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L. E. PORTER.

APPARATUS FOR EXTRACTING PRECIOUS METALS FROM ORES.

(Application filed Aug. 18, 1896.)

(No Model.)

Fig:1

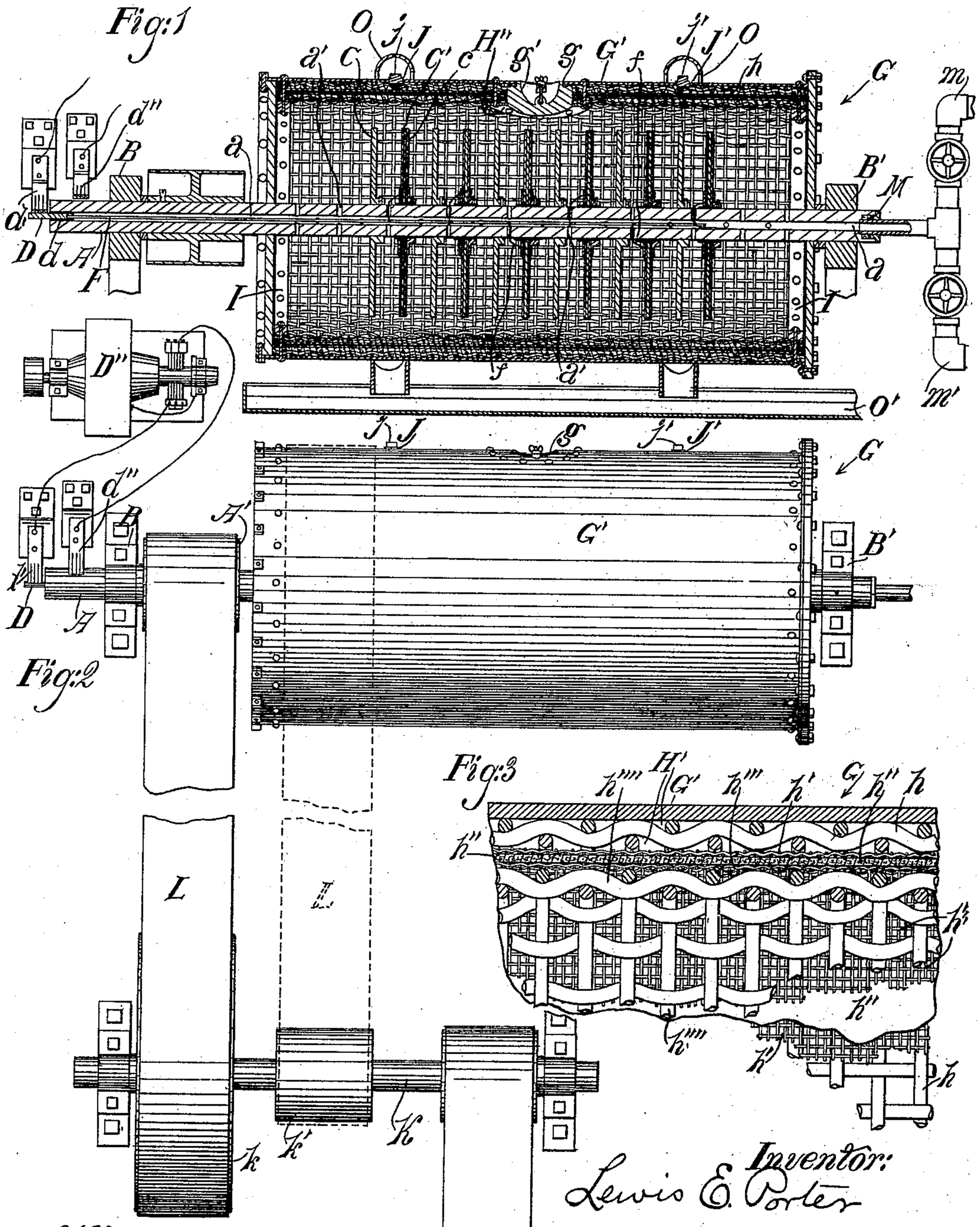

Fig:2

Fig:3

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR EXTRACTING PRECIOUS METALS FROM ORES.

