Dec. 4, 1934. P. M. GINDER ET AL 1,983,025

REDUCTION OF ZINCIFEROUS MATERIAL

Filed Dec. 30, 1931 2 Sheets-Sheet 1

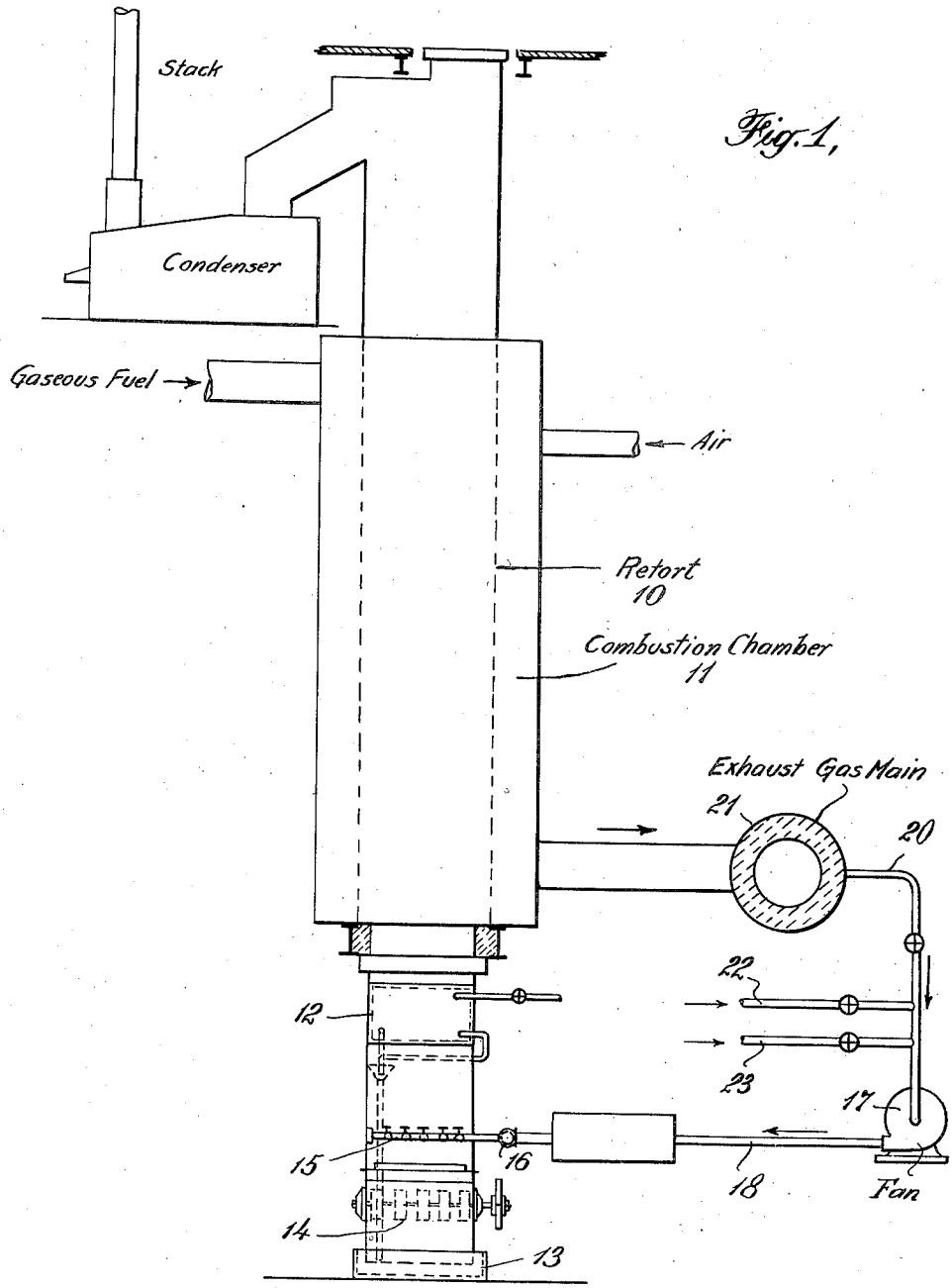


Fig. 1.

