Dec. 28, 1948. E. C. HANDWERK ET AL 2,457,545

CONDENSING ZINC VAPOR

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Fig. 1

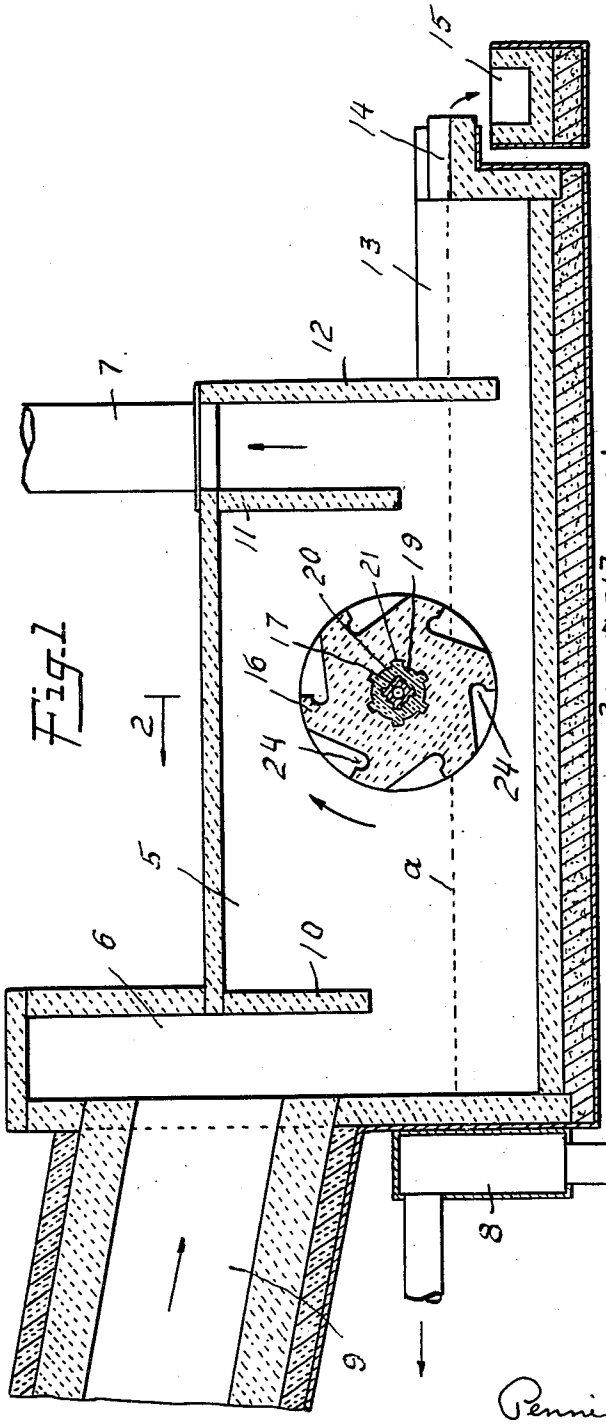
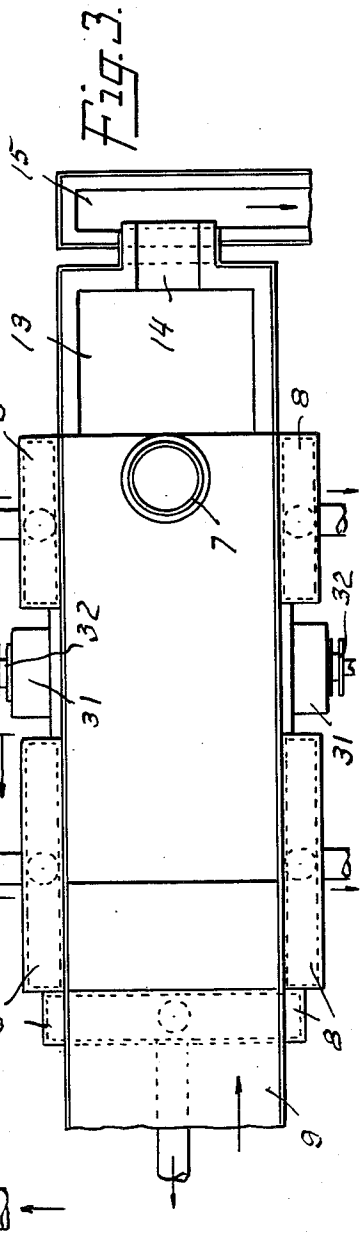