SPECIFICATION forming part of Letters Patent No. 617,512, dated January 10, 1899.

Application filed August 18, 1896. Serial No. 603,129. (No model.)

To all whom it may concern:

Be it known that I, LEWIS E. PORTER, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Apparatus for Extracting Precious Metals from Ores, of which the following is a specification.

My invention relates particularly to those apparatus in which the precious metals are dissolved from ores by means of chemical solutions and electrical action.

One object of my invention is to provide means for expeditiously and conveniently treating large quantities of ore with a slight expenditure of labor, material, and electrical energy and to extract from the ore a high percentage of the precious metals carried thereby.

One especial object of my invention is to provide means whereby the pulp may be electrically treated while undergoing chemical action without polarizing the electrodes.

Another object of my invention is to provide means for preventing the escape of the gases produced during the process of treatment and to so conduct the treatment that such gases will produce a pressure and by agitation will be brought into intimate contact and admixture with every particle of the ore being treated, the generation of such gases and the liberation of the precious metals from the ore being produced and assisted by the passage of a current of electricity through the pulp during the chemical treatment.

Another object of my invention is to provide improved means whereby the agitator serves as a filter for extracting from the slimes practically all of the precious-metal solutions after the chemical action has been completed.

Incidentally my improved filter may be utilized in separating any liquid from solid matter.

My invention comprises the various features of construction and combinations of parts hereinafter fully set forth and claimed.

The accompanying drawings illustrate means whereby my invention may be practiced.

Figure 1 is a vertical longitudinal mid-section of my improved combined agitator and filter. Fig. 2 is a plan view of a plant whereby my invention may be practiced. Fig. 3 is an enlarged fragmental section of the casing and filter.

In the drawings, A represents a shaft which is journaled in suitable journal-bearings B B′ and is provided with a longitudinal bore *a*, which, as shown, extends from end to end of the shaft. Upon this shaft I mount a series of anodes C, which are electrically connected with the shaft. Alternating between these anodes I arrange a series of cathodes C′, which are insulated from the shaft in the ordinary manner. The cathodes which I have employed in practice are of sheet metal, and I have found it advisable to cover them with canvas *c* or other porous fibrous material in order to prevent the metal deposited thereupon from being scoured off by the action of the pulp during agitation. The anodes are preferably insoluble, and in practice I have used carbon anodes with great success.

Into one end of the bore *a* of the shaft I drive a metal plug D, and between the plug and the shaft I arrange a collar of insulating material *d*, so that the plug is insulated from the shaft. Secured to the end of the plug is an electrical conductor F, which is insulated and leads from thence partially through the bore of the shaft. Wires *f* lead out through openings *a′* through the shaft and are electrically connected with the cathodes, so that by means of the commutator-brush *d′* electrical connection is made with the dynamo D″. The anodes C being electrically connected with the shaft A, when the commutator-brush *d″* rests upon the shaft and the dynamo D″ is operated the anodes are electrized. Secured upon this shaft A and surrounding the anodes and cathodes I provide a combined agitator-barrel and filter G. This consists of an outer imperforate casing G′, made of any suitable metal or material, and a lining H, of suitable filtering material, introduced inside of the casing and arranged to leave a space H′ between the filter and the barrel, through which the filtered liquid may flow to the outlets J J′. In practice I find it convenient and effective to introduce first a screen *h*, made of coarse wire, preferably one-