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Fig. 2,

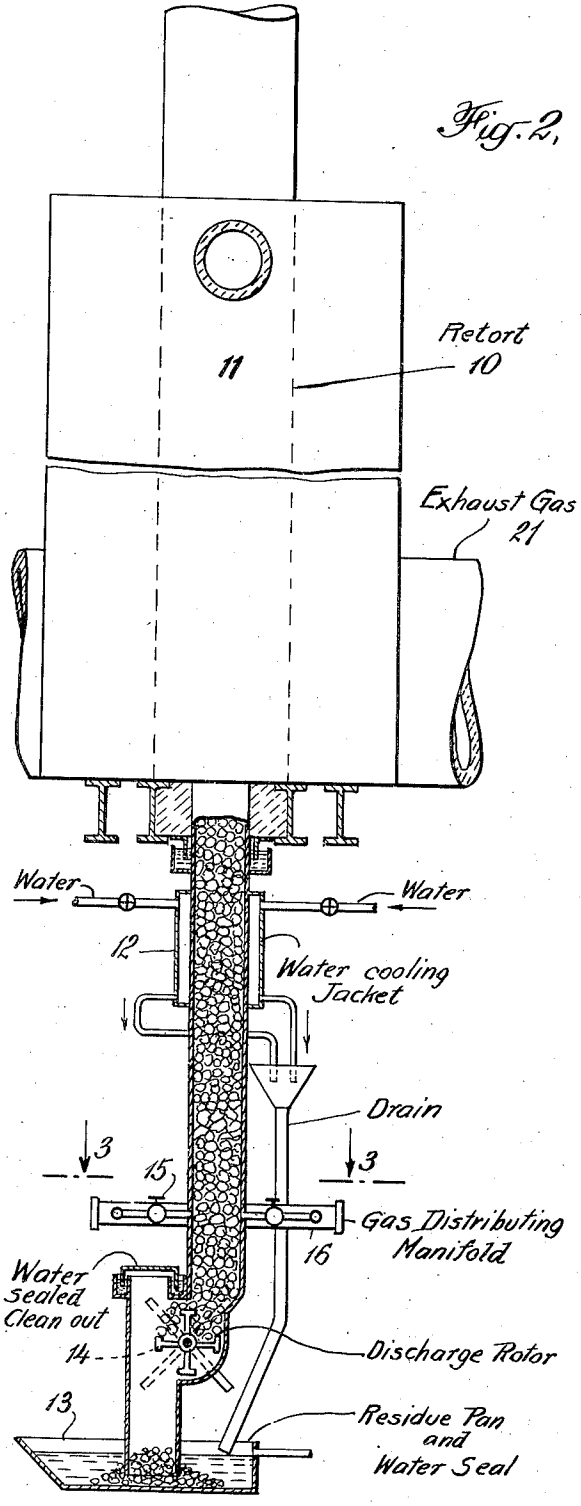
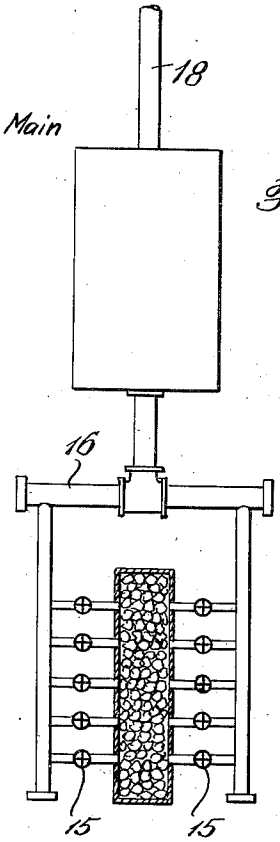


Fig. 3,



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Patented Dec. 4, 1934 1,983,025

UNITED STATES PATENT OFFICE

1,983,025

REDUCTION OF ZINCIFEROUS MATERIAL

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Application December 30, 1931, Serial No. 583,921

6 Claims. (Cl. 75—28)

This invention relates to the reduction of zinciferous material in vertical, upright or inclined reducing chambers, and has for its object the provision of certain improvements in the conduct of such reducing operations. More specifically, the invention aims to minimize the loss of zinc through the bottom of such reducing chambers, and in particular through the bottom of continuously operated vertical zinc retorts.

