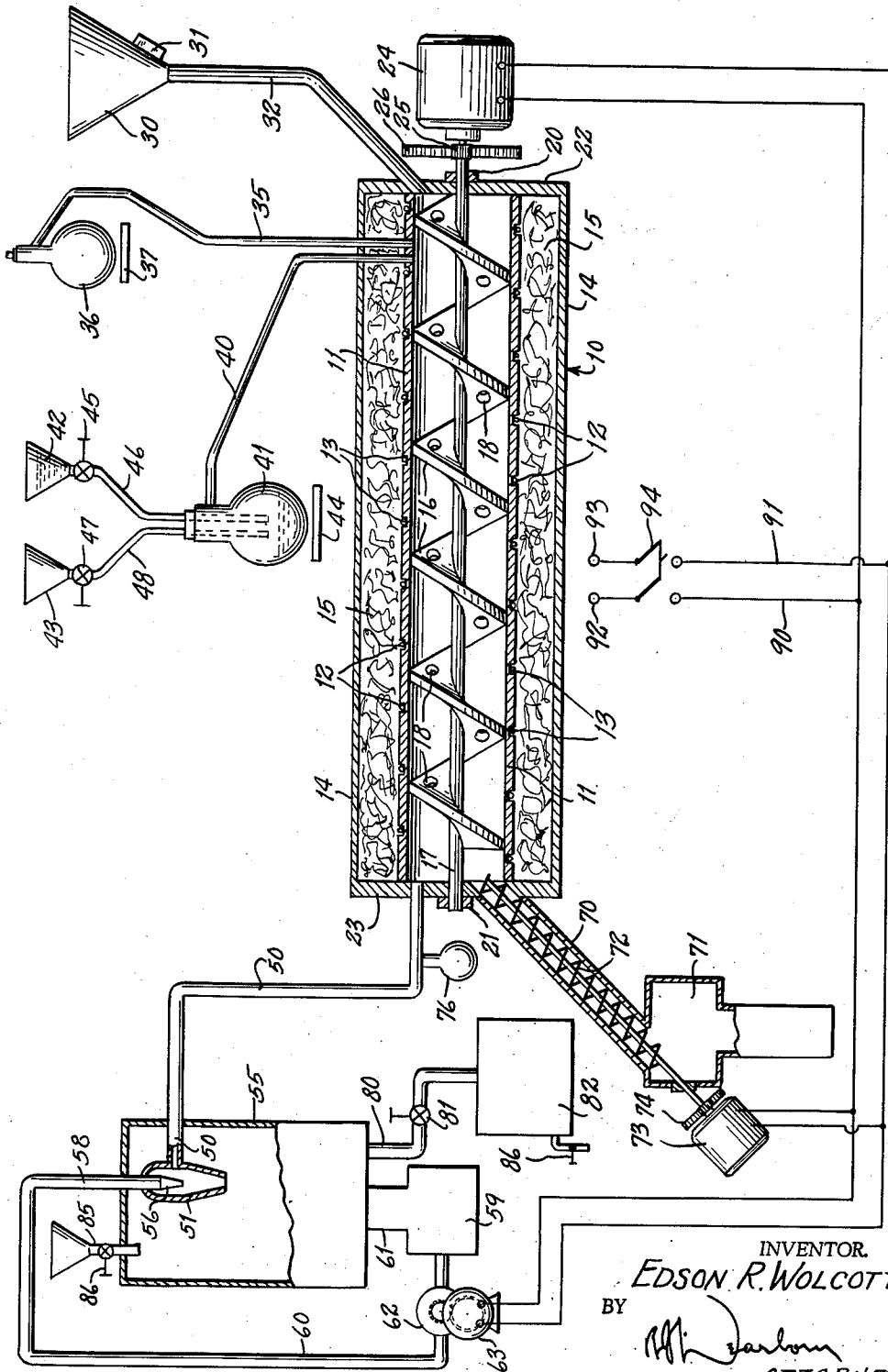


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APPARATUS FOR THE SEPARATION OF PLATINUM
AND GOLD BY VOLATILIZATION
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3,159,703 APPARATUS FOR THE SEPARATION OF PLATINUM AND GOLD BY VOLATILIZATION

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1 Claim. (Cl. 266-19)

In my copending application, Serial No. 858,208, filed Dec. 8, 1959, now matured into Patent No. 3,049,422, issued Aug. 14, 1962, of which this application is a continuation-in-part, I have disclosed my new and useful process for the separation of platinum and gold from finely divided ores and sands by volatilization, and my present invention pertains primarily to apparatus adapted for efficiently and continuously carrying out my aforesaid process.

