Aug. 8, 1933. E. C. HANDWERK ET AL 1,921,820

REDUCING ZINCIFEROUS MATERIAL

Filed June 15, 1932 2 Sheets-Sheet 1

Fig. 1.

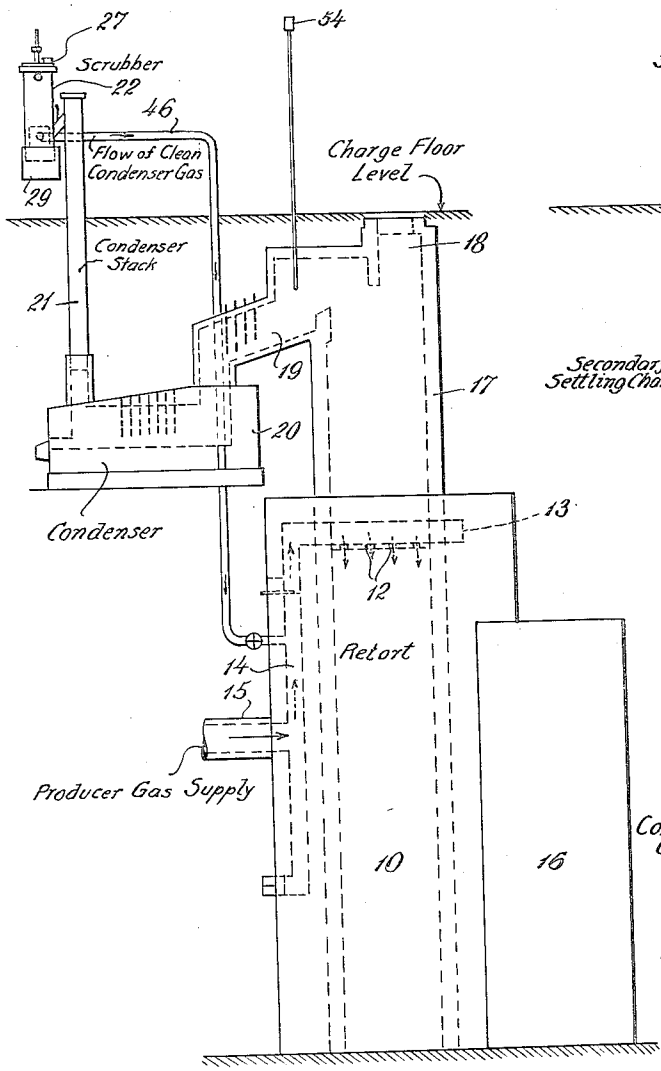
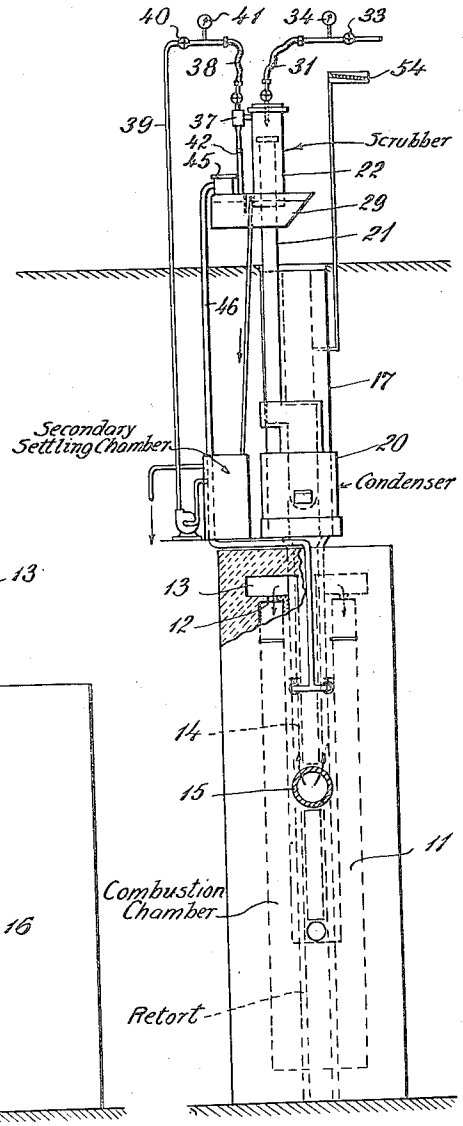


Fig. 2.