In the operation of continuous vertical zinc retorts in which a charge of oxidic zinc ore, or equivalent zinciferous material, and carbonaceous reducing material is smelted for the production of zinc vapor, it has been found that some zinc in the form of metallic zinc (as vapor, liquid or solid) or zinc oxide is lost out of the bottom of the retort. Furthermore, it has been found that accretions of zinc oxide tend to build up on the cooler portions of the retort walls near the bottom thereof, as well as on the residue discharge mechanism, and such accretions must be periodically removed.

We have discovered that this loss of zinc through the bottom of the retort is due primarily to the fact that while most of the zinc vapor produced in the heated portion of the retort passes to the condenser, some zinc vapor tends to diffuse downwardly toward the lower end of the retort which must in practice be kept relatively cool, for reasons hereinafter explained. That portion of the zinc vapor that diffuses downwardly may condense as liquid or solid zinc on the walls of the unheated lower end of the retort, or on the residue discharge mechanism or on the cooling residue itself. If oxidizing conditions are encountered, zinc oxide will be formed and may be deposited as rock oxide accretions on the retort walls, the discharge mechanism or the residue. The accretions of rock oxide and solid metallic zinc must be periodically removed at considerable expense, and the deposits on the residue are lost in the discharge. If the bottom of the retort is maintained at such a high temperature that no condensation of zinc vapor occurs, there will nevertheless be some loss of zinc as vapor, especially when the residue is removed or withdrawn from the bottom of the retort. At a temperature of 800–900° C. no condensation of zinc vapor occurs but rock oxide may form and be deposited on both the retort walls and the residue.

Air entering at or near the bottom of the retort will intensify the formation of rock oxide. But even if air is excluded by sealing the bottom of the retort, rock oxide may be produced by oxidation of metallic zinc vapor by carbon dioxide, the presence of which in the cooler portions of the zinc retort is an inevitable result of the chemical reactions that occur in the reduction of zinc oxide by carbonaceous material. The carbon dioxide is formed in two ways, viz:

(1) By the reduction of zinc oxide by carbon monoxide in accordance with the following equation:

$$ZnO:CO=Zn+CO_2$$

Not all of the carbon dioxide thus formed is reduced to carbon monoxide by reaction with the carbonaceous material of the charge, so that varying proportions of the carbon dioxide enter the relatively cooler parts of the retort, where temperatures prevail at which the reversal of the foregoing reaction takes place according to the following equation:

$$Zn+CO_2=ZnO+O$$

(2) At temperatures below 900° C., carbon monoxide tends to dissociate into carbon dioxide and carbon:

$$2CO=CO_2+C$$

The carbon dioxide thus formed is available for oxidizing zinc vapor at the temperatures below 900° C. prevailing in the lower cooler portions of the retort.

Since the oxidation of metallic zinc vapor in accordance with either of the two foregoing reactions is not due to air or free oxygen, it is not possible to prevent the occurrence of either reaction by excluding air from the retort.

It is impracticable to prevent the oxidation of the metallic zinc vapor by maintaining the discharge end of a vertical zinc retort at such a high temperature (around 900° C.) that the carbon dioxide present will not oxidize the zinc vapor, because of the extra heat thus required and the difficulty of handling such an extremely hot residue and operating the discharge mechanism at this temperature. In view of these difficulties, it is desirable from an operating standpoint to extend the retort downwardly some distance below the heated zone or portion thereof, so that the residue is cooled substantially below 900° C. prior to its discharge from the retort. Under certain conditions, it is advantageous to provide the lower extension of the retort with cooling means, such, for example, as water-cooling.

The present invention is concerned with decreasing the loss of zinc from the bottom of such zinc smelting retorts and avoiding the difficulties

incident to the deposit of rock oxide accretions. Thus, the invention contemplates an improved method of conducting the reducing operation so as to substantially prevent zinc vapor from moving or diffusing downwardly from the active reduction zone to the lower and cooler zone of the reducing chamber or retort. The invention accomplishes this condition of operation by the introduction at or near the bottom of the reducing chamber of sufficient gas to cause an upward gas current of adequate volume and velocity to counteract the downward movement or diffusion of the zinc vapor. The method of the invention is particularly applicable to processes involving the reduction of an agglomerated charge of zinc ore and carbonaceous material that does not disintegrate during the zinc smelting operation and remains permeable to gases. The invention may be advantageously applied to the reduction of zinciferous material in any type of elongated reducing chamber having a gaseous products outlet at a higher level and a residue discharge at a lower level than the active reducing zone of the chamber. In the following description, the application of the invention to a continuously operated vertical zinc retort (externally heated) will be particularly considered for the purposes of explanation and example, but it is to be understood that the principles of the invention are equally applicable to other types of zinc reducing chambers.