Fig. 3



ERWIN C. HANDWERK
GEORGE T. MAHLER
HARRY C. HAUPT
INVENTORS

BY Pennie, Davis, Marvin & Edmonds
ATTORNEYS

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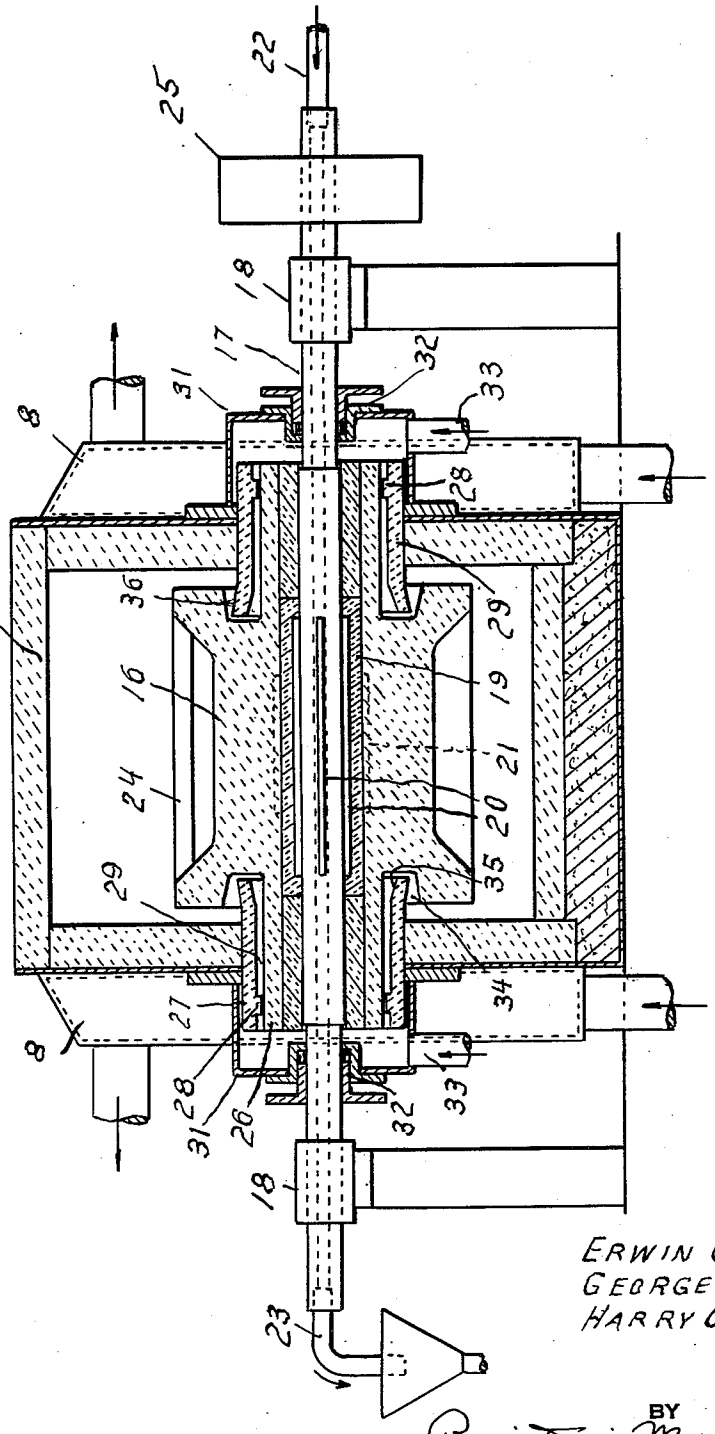
Fig. 2.



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CONDENSING ZINC VAPOR

Erwin C. Handwerk, George T. Mahler, and Harry C. Haupt, Palmerton, Pa., assignors to The New Jersey Zinc Company, New York, N. Y., a corporation of New Jersey

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11 Claims. (Cl. 266—1)

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This invention relates to condensing zinc vapor, and has for its object an improved apparatus for condensing zinc vapor.

In the customary pyrometallurgical practices of smelting zinc ores, the zinc is recovered as molten metal by condensing the zinc vapor contained in the gaseous products of the smelting operation. The condensers ordinarily used for condensing the zinc vapor produce a considerable amount of zinc dust or blue powder which usually is returned to the smelting operation. For example, the condensers heretofore used with modern externally-heated vertical zinc retorts commonly produce blue powder or zinc dust amounting to 7 to 15% of the output of zinc. It is ordinarily necessary to recirculate this blue powder through the vertical retorts, since it is usually not in the form of salable zinc dust and is difficult to melt down to liquid zinc with the use of the heretofore available equipment. A particular object of the invention is the provision of an improved apparatus for condensing zinc vapor diluted with ordinary smeltnig gases, such as carbon monoxide and the like, with the formation of only a minimum amount of blue powder. The invention is particularly adapted for use with smelting equipment of relatively large capacity such as modern externally-heated vertical zinc retorts or electro-thermally heated retorts.