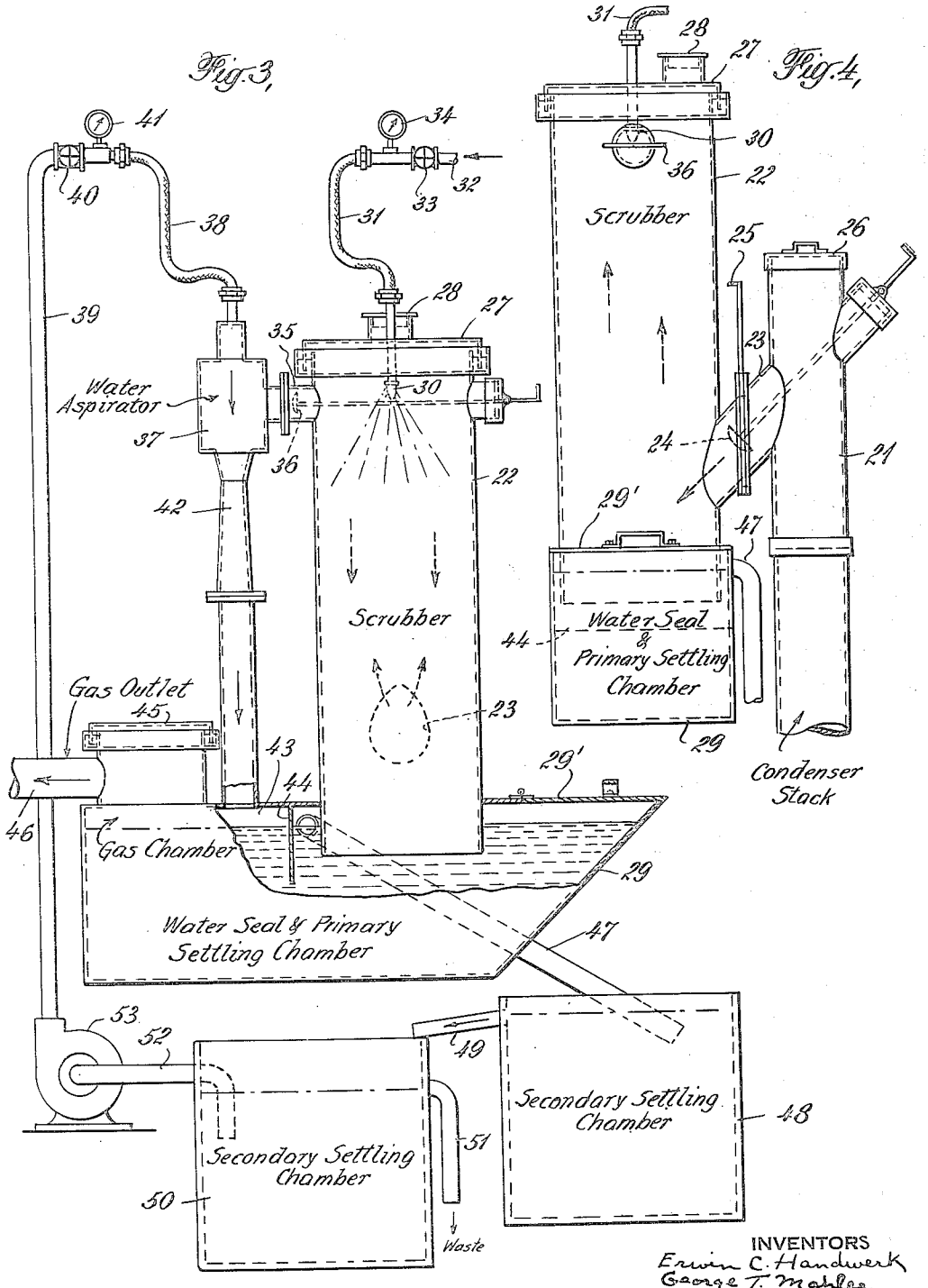


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UNITED STATES PATENT OFFICE

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REDUCING ZINCIFEROUS MATERIAL

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Application June 15, 1932. Serial No. 617,294

12 Claims. (Cl. 75—28)

This invention relates to the reduction of zinciferous material with condensation of the resulting zinc vapor, and has for its object the provision of certain improvements in the utilization of the exhaust condenser gas for generating heat.