fourth of an inch in diameter. Upon this screen I introduce a second screen h', which is of finer mesh than the other. Upon this finer screen I place any suitable filtering material h''—such as woolen blanket, burlap, or asbestos filtering-cloth—as may be found suitable or desirable. Upon this filtering material I place a fine-mesh screen h''' to hold the filtering material in place, and upon the inside of this fine screen I arrange another screen h'''', of coarse wire, to receive the wear of the material being agitated. I have found this to be practically the most efficient and satisfactory manner in which the filtering-lining can be arranged within the barrel. It is absolutely essential that the filtering-lining be supported a sufficient distance from the walls of the barrel to allow the filtered liquor ready escape between the filtering-lining and the walls of the barrel to the discharge-opening. When the barrel with its contained load of pulp is revolved at a high rate of speed, an enormous pressure is thus brought to bear against the filtering-lining, and were it not firmly supported it would be forced so tightly against the walls of the barrel as to prevent the escape of any liquor whatever through the filter. The same end might be secured by roughening the inner face of the barrel; but this would be more expensive, and I do not believe would be so effective in practical operation. The electrodes, especially the anodes, are attached to the shaft so that they revolve with the barrel, and while the pulp is being agitated the barrel is being revolved at a slow rate of speed, the pulp not revolving with the same speed as the barrel, and therefore the pulp scours against the electrodes, keeping them from polarizing.

At each end of the barrel an iron ring I is arranged to clamp the screen and the filtering material tightly against the wall of the barrel, so as to prevent any of the pulp from gaining access to the space H′ between the barrel and the filtering material without first passing through the filter. Near the mid-length of the drum I provide an opening g, which is closed by means of a removable plug g', which is similar to an ordinary hand-hole plug for boilers, but is convex upon its inner face, so that when the pulp is being filtered the liquid will readily flow off of the plug to the filter. A ring H″ is arranged surrounding the opening through the screens, and in order to prevent the unfiltered pulp from flowing from such opening into the space H′ the ring is tightly bolted to the walls of the casing in order to firmly clamp the filtering material to the casing. I provide two discharge-openings J and J′, which open through the walls of the casing into the space H′ between the filtering material and the walls of the barrel—that is to say, the coarse screen h holds the filtering material a sufficient distance away from the walls of the barrel to leave enough space to allow the liquid to flow readily from all portions of the barrel toward the discharge-openings. These discharge-openings J J′ are closed by means of removable plugs $j\,j'$. A suitable housing O is arranged to receive the liquor discharged from the openings J J′ and to conduct it to a suitable receptacle (not shown) arranged to receive it.

K represents the line-shaft, upon which are mounted two driving-pulleys k and k'. The larger pulley k is of a diameter equal to the diameter of the barrel G. Upon the shaft A I secure a driven pulley A′, which is of the same diameter as the pulley k.′ Thus when the drum is to be rotated slowly the belt L is arranged upon the pulley k' and the drum G, as indicated in dotted lines in Fig. 2, and when greater speed is required the belt is shifted to the pulleys A′ and k. At the end of the shaft opposite the plug D, I arrange a water and steam tight packing M, so that by means of the water and steam pipes $m\ m'$ water or steam may be supplied to the bore a of the shaft and discharged into the barrel through openings a''.

In practical operation the pulp or material to be treated is saturated with a suitable solution and placed in the barrel by removing the plug g' and introducing the material through the opening g.

The chemical solution which I employ in treating all ordinary ores consists of about the following proportions: water; common salt, enough to give suitable conductivity, ordinarily from one-quarter to three per cent.; cyanid of potassium, one-quarter of one per cent., and caustic soda, enough to neutralize the acid salts in the ore. One ton of the solution will treat about three tons of ore. After the chemically-saturated ore is introduced into the barrel the plug is replaced, care being taken that the plugs $j\,j'$ are tightly screwed home. Then the belt L is arranged upon the barrel, and the small driving-pulley k and the line-shaft are rotated by any suitable power to cause the drum or barrel to slowly rotate, thus to agitate the pulp. The dynamo D″ is set in operation, and the electrical current generated passes to the shaft A through the medium of the commutator-brush d'', and the anodes C are thus electrized. The electricity passes from the anodes through the intervening pulp to the cathodes C′, and as the chemical action proceeds a percentage of the precious metals is deposited upon the cathodes, and the electrical current returns through the electrical connection of the plug D and the commutator-brush d' to the dynamo D″, thus completing the circuit. By reason of the anodes being constantly subjected to the scouring action of the pulp undergoing agitation the bubbles of oxygen gas which form thereupon are scoured off and rise into the top of the barrel, which is not entirely filled with pulp. The chlorin gas generated by the electrical action also rises to the top of the barrel, and in a short time considerable pressure is generated, sometimes reaching thirty or forty pounds to the square inch. As the agitation continues these gases