The use of this new apparatus is not restricted to the carrying out of the process above indicated and may have other uses as well.

The apparatus and its advantages will be more fully understood and appreciated by referring to the accompanying drawings and the following detailed description.

The single figure of the drawings is a partially diagrammatic elevation of apparatus embodying this invention, in which the furnace is shown in sectional elevation, and the tank where the vapors containing the platinum and gold compounds are condensed is broken away to show the jet pump and other internal connections.

Referring to the drawings, the apparatus shown is composed of a tubular furnace 10 which is set in a substantially horizontal position and is cylindrical in form. It is composed of an inner tubular retort 11 which is preferably formed of clay or other ceramic material and has a helical groove 12 on its outer surface in which an electrical heating element 13 is wound. An outer metal furnace shell 14 of substantially larger diameter surrounds the retort, and the space between the furnace shell and the retort is filled with insulation, as shown at 15.

Within the retort 11 and extending axially through it is an auger feed 16 which is helical in form and is rotatably mounted in bearings 20, 21 on a central axis 17 which is coaxial with the retort 11. The bearings 20, 21 are mounted in end plates 22, 23 of the furnace. The auger 16 is rotated by motor 24 which includes suitable reduction gears 25 and 26 to turn the auger very slowly, for example at the rate of 10 revolutions per minute. The ore to be treated is contained in a hopper 30 which may be provided with a vibrating mechanism 31 to insure that the finely divided ore or sand flows freely from the hopper 30 downwardly through the feed pipe 32 into the inlet end of retort 11. The feed pipe extends through the end plate 22, as shown in the drawings. The ore is then advanced slowly through the retort by the auger feed 16. The auger feed may fit loosely in the retort 11 or may have holes 18 so that gas and vapors may pass through the retort but come in contact with the ore.

Steam is preferably introduced into the retort near the inlet end through a pipe 35 from a glass container or boiler 36 which is heated by electric heater 37. The introduction of steam is not an essential feature of the process and may be omitted.

Chemical in vapor form is fed through pipe 40 to the inlet end of the retort 11 from a glass container 41 which contains hydrochloric acid (HCl), which is fed at a predetermined rate from funnel 42 through control valve 45 and pipe 46, in liquid form. A predetermined amount of nitric acid (HNO₃) is also fed to the glass container 41 from funnel 43 through control valve 47 and pipe 48, in liquid form. The rate at which the two acids are fed to the glass container 41 is determined by the proportion

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of the desired acids which are united in the container 41 to form aqua regia, the usual proportion being three parts of hydrochloric acid to one part of nitric acid. The glass is warmed by an electric heater 44 and the vapors, produced by warming the acid mixture, which consist of nitrosyl chloride and chlorine flow through the retort 11 and are brought into intimate contact with the finely divided ore being advanced through the retort by the auger feed 16. As the ore is being treated, as above indicated, heat is applied to the ore from the retort 11 by the electric heater 13 which surrounds the retort, and I prefer to use a temperature as applied to the ore of about 400° F. I have found that utilizing an ore or sands ground to about 20 mesh gives satisfactory results in the process.

The ores to be treated contain small percentages of platinum and gold compounds, and the nitrosyl chloride plus chlorine vapors coming in contact with the ore under the heated conditions existing in the retort 11 volatilize out the platinum and gold by forming volatile compounds therewith. The vapors of these volatile compounds then flow outwardly through pipe 50 and are drawn there-through by a jet pump 51 into the receiving tank 55. The jet pump comprises a venturi nozzle 56 and the inlet pipe 50 through which the platinum compound vapors are drawn. A KOH or other suitable caustic solution is maintained in a container 59 and is forced through pipe 60 into the pipe 58 and through venturi nozzle 56 by a pump 62 operated by a motor 63. The container 59 is connected to the bottom of the tank 55 by pipe 61 and the solution contacts the gold and platinum vapors at the jet pump and absorbs them. It is recirculated through the container 59 and the pipes 60 and 58 and is consequently concentrated in the tank 55. As the gases mix with the KOH solution in the jet pump 51, the platinum is precipitated. Any gold which comes over in the vapors is held in solution and is precipitated separately at a later time.

The venturi nozzle through which the KOH solution flows produces a vacuum up to several inches of water and therefore draws the vaporous product from the retort.