In carrying out the invention in conjunction with a continuously operated vertical zinc retort, it is now our preferred practice to close or seal the bottom of the retort, as for example, by a water seal, and to equip the lower end of the retort with an appropriate residue discharging device such, for example, as a roller discharge. The gas introduced at or near the bottom of the retort may be oxidizing, reducing, or neutral. If the gas is oxidizing, due to constituents such as carbon dioxide, oxygen, or water vapor, no oxidation of the zinc vapor occurs if the flow of injected gas is properly adjusted, since the carbonaceous material in the hot residue reduces these oxidizing constituents in accordance with the following reactions:

$$CO_2+C=2CO$$

$$O_2+2C=2CO$$

$$H_2O+C=CO+H_2$$

Excessive dilution of the retort gases by the carbon monoxide and hydrogen thus formed from the steam produced by the descent of the hot residue into the water seal may be prevented by water-cooling the lower portion of the retort or its downward extension if any, so as to lower the temperature of the discharged residue and thus decrease the amount of steam formed.

The gas may be blown under pressure or otherwise appropriately injected into the retort at or near its lower end and below the heated reducing zone of the retort. The introduction of the gas should be so effected as to minimize the production of eddy currents within the charge in the retort. The primary aim in introducing the gas is to produce a positive, continuous and preferably uniform flow of gas upwardly through the retort (and particularly that portion of the retort below the heated reducing zone thereof) of such volume and intensity as to substantially inhibit any counterflow of zinc vapor.

The amount of gas injected into the retort should be adequate to substantially counteract the tendency of the zinc vapor to move or diffuse downwardly and the tendency of the descending charge to entrain some zinc vapor as it progresses through the retort. However, it is important that the amount of gas injected should not be so large as to dilute the zinc vapor reaching the condenser to such an extent as to interfere with its condensation to molten zinc. Furthermore, the injected gas should not contain oxidizing constituents in such large amount as to develop, through their reaction with carbon in the residue, enough heat to fuse or scorify any part of the residue or the retort. In the actual practice of the invention in the smelting of an agglomerated charge of mixed zinciferous and carbonaceous materials in a vertical retort, one foot by six feet in cross section and heated over a length or height of twenty-five feet and producing about 7,500 pounds of metallic zinc per day, two to four cubic feet of exhaust combustion gases per minute were introduced into the bottom of the retort with satisfactory results. The exhaust gas from the externally heated zinc retort setting, exit gas from the zinc condensers, producer gas, air and steam have been successfully employed in carrying out the method of the invention.

The invention may be considered in conjunction with the annexed drawings, which illustrate an embodiment of an apparatus for practicing the method of the invention.

Fig. 1 is a side elevation partly in section of a vertical retort and its auxiliaries for producing zinc, equipped with means for practicing the process of the present invention;

Fig. 2 is an end elevation partly in section of the apparatus shown in Fig. 1; and

Fig. 3 is a cross-section on the line 3—3 of Fig. 1.

A vertical zinc retort 10 is so constructed that it can be operated continuously. The retort is charged either continuously or intermittently at the top with a gas-permeable charge, and the residue is discharged at the bottom, as described in greater detail hereinafter. The zinc vapor evolved from the retort is discharged through the orifice at the top of the retort, and may be conducted to a condenser, as shown diagrammatically in the drawings.

The retort is externally heated by the combustion chamber 11 (shown diagrammatically in Figs. 1 and 2), equipped in conventional manner with fuel gas and air inlets, and an exhaust gas main for withdrawing the gaseous products of combustion.

The retort is provided with a lower extension 12, extending below the combustion chamber and dipping into a water seal 13, into which the spent residue from the retort is discharged. The extension is shown as equipped with a roller discharge 14, situated a short distance above the water-seal. The said roller discharge may be operated continuously or intermittently, by a manual or mechanical drive of conventional type (not shown). The extension may be constructed of metal and may be water-cooled, in a conventional manner, as shown.