The vapors evolved from the chamber or retort in which oxidic zinc ores or the like are reduced by carbonaceous reducing materials contain an amount of carbon monoxide gas at least equal in volume to the zinc vapor present and generally in substantial excess of this amount. The carbon monoxide gas that accompanies the zinc vapor is usually permitted to escape from the zinc condenser after the condensation of the zinc vapor, generally carrying with it a substantial amount of zinc in the form of zinc vapor, zinc dust and/or zinc oxide. It has heretofore been the general practice to ignite this carbon monoxide gas at the condenser outlet and burn it without utilizing its fuel value.

The aim of the present invention is to provide an improved method of and apparatus for utilizing the fuel value of the exhaust condenser gas and for recovering the zinc values contained therein. The invention contemplates more particularly the treatment and utilization of the exhaust gas from condensers attached to continuously operated vertical reducing chambers delivering a constant flow of gas rich in zinc vapor and carbon monoxide.

An apparatus for the recovery of the fuel and zinc values of condenser exhaust gas must fulfill the following requirements:

(1) The operation of the reducing chamber and the zinc condenser must not be interfered with by alteration of the gas pressure therein, and in particular the escape of the exhaust gas from the condenser must not be hindered.

(2) Air must not enter the apparatus because of the danger of explosion.

(3) The gas must be cooled as a further precaution against explosion and in order to remove water vapor that the gas may have taken up from water used for washing or cooling purposes and in water seals.

(4) Zinc dust and zinc oxide must be removed from the gas and collected in such form that they may be readily removed.

(5) The apparatus must be hermetically sealed so as to prevent the entrance of air or the escape of carbon monoxide gas.

(6) The cleaned gas must be delivered to the fuel gas pipe line at a fixed and uniform pressure.

(7) The apparatus must be easy to supervise and operate, and in particular periodical dismantling and reassembling of the apparatus must not be necessary in connection with the operations of charging and discharging the reducing chamber, tapping the condenser or cleaning out the condenser.

The method of this invention carried out in the apparatus of the invention admirably meets all of these requirements. In accordance with the invention, the exhaust condenser gas is withdrawn from the condenser and passed through a hermetically closed system (inhibiting the entrance of air and the escape of carbon monoxide) to an appropriate combustion means for utilizing the gas in generating heat. The invention is particularly characterized by promoting the passage of the gas through the closed system by an aspirator, preferably a water aspirator which simultaneously serves to wash and clean the gas. The gas is appropriately cleaned as for example by a washing or scrubbing thereof, in the course of its passage through the closed system, thereby removing zinc values therefrom in recoverable form as well as conditioning the gas for satisfactory combustion. The suction effect of the aspirator upon the exhaust gas outlet of the condenser is regulated and controlled to maintain a contemplated and predetermined gas pressure in the condenser thereby insuring the proper and contemplated operation of both condenser and reducing chamber.

The accompanying drawings illustrate, somewhat diagrammatically, an arrangement of apparatus embodying the principles of the invention. It is to be understood that the details of construction and arrangement shown in the drawings are illustrative and not restrictive of the invention, and those skilled in the art will recognize that the arrangement of apparatus illustrated in the drawings is susceptible of various modifications without departing from the spirit of the invention. In the drawings

Fig. 1 is an elevation of the apparatus,

Fig. 2 is an elevation at right angles to that of Fig. 1,

Fig. 3 is an enlarged detailed elevation of that part of the apparatus for treating the exhaust condenser gas, and

Fig. 4 is a similarly enlarged and detailed elevation at right angles to that of Fig. 3.

