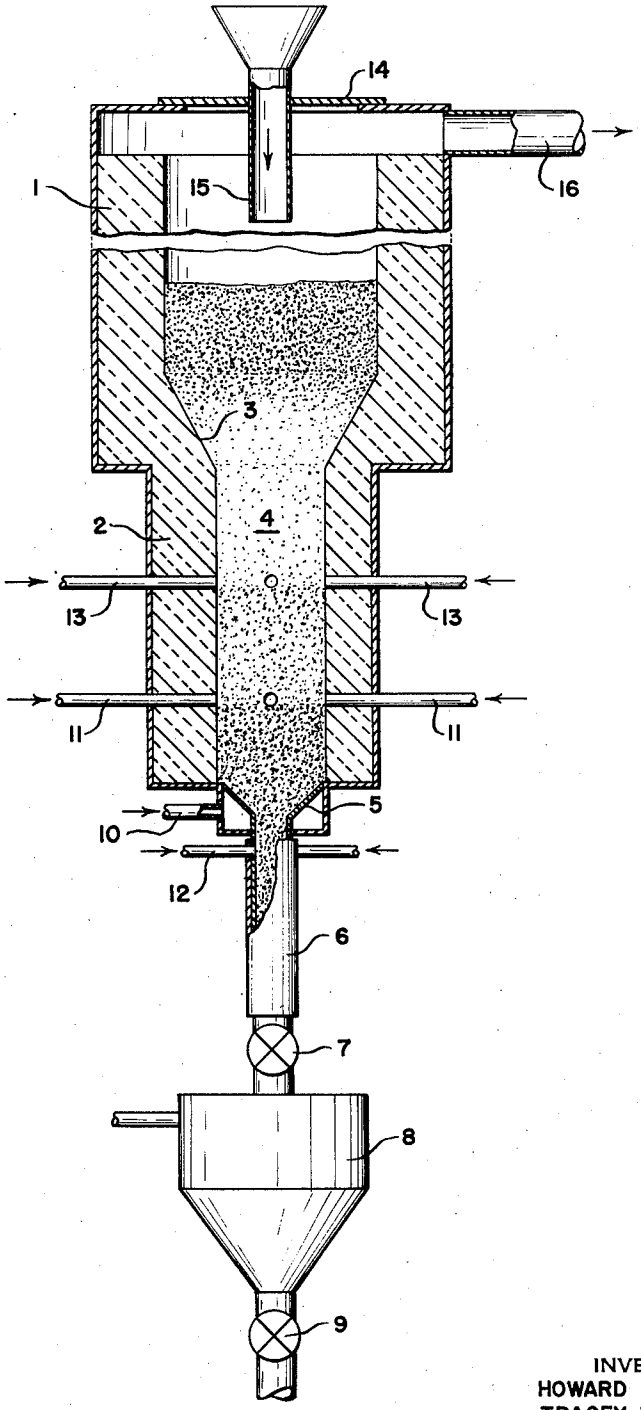
Oct. 7, 1958 H. M. CYR ET AL 2,855,288

METHOD OF FLUID BED ROASTING

Filed Sept. 4, 1956



INVENTOR
HOWARD M. CYR
BY TRACEY F. STEELE

Pennie, Edmonds, Morton, Barrows & Taylor
ATTORNEYS

United States Patent Office 2,855,288 Patented Oct. 7, 1958

2,855,288

METHOD OF FLUID BED ROASTING

Howard M. Cyr and Tracey F. Steele, Palmerton, Pa., assignors to The New Jersey Zinc Company, New York, N. Y., a corporation of New Jersey

Application September 4, 1956, Serial No. 607,833

8 Claims. (Cl. 75—9)

This invention relates to the roasting of zinc sulfide ore concentrates and, more particularly, to the separation of cadmium and lead sulfide components, as well as other indigenous volatile sulfide components, of zinc sulfide ore concentrates in the course of roasting these concentrates in a fluid bed operation.