The condenser of the invention comprises a condensing chamber having a zinc vapor inlet and a gas outlet and adapted to hold a body of molten zinc. A generally cylindrical rotor having peripheral surface pockets is rotatably mounted within said chamber with its axis substantially horizontal and with its lowermost pocket beneath the level of the molten zinc adapted to be held in the chamber. Means are provided for rotating the rotor so that its successively ascending pockets are adapted to pick up in rapid succession and throw into the chamber in a substantially continuous and upwardly-directed shower small amounts of the molten zinc held in the chamber. The rotor is mounted on a power driven horizontal shaft transversing the condensing chamber at such a level that its peripheral pockets successively dip into the molten metal as aforementioned. In the preferred construction of the condenser, the rotor shaft is artificially cooled and is mounted in bearings outside the condenser proper, and novel sealing means are provided where the shaft passes through the walls of the condensing chamber.

The foregoing and other novel features of the invention will be best understood from the following description taken in conjunction with the accompanying drawings, in which

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Fig. 1 is a longitudinal sectional elevation of the condenser of the invention,

Fig. 2 is a tranverse sectional elevation on the section line 2—2 of Fig. 1, and

Fig. 3 is a top plan view of the condenser.

The condenser of the invention as illustrated in the drawings comprises a generally rectangular condensing chamber 5 having a zinc vapor inlet 6 approximate one end and an exhaust or waste gas outlet 7 approximate its other end. The condensing chamber is lined with suitable refractory material and is exteriorly equipped with air or water-cooling jackets 8 having appropriate inlets and outlets for the cooling medium as conventionally indicated by the arrows on the drawings. The zinc vapor inlet 6 is connected by a pipe 9 to the source of zinc vapor, such as a vertical zinc smelting retort. The zinc vapor inlet 6 and the gas outlet 7 are shielded by depending refractory baffles 10 and 11, respectively, to prevent splashing or spraying of molten zinc into the inlet and outlet. The condensing chamber communicates, beneath the lower edge of its end wall 12, with a discharge well 13 having an overflow spout 14 determining the level a of the body of molten zinc in the condensing chamber. A collecting trough 15 receives the molten metal overflowing the spout 14 and conveys it to casting equipment or the like. The lower portion of the end wall 12 dips into the molten metal between the condensing chamber and the discharge well and seals the condensing chamber from the atmosphere at this point. The volume of molten zinc in the condensing chamber is thus maintained substantially constant by continuously withdrawing molten zinc from the chamber as zinc vapor is condensed therein.

A generally cylindrical rotor 16 is mounted within the condensing chamber 5. The rotor is carried by a hollow or axially-bored metal shaft 17 mounted in bearings 18 outside the condenser. The shaft 17 is horizontally disposed and extends through the side walls of the condensing chamber between the zinc vapor inlet and the gas outlet in a direction generally transverse to the direction of gas flow through the chamber. The rotor may be constructed of graphite, silicon carbide or other suitable refractory, and is separated from direct contact with the shaft 17 by a sleeve 19 of insulating cement. The shaft 17 has a plurality of circumferentially spaced peripheral ribs 20 embedded in the cement sleeve, and the bore of the rotor has a plurality of spaced

recesses 21 filled with the cement of the sleeve, so that the shaft, sleeve and rotor are effectively keyed together. The shaft 17 is cooled by the flow of a cooling medium, such as water, through its axial bore, the cooling medium being supplied to the bore at one end of the shaft by a pipe 22 and discharged from the other end through a pipe 23.

The peripheral surface of the rotor 16 has a plurality of circumferentially spaced pockets or cups 24. The shaft 17 is positioned at a level substantially above that of the molten zinc adapted to be held in the chamber 5, and the rotor 16 is of such outside diameter that its lowermost pocket is beneath the molten zinc level *a*. The rotor is rotated by means of a pulley 25 secured to the shaft 17 and operatively connected to a suitable source of power, such as an electric motor (not shown).