Referring to the drawings, the reducing chamber is shown as a vertically disposed and externally heated retort 10 of rectangular cross section. The retort is mounted in an appropriate furnace structure having combustion chambers 11

along each of the wide sides of the retort. Producer or equivalent fuel gas is delivered to the top of the combustion chambers through ports 12 in a manifold 13 connected by a flue 14 with the fuel gas main 15. Air preheated in a recuperator 16 is delivered to the top of the combustion chambers, along with the fuel gas, in conventional manner.

The upper end of the retort 10 preferably extends a substantial distance above the upper end of the furnace structure and constitutes a prolongation 17 in which purification of the zinc vapor may be carried out as described in United States Patent No. 1,749,127, March 4, 1930. During operation, the vertical retort 10 and its prolongation 17 are kept full of the charge of non-distintegrating agglomerates of zinciferous material and carbonaceous material, fresh agglomerates being introduced through the charging well 18 and spent residues being withdrawn from the bottom of the retort as required. The reducing or smelting of the porous charge of agglomerates of mixed zinciferous and carbonaceous materials is thus conducted in a continuous manner with the delivery to the condensing apparatus of a substantially constant and uniform flow of gas rich in zinc vapor and carbon monoxide. Thus, the zinc vapor and carbon monoxide gas evolved from the retort 10 ascend through the column of agglomerates in the prolongation 17 and pass through a down-comer 19 into a condenser 20 where the greater part of the zinc vapor is condensed to molten zinc. Carbon monoxide gas and other permanent gases that accompany the zinc vapor ascend through the condenser stack 21 for treatment in accordance with the principles of the invention.

The equipment for treating the exhaust condenser gas is shown in detail in Figs. 3 and 4 of the drawings. A cylindrical gas scrubbing column or tower 22, open at its bottom, is connected near its lower end with the upper end of the condenser stack 21 by means of a downwardly directed pipe 23. A scraper 24 is disposed within the pipe 23 for cleaning out the gas connection between the condenser stack and the scrubbing column. The pipe 23 is provided with a slide damper 25 for closing the gas connection between the condenser and the scrubber when desired or necessary. The top of the condenser stack 21 is normally closed by a cover 26 which may be removed, when the damper 25 is in its closed position, to permit the escape of the exhaust condenser gases.

The scrubber 22 may be made of sheet iron or equivalent metal. It is closed at its top by a water-sealed cap 27 providing a safety valve outlet in the event of an explosion within the scrubber. The cover 27 is provided with a removable cap 28 permitting the escape of gas to the atmosphere in the event of operating difficulties in the gas circuit, such as clogging of the aspirator or the like. The open bottom of the scrubber 22 extends an appropriate distance beneath the water level in a tank or settling chamber 29. The tank thus serves both as a water seal for the lower end of the scrubber and as a primary settling chamber for zinc dust and zinc oxide.

A removable spraying nozzle 30 extends through the cover 27 into the top of the scrubber 22 and is connected by a flexible pipe or hose 31 with a fresh water supply pipe line 32. The pipe line 32 is equipped with a valve 33 and a pressure gauge 34 to regulate and indicate respectively the water pressure.

The top of the scrubber 22 is connected by a pipe 35 (equipped with a clean-out scraper 36) with a water aspirator 37 supplied with water through a flexible pipe or hose 38 connected to a pipe line 39. The pipe line is equipped with a control valve 40 and a pressure gauge 41.

The water aspirator 37 is downwardly directed and serves to withdraw gas by suction from the scrubber and to force it through a pipe 42 into a gas chamber or compartment 43 at one end of the settling chamber 29. The gas compartment is formed by a transverse baffle 44 extending from the cover of the tank 29 to well beneath the level of the water therein, and about midway of the length of the tank. The top of the gas compartment 43 is closed by a water-sealed cap 45. A pipe 46 connects the gas compartment or chamber 43 with the combustion means for utilizing the cleaned gas in generating heat.

A water overflow pipe 47 maintains the contemplated water level in the tank 29 and conveys the overflow water to a secondary settling chamber 48. An overflow launder 49 connects the chamber 48 with another secondary settling chamber 50. The chamber 50 has a water overflow outlet 51 leading to waste. The water for the aspirator 37 is supplied from the tank 50 through a pipe 52 and a water pump 53 having its pressure side connected to the pipe line 39.