In United States Letters Patent No. 2,621,118 there is described a method of roasting zinc sulfide ore concentrates in a multi-bed fluid column. Although this method is extremely effective insofar as roasting is concerned, the cadmium and lead components of the ore are largely retained in the roasted product with the result that the cadmium and lead appear as impurities in the final zinc metal product obtained by smelting the roasted ore. However, by using a combination of physical and chemical controls to maintain separate but continguous volatilizing and roasting zones in the upper and lower portions, respectively, of such a fluid column, one of us found that it was possible to obtain at least about 90% elimination of the cadmium and lead components of a zinc sulfide ore concentrate while the ore was being roasted. This expedient was characterized by the fact that less than "theory" air was used for roasting so as to insure an upper fluid bed zone in which substantially non-oxidizing conditions prevailed and further by the fact that the bed temperature was maintained close to and preferably somewhat above 1100° C. The use of less than "theory" roasting air was disadvantageous because it resulted in rather high residual sulfur contents in the calcine, and the use of such high temperature generally required the adoption of sintering-control expedients such as the recirculation of a considerable quantity of the calcine through the column.

In the aforementioned procedure for effecting improved cadmium and lead elimination, the use of less than "theory" roasting air appeared to be essential even though a solid reducing material such as coal was introduced into the upper portion of the column along with the zinc sulfide charge. For example, in three similar runs at about 1090° C., with coal added to the charge to insure sulfide-volatilizing conditions in the upper portion of the fluid column, and in which the only significant variation was the proportion of roasting air, 80% of "theory" air produced 95% elimination of lead and 99% elimination of cadmium from the charge, 90% of "theory" air produced corresponding eliminations of 92% and 98%, respectively, and 105% of "theory" air lowered these eliminations to 53% and 79%, respectively. The sulfide-sulfur contents of the calcines in these three runs were 4.0%, 1.8% and 0.13%, respectively.

We have now discovered that it is possible to operate a fluid column roaster for zinc sulfide ore concentrates so as to obtain a calcine low in residual sulfur while nevertheless achieving the desired elimination of the cadmium and lead sulfide and other sulfide components of the ore. This result is achieved, pursuant to the present invention, by concurrently using a substantial excess over "theory" roasting air and a substantial amount of

fuel gas. The substitution of fuel gas for the solid fuel referred to hereinbefore makes it possible to use an excess of air, so as to obtain effective roasting, while nevertheless consuming the excess air so as to maintain non-oxidizing conditions in the upper portion of the fluid column wherein volatilization of the non-zinciferrous sulfides can take place.

The method of roasting and of separating indigenous cadmium, lead, arsenic, antimony, tin, germanium and mercury sulfide components from a finely-divided zinc sulfide ore concentrate pursuant to the present invention comprises agglomerating the are concentrates into discrete particles ranging in size between 4 and 65 mesh and then charging the agglomerates into the upper portion of the cloumnar fluid bed of the discrete particles maintained in the fluidized condition substantially exclusively by the upward flow of gas. Sulfide-roasting air is introduced into the lower portion of the fluid bed in an amount at least 5% in excess of that theoretically required to combine with the zinc sulfide component of the charge, and fuel gas is introduced into the upper portion of the fluid bed a substantial distance below the upper surface thereof in amount at least sufficient to consume the aforesaid excess of sulfide-roasting air and thus provide an atmosphere in the upper portion of the fluid bed non-oxidizing with respect to the sulfides. The sulfide-roasting air and the fuel gas provide the principal source of the aforementioned fluidizing gas. The fluid bed is maintained at a temperature of at least about 900° C., the roasted zinciferous particles are discharged from the lower end of the fluid bed substantially free of the elements whose sufides were volatilized, and roaster gases containing the sulfides volatilized from the zinc sulfide charge are withdrawn from the upper end of the fluid bed.

The method of the invention is applicable to the treatment of any zinc sulfide ore concentrate containing a significant amount of one or more of the sufides of cadmium, lead, arsenic, antimony, tin, germanium and mercury. These concentrates are generally obtained by crushing the zinc sulfide ore and subsequently separating and collecting the zinc sulfide component of the ore by flotation methods. The resulting concentrate is in very finely divided form and should be agglomerated into aggregates or discrete particles of such size that the particles range between 4 and 65 mesh (Tyler standard). Within this range of particle size, we have obtained particularly satisfactory results with particles falling within the range of 6 to 20 mesh. By agglomerating the ore concentrate to particles of this size range, we find that volatilization of the cadmium and lead and roasting of the zinc sulfide can be effectively achieved with dust losses maintained below 30% and generally within the range of 10 to 20%.