The condenser is provided with effective seals for preventing the leakage of zinc vapor through and the freezing of molten zinc in the apertures in the side walls through which the shaft 17 extends. Thus, the rotor 16 has a laterally extending sleeve 26 at each end thereof surrounding the cement sleeve 19 where the latter extends through the wall of the condenser. The rotating sleeves 26 extend through stationary sleeves 27. Each stationary sleeve 27 has a constricted portion 28, near its outer end, to provide a close clearance with the rotating sleeve 26, and is elsewhere spaced from the rotating sleeve to provide an elongated inner annular space 29. The outer ends of the concentric sleeves 19, 26 and 27 are enclosed in a gas seal comprising a tight fitting cap or housing 31 having a gland bushing 32 through which the shaft 17 extends. A suitable non-oxidizing gas, such for example as a portion of the exhaust gas exiting from the condenser through the outlet 7, is pumped into the caps 31 through the inlet pipes 33 to maintain a sufficiently high gas pressure within the caps to prevent zinc vapor and diluting gas from flowing outwardly between the stationary sleeves 27 and the rotating sleeves 26.

The sleeves 26 and 27 are so shaped that molten metal does not accumulate in the elongated annular space 29 between the sleeves, but on the contrary runs out by gravity into the molten zinc at the bottom of the condensing chamber. Thus, the ends of the stationary sleeves 27 extend into annular grooves 34 in the ends of the rotor 16, and the lower portions of these ends are internally beveled or thinned to form spouts 35 for discharging by gravity any molten metal entering the space 29 between the sleeves. The annular grooves 34 are outwardly flared to facilitate the flow of molten metal therefrom. The upper portion of the end of each sleeve 27 is beveled or thickened to form a backwardly sloping surface 36 for guiding any molten metal falling on or wetting the upper surface of the sleeves towards the condenser wall and thence downwardly over the sleeve to the body of molten metal.

In the operation of the condenser illustrated in the drawing, a continuous stream of gas containing zinc vapor enters the condensing chamber beneath the baffle 10 of the inlet 6, and flows in a generally horizontal direction through the chamber to the exhaust gas outlet 7. Where the entering gas is derived from a vertical retort smelting operation it will have a temperature of around 850 to 900° C. and will generally contain around 30 to 50% zinc vapor diluted for the most part with carbon monoxide gas. Dissipation of heat from the condenser is controlled by regulating the cooling medium flowing through the jackets 8 to maintain within the condenser an operating temperature of about 530 to 550° C. The rotor 16 is rotated at a relatively high speed, say around 100 to 150 R. P. M., clockwise as viewed in Fig. 1, so that the pockets 24 in rapid succession pick up and throw sheets or showers of molten zinc into the entering gas stream. The pockets 24 have a generally scoop-like section with a relatively long advancing flat surface and a shallow semi-circular depression at the inner end or bottom of the pocket. The pockets terminate short of the circumferential peripheral ends of the rotor, so that little or no molten metal is thrown laterally against the side walls of the condensing chamber. The upwardly-directed and rapidly succeeding sheets or showers of molten metal splash into the shower or rain of molten zinc particles falling through the chamber, and also splash against the baffle 10 and the roof of the condensing chamber, with the result that this area of the condensing chamber is substantially filled with sheet-like showers and moving particles of molten zinc which form ideal nuclei for the condensation and subsequent coalescence of the zinc vapor. Formation of blue powder or zinc dust is practically negligible, and whatever particles are formed are dissolved in the splashing and showering molten zinc or carried thereby into the bath of molten zinc and there melted.

Cooling of the shaft 17 permits the use of a metal shaft, and the sleeve 19 of insulating cement inhibits appreciable cooling of the condensing chamber by the cooling medium flowing through the shaft, and eliminates any thermal stresses in the rotor 16. The special configuration of the stationary sleeve 27 prevents the collection and freezing of zinc metal in the close clearance between the sleeves 26 and 27, and consequent stoppage of the drive shaft. The gas seals prevent the escape of zinc vapor through the rotating contact between the sleeves 26 and 27, and thus insure free relative movement of these sleeves.

While the invention is particularly applicable to the condensation of zinc vapor from the gaseous products of zinc smelting operations carried out in externally or electrically heated retorts, where the zinc vapor content is relatively high, it is also applicable to the condensation of zinc vapor from larger relative amounts of diluting gases. For example, the invention may be advantageously applied to condensing zinc vapor from the gases produced in zinc smelting operations carried out in blast or cupola furnaces, where the zinc vapor content of the gas may be as low as 2 to 5%, provided the carbon dioxide content of such gases is low enough and if the temperature is sufficiently below the zinc dew point. In all cases, the condensing efficiency is high, and the exhaust gas contains only a relatively small percentage of uncondensed zinc, and little or no blue powder is otherwise formed. While the upwardly-directed and splashing sheets or showers of molten zinc are preferably thrown into the gaseous stream in the initial stage of its passage through the chamber, by rotation of the rotor 16 clockwise as viewed in Fig. 1, the rotor may be arranged to throw the splashing sheets or showers of molten zinc into the gas stream at any stage in its passage through the condensing chamber.