The exhaust condenser gas flows into the lower end of the scrubber 22 through the downwardly directed connection 23, and the gas then ascends in the scrubber against the downwardly directed water spray from the nozzle 30. The water aspirator 37 withdraws the gas by a regulated and controlled suction from the top of the scrubber 22 and forces the gas into the chamber 43. The zinc dust and zinc oxide in the exhaust condenser gas are carried down into the settling chamber 29 in part by the spray in the scrubber 22 and in part by the water jet of the aspirator 37, and thus enter the settling chamber 29 in suspension in the water. Zinc dust and zinc oxide settling in the primary settling chamber 29 are periodically scraped out through the inclined end of the chamber, the door 29' in the normally closed top of the chamber being opened for the purpose. The excess water supplied to the primary settling chamber 29 by the scrubber 22 and aspirator 37 escapes through the overflow pipe 47 into the first secondary settling chamber 48. The amount of water overflowed to waste from the secondary settling chamber 50 through the pipe 51 is equal to the amount of water introduced into the system by the sprayer 30. The pressure of the water supplied to the aspirator 37 may be regulated by means of the valve 40 and the amount of water supplied to the aspirator is adjusted to the amount of gas entering the scrubber. When the gas pressure in the condenser or reducing chamber, as shown for example by an appropriate gauge 54 at the top of the retort, increases above normal, the valve 40 is opened wider to supply more water to the aspirator thus creating a higher suction and pressure to take care of the increased gas volume. Conversely abnormally low gas pressures in the condenser or reducing chamber are compensated by decreasing the suction effect of the aspirator 37.

The water aspirator is of particular advantage in conveying the exhaust condenser gas through the scrubber and into the fuel gas line, since it obviates the use of mechanisms that might be clogged up and stopped by zinc dust and zinc

oxide. In practice, we have found the water aspirator greatly superior in reliability of operation to mechanical pumps and fans.

For the treatment of the exhaust condenser gas from a condenser condensing approximately three tons of zinc per day of twenty-four hours a scrubber 18 inches in diameter and 3 feet in effective height has been found adequate. The spray 30 used with this scrubber has a nozzle 4.5 millimeters in diameter and deliver two gallons of water per minute at a pressure of 25 pounds per square inch. The aspirator 37 has a four-inch inlet and outlet and contains a six millimeter spray nozzle and uses 6 to 8 gallons of water per minute at a pressure of 25 to 35 pounds per square inch (this water being recirculated clarified water from the settling chambers). This aspirator delivers gas at a pressure of 0.5 to 0.8 inches water column. The volume of condenser gas treated by this equipment is 25 to 35 cubic feet (or more) per minute at 0° C. and atmospheric pressure. This gas enters the scrubber under its own pressure at a temperature of about 400–450° C. The scrubber cools the gas to about 50–60° C. and removes about 90–95% of the zinc dust and zinc oxide in the gas. The aspirator further cools the gas to about 20–30° C. and removes substantially all of the zinc dust and zinc oxide that remain in it after the treatment in the scrubber. The cleaned gas has a heating value of about 250–300 British thermal units per cubic foot.

In the apparatus shown in the accompanying drawings, the clean gas flows through the pipe 46 into the fuel gas flue 14 of the reducing furnace. It is preferable to supply the cleaned exhaust condenser gas to the flue 14 rather than directly to the combustion chambers of the furnace, because the clean gas (mainly carbon monoxide) is then given an opportunity to thoroughly mix with the fuel gas supplied through the pipe 15, thereby insuring the delivery to the combustion chambers of a practically uniform composition of fuel gas. Where the cleaned exhaust condenser gas and producer gas are supplied separately to the combustion chambers 11, irregularities in temperature will develop on account of the fact that the cleaned exhaust condenser gas has a substantially greater thermal value than ordinary producer gas.

We claim:

1. The improvement in the reduction of zinciferous material and condensation of the resulting zinc vapor which comprises passing the exhaust gases from the condenser through a closed system to a combustion chamber associated with the reduction retort for utilizing said gases in generating heat, promoting the passage of the gases through said system by aspiration with liquid, and regulating the suction effect of said aspiration upon the exhaust gas outlet of the condenser to maintain a predetermined gas pressure in the condenser.