The zinc sulfide ore concentrates in fine form may be agglomerated by any suitable procedure. For example, we have obtained wholly satisfactory results by mixing the fine ore concentrate with 2–3% of bentonite, about 1% sulfite liquor and about 5% water (all percentages being by weight) in a chaser (Chilean) mill for about 20 minutes. The bentonite contributes strength to the resulting pellets at high temperature, and the sulfite liquor improves the strength of the pellets while still "green." The damp mixture was passed through a 6-mesh "Rotex" screen moving in a horizontal plane with a gyratory motion, then onto a conventional disk pelleter. Additional water was sprayed onto the charge on the pelleting disk during this stage. The resulting pellets were dried in an oven and were then sized through 6 mesh, on 20 mesh "Rotex" screen of the type described before. Regardless of whether the discrete particles of the agglomerated zinc sulfide ore concentrate are formed by the aforementioned procedure or by any other conventional type of pelleting

technique, the discrete particles of the agglomerated ore concentrate having the aforementioned size range are amenable to the establishment of contiguous superimposed volatilizing and roasting fluid beds pursuant to the invention.

Roasting air is delivered primarily to the lowermost portion of the fluid column of the charge particles in amount in excess of that theoretically required to combine with the zinc sulfide component of the charge. The excess air is used to obtain complete and prompt elimination of sulfur from the zinc sulfide. As the amount of this excess is diminished, the residual sulfur in the roasted ore tends to increase, but the amount of fuel gas needed to consume the unused air is also diminished. As the excess of air is increased, residual sulfur in the roasted ore tends to decrease and the amount of fuel gas must be increased, resulting in more heat evolution in the sulfide-volatilization zone. The sulfur dioxide emitted from the roaster also becomes more dilute as the amount of excess air is increased. Accordingly, the preferred amount of excess air depends upon the ore used, the size and condition of the pellets, the amount of residual sulfur which can be tolerated in the roasted ore, the temperature of operation and the desired composition of the roaster gases. In general, we have found that the amount of roasting air should be at least about 5% in excess of that theoretically required to combine with the zinc sulfide component of the charge and need not be more than about 50% in excess of this amount. Within this range, we have found it particularly advantageous to use about 15 to 35% excess of roasting air, and even within this range the greater the excess air the lower the residual sulfide and sulfur content of the calcine and the leaner the roaster gases in recoverable sulfur dioxide. Although it is presently preferred to introduce all of this roasting air at a single level or at two vertically spaced levels in the lowermost portion of the fluid column, we have found that slightly lower residual sulfur contents are obtained when about 5 to 10% of the total roasting air is introduced into the calcine discharge line immediately below the bottom of the fluid column. With either of these procedures for adding the roasting air, the simultaneous addition of fuel gas pursuant to the invention insures the maintenance of a non-oxidizing and sulfide-volatilizing zone in the upper portion of the fluid column.

The fuel gas which we have found useful in practicing the invention may be natural gas, cracking refinery gas or manufactured gas, such as producer gas or coal gas. It may also consist exclusively or in part of vaporized fuel oil, obtained by charging fuel oil directly into the fluid column. Accordingly, the term "fuel gas" as used herein and in the claims includes both normally gaseous and normally liquid fuels which are gaseous at the prevailing roasting temperature.

The amount of fuel gas introduced into the fluid column depends upon the amount of roasting air supplied to the column. In every instance, however, the amount of fuel gas must be sufficient to consume in the upper portion of the fluid bed the oxygen of the roasting air unconsumed in the lower portion of the column by the downwardly descending zinc sulfide charge. Such an amount of fuel gas will thus establish in the upper portion of the column a gaseous atmosphere substantially non-oxidizing with respect to the non-zinciferous sulfides and thus permit these sulfides to be volatilized as such. However, in order to insure the maintenance of the aforementioned non-oxidizing conditions in the sulfide-volatilizing portion of the column, we presently prefer to use a slight excess of fuel gas but less than that which will significantly reduce the sulfur dioxide in the exit roaster gases.

The fuel gas is introduced into the fluid column a substantial distance below the upper surface thereof, the magnitude of this distance varying according to the geometry of the roasting vessel, but in any event it should be sufficient to permit the fuel gas to combine with the oxygen in the excess air rising into the upper portion of the charge. The depth of the resulting non-oxidizing zone in the upper portion of the fluid column determines the retention period of the sulfide charge under the high-temperature volatilizing conditions prevailing therein.