The ore from which the platinum and gold have thus been separated by vaporization is discharged at the outlet end of the retort through pipe 70 and is accumulated in a container 71 which is adapted to receive the tailings. The tailings are broken up, if caked, and are forced through the pipe 70 by an auger feed 72 driven slowly by motor 73 and reduction gears 74.

The operation is as follows:

Finely divided particles of ore or sand are introduced into the hopper 30 which is vibrated by vibrator 31 so that they pass freely down through pipe 32 and enter the inlet end of the retort 11 and are carried gradually forward through the retort from the inlet end by the auger feed 16. At the same time nitrosyl chloride and chlorine are introduced through pipe 40 and preferably steam is introduced through pipe 35 into the retort at the inlet end and are mixed with the finely divided ore, the auger feed acting as a mixing device as well as a means of feeding the ore forward.

The nitrosyl chloride plus chlorine volatilizes any platinum, platinum compounds or gold which are contained in the ore. These vapors pass outwardly through pipe 50 and after being mixed with caustic in tank 55 are recirculated through pipe 58 into the tank 55 by the jet pump 51, as hereinbefore explained.

A trap 76 of glass or other transparent material is connected to the pipe 50 so that the operator may make a visual observation of the vapors passing through the pipe 50.

A caustic solution, preferably KOH, is placed in the tank 59 and by reason of the pump 62 is circulated from

the tank 59 through pipes 60 and 58 and is then discharged downwardly through the venturi nozzle 56 of the jet pump 51. The pipe 50 enters the jet pump so that the stream of caustic will draw the vapors into the tank 55 and at the same time mix the vapors thoroughly with the caustic.

When the vapors contact the caustic solution, platinum is precipitated and may be removed at the end of the run or continuously by drawing off from tank 55 through outlet pipe 80, control valve 81 and into container 82. The precipitate solution may be withdrawn from container 82 through valve 86.

The tailings of the ore, from which the platinum and gold have been removed by volatilization, may contain iron oxide or other compounds which remain in solid condition, because the temperature of the retort is not sufficiently high to break them down, and moreover they do not tend to form volatile chlorine compounds because of the strong oxidizing effect of the nitrosyl chloride.

To avoid the KOH solution in tank 55 becoming saturated, I prefer to add a predetermined quantity of fresh KOH continuously through feed inlet pipe 85 and control valve 86 and to continuously withdraw the spent solution and precipitate from the outlet pipe 80.

The ore tailings, from which the platinum and gold have been extracted by volatilization flow downwardly, being advanced by auger feed 72, through pipe 70 into the tailings receiver 71.

It is important to regulate the rate at which the hydrochloric acid is supplied through pipe 42 into glass 41 with reference to the rate at which the nitric acid is added to pipe 43. The preferred ratio of the mixture is three parts of hydrochloric acid to one part of nitric acid. The glass container 41 is warmed by the heater 44 so that the aqua regia is vaporized into nitrosyl chloride and chlorine.

The motors 24, 63 and 73 are preferably connected to the same power circuit 90, 91 from any suitable source 92, 93 through a double knife switch 94. Thus when the switch is closed, all three motors operate concurrently and continue during the operation of the process which is substantially continuous. When necessary or desirable to stop the operation, the switch 94 is opened and all three motors stop.

The arrangement of the apparatus illustrated and above

described constitutes the best embodiment of my invention now known to me, but other embodiments may be made without departing from the invention. Consequently, only such limitations should be imposed as are indicated in the appended claim.

I claim:

Apparatus for the separation of platinum from finely divided ores or sands containing the same that comprises a horizontal ceramic tube constituting a retort, means for supplying heat at moderate temperature to said ceramic tube, an outer metal tube of larger diameter, insulating material around the ceramic tube within the outer metal tube, a helical auger centered within the ceramic tube, means for continuously supplying finely divided ore or sand to the inlet end of the ceramic tube, means for slowly rotating the helical auger to feed the ore or sand through the tube and agitate it therein, means for passing a mixture of nitrosyl chloride and chlorine vapors through the ceramic tube concurrently with and in contact with the ore, a vapor off-take near the top of the outer end of the ceramic tube, a solid off-take near the bottom of the outer end of the ceramic tube, a precipitation tank connected to the vapor off-take, a KOH tank connected to the precipitation tank at the bottom, a return pipe connected from the KOH tank to the precipitation tank and extending into said tank at the top, means for circulating the KOH through the return pipe, and a jet pump connected to receive vapor from the vapor off-take and actuated by the KOH circulated through the return pipe.

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