tanks arranged one after the other, causing the gases to pass successively through the receptacles in such a manner, that they penetrate the still standing material column in each receptacle in a substantially vertical direction, and, after the gases have passed in that manner for a period sufficient for finishing the treatment of the material in the first receptacles of the series, disconnecting said receptacles and introducing the gases into a following receptacle of the series and causing them to pass through the previously treated receptacles and also through freshly charged receptacles which have been connected to the series.

The tanks may either be interconnected in such a manner that the gases in all tanks will pass in the same direction, either from the top to the bottom or vice versa, or they may be connected in such a manner, that the gases in every other tank are caused to pass from the top to the bottom thereof and in every other one from the bottom to the top thereof.

According to the invention the tanks may

be arranged either one after the other in a straight line, or in an annular form, in zig-zag or in any other convenient manner. When they are intended to be movable with regard to the inlet or the discharge openings for the gases, they are preferably placed on carriages or on a rotatable support.

When the treatment of the solid material in one or more of the tanks has been finished said tanks may be excluded or disconnected from the system and discharged, for instance by tipping them or by means of a suitable discharging device at the lower part thereof. Afterwards they are recharged with fresh material and again connected to the opposite or rear end of the system. The gas is thereupon introduced into a tank, which has now become the foremost in the system.

For the purpose of explaining the invention the process will be described hereinafter in connection with an apparatus system shown by way of example in the annexed drawings.

Fig. 1 shows in a diagrammatic side elevation a form of embodiment of an apparatus system. Fig. 2 shows in plan view the tanks according to one embodiment and Fig. 3 the arrangement of the tanks according to another embodiment of the invention likewise in plan view.

In the present example the invention is supposed to be applied to the reduction of iron ore according to the principle disclosed in applicant's U. S. A. Patent No. 1,401,222.

The ore to be reduced is charged into a series of tanks 1-14 being heat insulated in any suitable manner and interconnected in pairs by means of ducts 15 and supported on carriages 16. The tanks may be closed by means of covers 17 and interconnected by means of the tubes 18, which also may be closed by means of shutters 19 and 20. In Fig. 2 the tanks are shown in plan view, it being supposed that they are arranged in a straight line one after the other, and in Fig. 3 it is supposed that they are arranged in zig-zag. They may of course also be arranged in annular form or in any other suitable manner. In Fig. 1 the tanks 3 and 4 are shown in vertical section. The reducing

gas from the carburettor 21, where it is supposed, that the CO_2 -content has been reduced to CO , is conducted into the tank 1 through the gas pipe 22 and then passes downwards through the ore charge in said tank and upwards through the ore charge in the next tank 2 and so on until it enters the upper part of the tank 7, where the gas current is divided into two currents, one of which escapes through the gas pipe 23 and by means of the blower 24 blown into the carburettor 21, where the gas in any known manner is regenerated with respect to carbon monoxide, and again introduced as reducing gas into the tank 1 through the gas pipe 22, while the other gas current will proceed from the upper part of the tank 7 and downwards through said tank and upwards through the tank 8 for the purpose of pre-reducing the ore, the gas in the upper part of the tank 9 being then mixed with air entering through the pipe 124 and burnt for the purpose of pre-heating the ore in the tanks 9, 10, 11 and 12. The combustion gases escape through the conduit 25. Air may, if wanted, be introduced partly through the pipe 124 and partly through the pipe 26. The gas will then be incompletely burnt in the tank 9 and the remaining combustible compounds burnt only in the tank 10. A more even distribution of the temperature in the ore charge is thus attained and also a certain degree of pre-reduction in the tanks 8 and 9.

When the reduction of the ore in the tanks 1 and 2 has been finished, the shutters 19 and 20 are opened and the tank 13 is connected with tank 12. The gas circulation will be stopped and the covers of the tanks 3, 11 and 14 are then opened, all pipes are loosened from the tanks and said tanks are pushed forward in a direction as indicated by arrow X, Fig. 1 opposite to that of the gas current for such a distance that the gas pipe 22 will be positioned right above the tank 3 etc. Gas and blower conduits as well as the escape conduit 25 will thereafter be connected to the tanks below the same in their new places, the covers of the tanks 1, 7 and 12 now being closed, the tanks 1 and 2 disengaged and the shutters of the ducts 27 and 28 are closed, whereupon the gas circulation will be started anew. The tanks 1 and 2 containing the reduced spongy iron thereafter will be discharged in any suitable manner and then recharged with ore and are then ready to be connected to the opposite end of the system. In such a manner the ore will be reduced according to the counter current principle without the same moving within the tanks. By this means the above mentioned inconveniences connected with such movement in a shaft furnace are avoided. Many ores, briquettes, or sinters, which, owing to too great a dust-formation, could hitherto not be reduced in an ordinary shaft furnace, can

in such a manner be reduced by means of the present gas reduction process.

It is evident, that the process is not limited to the reduction method as described hereinbefore but can be used in any process whatever, where solid substances are to be acted upon by gases, for instance roasting or reduction of ores, burning of limestone or the like mixed or unmixed with solid fuel, drying or charring wood or other fuel by means of hot gases, purifying gases by means of solid absorbents, carrying out gas reactions through the effect of solid catalysts and so on. The number of tanks in every special case will be adapted to the nature of the treatment to be carried out. In charring wood or like processes where volatile products are formed and condensed so as to form fluid products in some of the tanks, said tanks are then preferably provided with a discharge device for removing such fluid products before the uncondensed gases leave the last tank.

I claim:

1. Method for the reduction of ores by means of hot reducing gases, consisting in enclosing the ore in a series of substantially vertical receptacles connected with one another, causing the hot reducing gases to pass successively through the still standing ore in said receptacles in a substantially vertical direction, passing from top to bottom in every other receptacle and from bottom to top in the others, dividing the gas current into two portions, after the same has passed through a number of receptacles, leading one portion through a regenerating apparatus and back to the inlet end of the series of receptacles, causing the other portion of the gas current to continue through some other receptacles for preliminarily reducing the ore in the same, and then introducing air for burning the gases so as to preheat the ore in the receptacles at the end of the series.

2. Method as set forth in claim 1, characterized by connecting one pair of freshly charged receptacles to the end of the system, disconnecting the receptacles from the conduits for supplying reducing gas, for leading off the gas quantity to be regenerated, for supplying air for burning the gas quantity continuing through the system, and for leading off the combustion gases, moving the receptacles in opposite direction to the gas current a distance corresponding to that occupied by one pair of receptacles, connecting the gas and air conduits to the receptacles now being below the said conduits, and disconnecting one pair of receptacles from the end of the system where the reduction of the ore has been finished.

In testimony whereof I have hereunto affixed my signature.

FPANS MARTIN WIBERG.