The temperature prevailing in the fluid column is largely determined by the rate at which the sulfide charge is delivered to the vessel. The charge rate should be correlated with the amount of air and fuel gas supplied to the column so as to maintain a bed temperature of about 900° to 1100° C., and preferably about 1050°–1075° C. Temperatures of at least 900° C. appear to be sufficient to obtain adequate elimination of certain of the aforementioned sulfides, provided that a relatively long column of charge is established so as to maintain a relatively long retention period for the charge in the roasting furnace. With shorter columns, a minimum roasting temperature of about 1000° C. is required. At the other extreme, temperatures in excess of about 1100° C. (i. e. as high as 1125° C.) promote sintering problems in the bed and high dust losses. We have observed that an operating temperature of about 1050°–1075° C. is effective, pursuant to the invention, in eliminating over 90% of the cadmium and lead sulfides, and similar eliminations of the other non-zinciferous sulfides, in the charge without introducing any serious danger of sintering of the charge. However, charge sintering can be further guarded against, particularly in large cross-section fluid columns where excess heat is generated, by immersing water coolers in the bed or by recirculating through the fluid column some of the calcine discharged from the bottom of the column, or by a combination of these expedients. The amount of recirculated calcine useful for this control over the bed temperature and sintering tendencies is generally within the range of 10 to 25% by weight of the charge of zinc sulfide ore concentrate.

Apparatus suitable for practicing the method of the invention is shown in the single figure of the drawing which is a cross-sectional elevation of the roasting vessel. This vessel comprises a two-section cylindrical vessel, the upper section **1** having an internal diameter substantially greater than the lower section **2** and the two sections being joined by a conical intermediate section **3**. The roasting vessel is adapted to contain a column **4** of fluidized charge of the aforementioned discrete particles in the lower section **2** thereof with this charge extending upwardly into at least the lower portion of the upper section **1** of the vessel. The bottom of the lower section **2** of the vessel is advantageously provided with a conically shaped blow box **5** which communicates with a downwardly extending discharge pipe **6**. The lower end of the discharge pipe **6** is provided with a discharge valve **7** which delivers the roasted material into the top of a closed discharge hopper **8**. The roasted material which accumulates in the hopper is discharged through a valve outlet **9**. A main air inlet **10** is provided in the lowermost portion of the treating vessel, preferably beneath the conical blow box **5**. Auxiliary air inlets are also advantageously provided, one of these inlets **11** being positioned a short distance above the main air inlet and the other auxiliary inlet **12** being positioned below the main inlet near the upper end of the discharge pipe **6**. A fuel gas inlet **13** is provided in the upper portion of the lower section **2** of the roasting vessel substantially below the desired level of the upper surface of the fluid column. The uppermost end of the treating vessel is closed with a cover plate **14** through which there depends a charge inlet **15** and below which there is also provided a roaster gas outlet **16**.

The practice of the invention is illustrated by the following specific operation. Paragsha zinc sulfide concentrates were used as the charge material and contained 46.7% zinc, 32.0% sulfur, 2.1% lead, 0.16%

cadmium, 12.6% iron and 0.12% copper. The concentrates, which were about 80% minus 325 mesh (Tyler standard), were mixed with about 2% of bentonite, 1% of sulfite liquor and about 5% of water, all percentages being by weight. The mixture was compacted in a chaser mill for about 20 minutes, and the resulting damp mixture was passed through a 6-mesh gyratory screen, thence into a conventional disk pelleter. Additional water was sprayed onto the charge on the disk pelleter, the resulting pellets were dried in a tray-like oven, and the dry pellets were finally sized to a range of through 6 and on 20 mesh on the aforementioned "Rotex" gyratory screen.

The roasting was carried out in a furnace such as that shown in the drawing. The lower cylindrical section **2** of the furnace had an internal diameter of 1 foot and a height of about 3½ feet. The conical section **3** of the furnace interconnecting the lower cylindrical section with the upper cylindrical section was 11 inches high. The enlarged upper cylindrical section of the furnace had an internal diameter of two feet and a height of about 7 feet. The furnace was charged through the inlet **15** with the pellets obtained as described hereinbefore, and the roasted pellets (calcine) passed through the conically shaped blow box **5** at the bottom of the furnace and into the calcine discharge pipe **6**. The discharge pipe **6** and the closed discharge hopper **8** effectively sealed off the bottom of the vessel so that the amount of roasting air could be carefully measured and controlled. Roasting air was delivered through the main inlet **10** immediately below the conical blow box **5** and through the auxiliary inlet **11**, and this air supply effected fluidization of the charge in the furnace. Bottled butane gas was introduced into the furnace through the inlet **13** positioned about 30 inches below the upper surface of the fluidized bed. Roaster gases were removed through the outlet **16**, and the cadmium and lead sulfides volatilized from the charge were separated from the roaster gases. A portion of the roasted charge (the calcine) was recirculated by introducing it into the furnace through the charge inlet **15** along with the sulfide charge.