We claim:

1. A condenser for zinc vapor comprising a condensing chamber provided with top, wall and bottom members and having a zinc vapor inlet approximate one end and a gas outlet approximate its other end and adapted to hold a body of molten zinc, a horizontally disposed shaft extending through the walls of said chamber between said inlet and said outlet in a direction generally transverse to the direction of gas flow through the chamber and at a level substantially above that of the molten zinc adapted to be held in the chamber, a generally cylindrical rotor having peripheral surface pockets secured to said shaft within the chamber with the lowermost pocket beneath the level of the molten zinc adapted to be held in the chamber, means providing zinc vapor and molten metal seals where said shaft extends through the walls of the chamber, and means for rotating said shaft so that the successively ascending pockets of the rotor are caused to throw an upwardly-directed shower of molten zinc into the chamber.

2. A condenser for zinc vapor comprising a condensing chamber provided with top, wall and bottom members and having a zinc vapor inlet and a gas outlet and adapted to hold a body of molten zinc, a horizontally disposed shaft extending through the walls of said chamber and mounted in bearings outside the chamber, means providing zinc vapor and molten metal seals where said shaft extends through the walls of the chamber, a generally cylindrical rotor having peripheral surface pockets secured to said shaft within the chamber with the lowermost pocket beneath the level of the molten zinc adapted to be held in the chamber, and means for rotating said shaft so that the successively ascending pockets of the rotor are caused to throw an upwardly-directed shower of molten metal into the chamber.

3. The condenser defined in claim 2 further characterized in that the peripheral surface pockets of the rotor terminate short of the circumferential peripheral ends of the rotor.

4. The condenser defined in claim 2 further characterized in that the horizontally disposed shaft is axially bored and means are provided for passing a cooling medium through the axial bore.

5. The condenser defined in claim 2 further characterized in that the horizontally disposed shaft is hollow and thus adapted to be artificially cooled by the passage therethrough of a cooling medium, and a heat insulating sleeve is disposed between the shaft and the rotor.

6. The condenser defined in claim 2 further characterized in that the horizontally disposed shaft is surrounded by a gas seal where it extends through the walls of the condensing chamber.

7. The condenser defined in claim 2 further characterized in that the rotor has at each end a sleeve surrounding the shaft where the shaft extends through the walls of the condensing chamber, and a stationary sleeve surrounds each rotor sleeve in spaced relation therewith except for a constricted portion forming a close clearance between the sleeves.

8. The condenser defined in claim 2 further characterized in that the rotor has at each end a sleeve surrounding the shaft where the shaft extends through the walls of the condensing chamber, and a stationary sleeve surrounds each rotor sleeve in spaced relation therewith except for a constricted portion forming a close clearance between the sleeves, the lower inner end of the stationary sleeve being shaped to promote inward flow of any molten metal in the space between the sleeves, and the upper inner end of the stationary sleeve being shaped to promote outward flow towards the condenser wall of any molten metal on the top surface of the stationary sleeve.

9. The condenser defined in claim 2 further characterized in that the rotor has at each end a sleeve surrounding the shaft where the shaft extends through the walls of the condensing chamber and further has an annular groove in each end surrounding the sleeve, and a stationary sleeve surrounds each rotor sleeve in spaced relation therewith except for a constricted portion forming a close clearance between the sleeves, the inner end of each stationary sleeve extending into the annular groove in the adjacent end of the rotor.

10. The condenser defined in claim 2 further characterized in that the horizontally disposed shaft is surrounded where it extends through the walls of the condensing chamber by a cap tightly fitted to the exterior of the condenser, each cap carrying a bushing for the shaft and having a gas supply means.

11. A condenser for zinc vapor comprising a condensing chamber provided with top, wall and bottom members and having a zinc vapor inlet and a gas outlet and adapted to hold a body of molten zinc, a generally cylindrical rotor having peripheral surface pockets rotatably mounted within said chamber with its axis substantially horizontal and with its lowermost pocket beneath the level of the molten zinc adapted to be held in the chamber, and means for rotating said rotor so that its successively ascending pockets are caused to pick up in rapid succession and throw into the chamber in a substantially continuous and upwardly-directed shower small amounts of the molten zinc held in the chamber.

ERWIN C. HANDWERK.
GEORGE T. MAHLER.
HARRY C. HAUPT.

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