Each long side of the extension 12 of the retort 10 is equipped with a row of valved gas inlets 15, connected with a gas distributing manifold 16. The inlets serve to inject regulated amounts of gas into the bottom of the vertical retort 10 (that is to say, into its lower extension 12) according to the hereinabove described process.

Power for the injection of this gas is supplied by a fan 17, which forces the gas through a pipe 18 into the manifold 16 (see Fig. 3).

In Fig. 1, the fan 17 is shown as connected by a valved bleeder pipe 20 with an exhaust gas main 21 leading away the exhaust gases from the combustion chamber 11 that heats the vertical retort 10, so that exhaust gases from this source can be injected into the vertical retort through the inlets 15. The bleeder pipe 20 is connected with valved branch pipes 22 and 23, through which air, producer gas or other gases can be likewise supplied to the fan 17 for injection into the vertical retort. In this case the supply of exhaust gas from the exhaust gas main can be regulated or shut off by the valve in the bleeder pipe.

We claim:

1. In the reduction of an agglomerated charge of mixed zinciferous material and carbonaceous reducing agent in a vertically disposed externally heated reduction retort, the steps which comprise, sealing the spent residue discharge end of the retort against ingress of outside air and egress of inside retort gases and zinc vapor, introducing under pressure a controlled amount of exhaust gases from the combustion chamber surrounding the retort into the retort at or near its lower end to inhibit the flow downward in the retort of zinc vapor.

2. In the reduction of an agglomerated charge of mixed zinciferous material and carbonaceous reducing agent in a vertically disposed externally heated reduction retort, the steps which comprise sealing the residue discharge end of the retort against ingress of outside air and egress of inside retort gases and zinc vapor, introducing under pressure an appropriate gas at or near the bottom of the retort to provide a positive and substantially uniform upward flow of gas throughout that portion of the retort directly below the active reducing zone thereof, said gas being selected from the group comprising exhaust gas from the externally heated retort, setting, exit gas from the zinc condensers, producer gas, air, and steam.

3. In the reduction of a porous charge of zinciferous material and carbonaceous reducing agent in a vertically disposed externally heated reduction retort with sealed residue discharge at its lower end, the method of decreasing the loss of zinc in the discharged residue which comprises introducing under pressure at or near the bottom of the retort gas of such a nature as not to produce sufficient heat in the retort to scorify the charge and in such quantities as to provide an upward flow of gas of sufficient velocity to prevent the downward diffusion of zinc vapor into the residue while not diluting the retort gases to such an extent as to interfere with the condensation of the zinc vapor.

4. The improvement in the reduction of zinciferous material in an elongated reducing chamber having a gaseous products outlet at a higher level and a residue discharge at a lower level than the active reducing zone of the chamber which comprises water sealing the spent residue discharge against ingress of outside air, and substantially inhibiting a downward flow in the chamber of zinciferous vapors by introducing under pressure a controlled amount of an appropriate gas into the chamber at a level lower than the active reducing zone thereof, said gas being introduced into the reducing chamber at a plurality of spaced points to minimize the production of eddy currents within the charge in the chamber and thus provide a positive and substantially uniform flow of gas throughout that portion of the chamber directly below the active reducing zone thereof.

5. The improvement in the reduction of a porous charge of mixed zinciferous and carbonaceous materials in a vertically disposed reducing chamber which comprises conducting the reducing operation with the residue discharge of the retort sealed, and inhibiting the flow downward in the retort of zinciferous vapors by introducing under pressure a controlled amount of an appropriate gas into the retort at or near its lower end, said gas being introduced into the reducing chamber at a plurality of spaced points to minimize the production of eddy currents within the charge in the chamber and thus provide a positive and substantially uniform flow of gas throughout that portion of the chamber directly below the active reducing zone thereof.

6. The improvement in the operation of an upright and continuously operated zinc reducing chamber which comprises maintaining the lower end of the chamber closed against the admission of atmospheric air, and introducing under pressure into the chamber below the active reducing zone thereof an appropriate gas in such volume as to substantially counteract any tendency to a downward flow of zinc vapor in the lower portion of the chamber, said gas being introduced into the reducing chamber at a plurality of spaced points to minimize the production of eddy currents within the charge in the chamber and thus provide a positive and substantially uniform flow of gas throughout that portion of the chamber directly below the active reducing zone thereof.

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