The specific operating data for this roasting operation are given in the following Table I:

Table I

Run	A
Duration (Hrs.)	26
Feed, Lb./Hr.:	
Ore	200
Calcine	24
Air Total:	
Cu. Ft./Min.	135
Percent of Theory	134
Temp. (° C.)	1,075
Product:	
Total S, Percent	0.73
S/S, Percent	0.58
Pb, Percent	0.22
Cd, Percent	.006
Elimination:	
Pb, Percent	91
Cd, Percent	97

The high elimination of lead and cadmium by the method of our invention is clearly apparent from Table I. Moreover, the sulfur removal from the charge is also high, the ratio of "S/S" (sulfide-sulfur) to "Total S" (total sulfur) indicates that there was very little sulfate formation during the roasting operation.

In another run which differed from Run A essentially only in that the roasting air was delivered through the main air inlet **10** and through the auxiliary air inlet **12** below the blow box **5**, a still higher cadmium and lead elimination was achieved without significant effect upon the sulfur elimination. The pertinent data for this operation are shown in Table II:

Table II

Run	B
Duration (Hrs.)	8
Feed, Lb./Hr.:	
Ore	200
Calcine	52
Air Total:	
Cu. Ft./Min.	135
Percent of Theory	134
Temp. (° C.)	1,075
Product:	
Total S, Percent	0.86
S/S, Percent	0.73
Pb, Percent	0.02
Cd, Percent	0.005
Elimination:	
Pb, Percent	99
Cd, Percent	98

In still another run pursuant to our invention, the operating conditions reported for run A were maintained except that a small proportion of the total roasting air was blown into the discharge hopper **8** so that it could ascend the calcine discharge pipe **6**. The result of this variation is indicated in Table III, the run being carried out at a period when the sulfide-sulfur content of the roasted ore averaged 0.70%:

Table III

Amount of air to bottom of calcine discharge pipe, cu.ft/min.	Sulfide-sulfur in calcine, percent
0	0.70
2	0.68
5	0.63
10	0.55

The cadmium and lead eliminations during the variation in air distribution reported in Table III remained substantially the same as in run A (Table I).

The method of our invention is applicable to the removal from the zinc sulfide ore of any of the volatile sulfides indigenous to the ore. It will be readily appreciated that not all zinc sulfide ores will contain significant amounts of cadmium, lead, arsenic, antimony, tin, germanium and mercury sulfides, but any of these sulfides present in the ore will be largely removed from the zinc sulfide charge in the upper portion of the fluid column in the practice of the invention. The thus-volatilized non-zinciferous sulfides are readily recoverable from the exit roaster gases by conventional procedures.

We claim:

1. The method of separating indigenous cadmium, lead, arsenic, antimony, tin, germanium and mercury sulfide components from a finely-divided zinc sulfide ore concentrate in a fluid bed roasting operation which comprises agglomerating the ore concentrate into discrete particles ranging in size between 4 and 65 mesh, charging the agglomerates to the upper portion of a columnar fluid bed of the discrete particles maintained in the fluidized condition substantially exclusively by the upward flow of gas, introducing sulfide-roasting air into the lower portion of the fluid bed in amount at least 5% in excess of that theoretically required to combine with the zinc sulfide component of the charge, introducing into the upper portion of the fluid bed but a substantial distance below the upper surface thereof an amount of fuel gas at least sufficient to consume said excess of sulfide-roasting air and thus provide an atmosphere in the upper portion of the fluid bed non-oxidizing with respect to the sulfides, the sulfide-roasting air and the fuel gas providing the principal source of said fluidizing gas, maintaining the fluid bed at a temperature of at least about 900° C., discharging roasted zinciferous particles from the lower end of the fluid bed and withdrawing from the upper end of the fluid bed roaster gases containing the sulfides volatilized from the zinc sulfide charge.