2. The improvement in the reduction of zinciferous material and condensation of the resulting zinc vapor which comprises passing the exhaust gases from the condenser through a closed system to a combustion chamber associated with the reduction retort for utilizing said gases in generating heat, washing said gases in the course of their passage through said system, and promoting the passage of the gases through said system by aspiration with water.

3. The improvement in the reduction of zinciferous material and condensation of the resulting zinc vapor which comprises passing the exhaust gases from the condenser through a closed system to a combustion means for utilizing said gases in generating heat, washing said gases in the course of their passage through said system, promoting the passage of the gases through said system by aspiration with liquid, and regulating the suction effect of said aspiration upon the exhaust gas outlet of the condenser to maintain a predetermined gas pressure in the condenser.

4. The improvement in the operation of reducing a porous charge of agglomerates of mixed zinciferous and carbonaceous materials in an externally heated upright reducing chamber and condensing the resulting zinc vapor which comprises passing the exhaust gases from the condenser through a closed system to a combustion means for utilizing said gases in the heating of said chamber, washing said gases in the course of their passage through said system, promoting the passage of the gases through said system by aspiration with water, and regulating the suction effect of said aspiration upon the exhaust gas outlet of the condenser to maintain a predetermined gas pressure in the condenser.

5. The combination with a furnace with imperforate walls for reducing zinciferous material and an associated condenser, of a water-aspirator for promoting the withdrawal of the exhaust gases from the condenser and the cleaning of said gases for their subsequent utilization in generating heat.

6. The combination with a retort with imperforate walls for reducing zinciferous material and an associated condenser, of an aspirator for promoting the withdrawal of the exhaust gases from the condenser into a closed system communicating with a combustion chamber associated with said retort for utilizing said gases in generating heat, and means included in said system for cleaning said gases.

7. The combination with an externally heated reducing chamber for reducing zinciferous material and an associated condenser, of a water aspirator for promoting the withdrawal of the exhaust gases from the condenser into a closed system communicating with a combustion means thermally associated with said reducing chamber, and means included in said system for washing said gases.

8. The combination with a furnace for reducing zinciferous material and an associated condenser, of a gas washing column communicating near its lower end with the exhaust gas outlet of the condenser and having near its upper end a gas outlet, means for spraying water downwardly through said column, a settling chamber beneath said column for collecting the water sprayed therethrough and adapted to contain an appropriate body of water to seal the lower open end of the column, a downwardly directed water aspirator operatively associated with the gas outlet of said column for promoting the withdrawal of gas therefrom and the delivery of the gas to a compartment at one end of said settling chamber, and means permitting the flow of gas from said compartment to a combustion means for utilizing the gas in generating heat.

9. In the reduction of zinciferous material to produce binc metal, the improvement which comprises subjecting the exhaust gases from the condenser to a scrubbing action by aspiration with water, placing the condenser under controlled suction by regulating said aspiration to

obtain optimum condensation of zinc vapor in the condenser.

10. In the reduction of zinciferous material to produce zinc metal, the improvement which comprises withdrawing the gases from the condenser under suction by aspiration with water, and regulating and controlling said suction to maintain a contemplated and predetermined gas pressure in the condenser to obtain optimum condensation of zinc vapor therein.

11. In the reduction of zinciferous material to produce zinc metal, the improvement which comprises subjecting the exhaust gases and accompanying zinc containing particles to a preliminary scrubbing action with water, then subjecting the preliminary washed gas to a second scrubbing action by aspiration with water adapted to place the condenser under suction, and regulating and controlling said suction to maintain a contemplated and predetermined gas pressure in the condenser to obtain optimum condensation of zinc vapor therein.

12. In the reduction of zinciferous material to produce zinc metal, the improvement which comprises continuously withdrawing the gases from the condenser by aspiration with water, continuously returning the water at least in part to subject further amount of the gases from the condenser to aspiration, carefully regulating the strength of said aspiration to maintain a desired and predetermined gas pressure in the condenser to obtain optimum condensation of zinc vapor therein.

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