2. The method of separating indigenous cadmium,

lead, arsenic, antimony, tin, germanium and mercury sulfide components from a finely-divided zinc sulfide ore concentrate in a fluid bed roasting operation which comprises agglomerating the ore concentrate into discrete particles ranging in size between 4 and 65 mesh, charging the agglomerates to the upper portion of a columnar fluid bed of the discrete particles maintained in the fluidized condition substantially exclusively by the upward flow of gas, introducing sulfide-roasting air into the lower portion of the fluid bed in amount about 15 to 35% in excess of that theoretically required to combine with the zinc sulfide component of the charge, introducing into the upper portion of the fluid bed but a substantial distance below the upper surface thereof an amount of fuel gas at least sufficient to consume said excess of sulfide-roasting air and thus provide an atmosphere in the upper portion of the fluid bed non-oxidizing with respect to the sulfides, the sulfide-roasting air and the fuel gas providing the principal source of said fluidizing gas, maintaining the fluid bed at a temperature of at least about 900° C., discharging roasted zinciferous particles from the lower end of the fluid bed and withdrawing from the upper end of the fluid bed roaster gases containing the sulfides volatilized from the zinc sulfide charge.

3. The method of separating indigenous cadmium, lead, arsenic, antimony, tin, germanium and mercury sulfide components from a finely-divided zinc sulfide ore concentrate in a fluid bed roasting operation which comprises agglomerating the ore concentrate into discrete particles ranging in size between 4 and 65 mesh, charging the agglomerates to the upper portion of a columnar fluid bed of the discrete particles maintained in the fluidized condition substantially exclusively by the upward flow of gas, introducing sulfide-roasting air into the lower portion of the fluid bed in amount at least 5% in excess of that theoretically required to combine with the zinc sulfide component of the charge, introducing into the upper portion of the fluid bed but a substantial distance below the upper surface thereof an amount of butane gas at least sufficient to consume said excess of sulfide-roasting air and thus provide an atmosphere in the upper portion of the fluid bed non-oxidizing with respect to the sulfides, the sulfide-roasting air and the fuel gas providing the principal source of said fluidizing gas, maintaining the fluid bed at a temperature of at least about 900° C., discharging roasted zinciferous particles from the lower end of the fluid bed and withdrawing from the upper end of the fluid bed roaster gases containing the sulfides volatilized from the zinc sulfide charge.

4. The method of separating indigenous cadmium, lead, arsenic, antimony, tin, germanium and mercury sulfide components from a finely-divided zinc sulfide ore concentrate in a fluid bed roasting operation which comprises agglomerating the ore concentrate into discrete particles ranging in size between 4 and 65 mesh, charging the agglomerates to the upper portion of a columnar fluid bed of the discrete particles maintained in the fluidized condition substantially exclusively by the upward flow of gas, introducing sulfide-roasting air into the lower portion of the fluid bed in amount at least 5% in excess of that theoretically required to combine with the zinc sulfide component of the charge, introducing into the upper portion of the fluid bed but a substantial distance below the upper surface thereof an amount of fuel oil which when vaporized within the column provides an amount of fuel gas at least sufficient to consume said excess of sulfide-roasting air and thus provide an atmosphere in the upper portion of the fluid bed non-oxidizing with respect to the sulfides, the sulfide-roasting air and the fuel gas providing the principal source of said fluidizing gas, maintaining the fluid bed at a temperature of at least about 900° C., discharging roasted zinciferous particles from the lower end of the fluid bed and withdrawing from the upper end of the fluid bed roaster gases containing the sulfides volatilized from the zinc sulfide charge.

5. The method of separating indigenous cadmium, lead, arsenic, antimony, tin, germanium and mercury sulfide components from a finely-divided zinc sulfide ore concentrate in a fluid bed roasting operation which comprises agglomerating the ore concentrate into discrete particles ranging in size between 4 and 65 mesh, charging the agglomerates to the upper portion of a columnar fluid bed of the discrete particles maintained in the fluidized condition substantially exclusively by the upward flow of gas, introducing sulfide-roasting air into the lower portion of the fluid bed in amount at least 5% in excess of that theoretically required to combine with the zinc sulfide component of the charge, introducing into the upper portion of the fluid bed but a substantial distance below the upper surface thereof an amount of fuel gas at least sufficient to consume said excess of sulfide-roasting air and thus provide an atmosphere in the upper portion of the fluid bed non-oxidizing with respect to the sulfides, the sulfide-roasting air and the fuel gas providing the principal source of said fluidizing gas, maintaining the fluid bed at a temperature of about 1050°–1075° C., discharging roasted zinciferous particles from the lower end of the fluid bed and withdrawing from the upper end of the fluid bed roaster gases containing the sulfides volatilized from the zinc sulfide charge.

6. The method of separating indigenous cadmium, lead, arsenic, antimony, tin, germanium and mercury sulfide components from a finely-divided zinc sulfide ore concentrate in a fluid bed roasting operation which comprises agglomerating the ore concentrate into discrete particles ranging in size between 4 and 65 mesh, charging the agglomerates to the upper portion of a columnar fluid bed of the discrete particles maintained in the fluidized condition substantially exclusively by the upward flow of gas, introducing sulfide-roasting air into the lower portion of the fluid bed in amount at least 5% in excess of that theoretically required to combine with the zinc sulfide component of the charge, introducing into the upper portion of the fluid bed but a substantial distance below the upper surface thereof an amount of fuel gas at least sufficient to consume said excess of sulfide-roasting air and thus provide an atmosphere in the upper portion of the fluid bed non-oxidizing with respect to the sulfides, the sulfide-roasting air and the fuel gas providing the principal source of said fluidizing gas, maintaining the fluid bed at a temperature of at least about 900° C., discharging roasted zinciferous particles from the lower end of the fluid bed through a confined path to an exit valve, introducing a minor portion of said roasting air into the path of the roasted particles in said confined path, and withdrawing from the upper end of the fluid bed roaster gases containing the sulfides volatilized from the zinc sulfide charge.

7. The method of separating indigenous cadmium, lead, arsenic, antimony, tin, germanium and mercury sulfide components from a finely-divided zinc sulfide ore concentrate in a fluid bed roasting operation which comprises agglomerating the ore concentrate into discrete particles ranging in size between 4 and 65 mesh, charging the agglomerates to the upper portion of a columnar fluid bed of the discrete particles maintained in the fluidized condition substantially exclusively by the upward flow of gas, introducing sulfide-roasting air into the lower portion of the fluid bed in amount at least 5% in excess of that theoretically required to combine with the zinc sulfide component of the charge, introducing into the upper portion of the fluid bed but a substantial distance below the upper surface thereof an amount of fuel gas at least sufficient to consume said excess of sulfide-roasting air and thus provide an atmosphere in the upper portion of the fluid bed non-oxidizing with respect to the sulfides, the sulfide-roasting air and the fuel gas providing the prin-

cipal source of said fluidizing gas, maintaining the fluid bed at a temperature of at least about 900° C., discharging roasted zinciferous particles from the lower end of the fluid bed, withdrawing from the upper end of the fluid bed roaster gases containing the sulfides volatilized from the zinc sulfide charge, and separating from the withdrawn roaster gases the cadmium and lead sulfides volatilized from the zinc sulfide charge in the upper portion of the fluid column.

8. The method of separating indigenous cadmium, lead, arsenic, antimony, tin, germanium and mercury sulfide components from a finely-divided zinc sulfide ore concentrate in a fluid bed roasting operation which comprises agglomerating the ore concentrate into discrete particles ranging in size between 6 to 20 mesh, charging the agglomerates to the upper portion of a columnar fluid bed of the discrete particles maintained in the fluidized condition substantially exclusively by the upward flow of gas, introducing sulfide-roasting air into the lower portion of the fluid bed in amount at least 5% in excess of that theoretically required to combine with the zinc sulfide component of the charge, introducing into the upper portion of the fluid bed out a substantial distance below the upper surface thereof an amount of fuel gas at least sufficient to consume said excess of sulfide-roasting air and thus provide an atmosphere in the upper portion of the fluid bed non-oxidizing with respect to the sulfides, the sulfide-roasting air and the fuel gas providing the principal source of said fluidizing gas, maintaining the fluid bed at a temperature of at least about 900° C., discharging roasted zinciferous particles from the lower end of the fluid bed and withdrawing from the upper end of the fluid bed roaster gases containing the sulfides volatilized from the zinc sulfide charge.

References Cited in the file of this patent

UNITED STATES PATENTS

303,456	Rae	Aug. 12, 1884
414,051	Hutchinson	Oct. 29, 1889
2,596,580	McKay et al.	May 13, 1952
2,621,118	Cyr et al.	Dec. 9, 1952
2,650,159	Tarr et al.	Aug. 25, 1953
2,789,034	Swaine et al.	Apr. 16, 1957