are reabsorbed by the water, and every portion and particle of the ore is subjected to their action. Since no gases can escape from the barrel, the operation is economically conducted and is more rapid than is possible by any other means. A percentage of the metal is deposited upon the cathodes C′, and as fast as it is deposited the cyanogen is released and the solution regenerated thereby.

By employing the salt I make of the solution a good conductor for electricity, enabling me to use a current of low voltage and to produce a large quantity of oxygen and chlorin which is liberated at the anodes, and were it not scoured off by the pulp would assume the form of gaseous bubbles upon the anodes and cause partial or total polarization thereof. This has heretofore been the principal difficulty to be overcome in treating ores electrically and chemically. The salt when decomposed by the electrical current forms chlorin gas which, in combination with the oxygen gas and the cyanid, forms a very powerful solvent. The caustic soda is very cheap and neutralizes the acid salts in the ores, leaving the metals free to be acted upon by the oxygen and chlorin gases and the cyanogen. There are chemicals other than caustic soda which will neutralize the acid salts; but they are, so far as I am aware, either so expensive as to be incapable of use in the treatment of low-grade ores or do not perform the service required in as efficient a manner as does the caustic soda. When the electrical current is passed through the chemically-saturated pulp, not only is oxygen and chlorin gas liberated, as before explained, but the cyanid is converted into cyanogen, one of the most powerful solvents known, and this cyanogen immediately dissolves as much metal as it will combine with, passes to the cathodes, where the metal deposits, liberating the cyanogen, which again mixes with the pulp, dissolves more metal and deposits it, and again regenerating the solution until all the metal is dissolved and deposited. The chlorin and oxygen gases confined under heavy pressure produce a condition most favorable for the dissolution and deposition of the metals by the cyanogen, and the expense and time necessary for the treatment of the ore are reduced to a minimum, thus enabling me to treat at a profit ores which cannot be successfully treated by any other known process.

I am aware that it has been proposed heretofore to use sodium chlorid and potassium cyanid in conjunction with an electrical current. The effect of this is that when the chemicals are mixed with the pulp if the ore contains acid salts these salts attack the cyanid, converting it into hydrocyanic acid. When the electric current is afterward passed through the ore, caustic soda is produced; but the cyanid which has not been attacked by the acid salts is attacked by the hydrochloric acid and rendered inert and valueless for dissolving the metal. By this process a very large amount of cyanid is necessary to dissolve a very small amount of metal, while with my invention the acid salts are neutralized before the electric current is passed through the chemically-saturated pulp, and the hydrochloric acid as fast as liberated is neutralized by the presence of the caustic soda present in the solution.

When the metals are dissolved, the rotation of the barrel is stopped and the belt is shifted from the barrel to the smaller driven wheel A′ and the larger driving-wheel *k* upon the line-shaft K. The plugs *j j′* are removed, thus to leave the openings J J′ unobstructed, and the line-shaft is revolved to cause the barrel to rotate at a high rate of speed. The centrifugal action causes the pulp to spread itself about the interior of the drum and also causes the precious liquors to be driven out through the filter and into the intervening space H′ between the filter and the casing G′, from whence it escapes through the openings J J′ and is caught by the housings O and conducted to the trough O′, which leads it to a suitable receptacle. (Not shown.) By revolving a barrel of four feet in diameter at a speed of seven hundred revolutions per minute practically every particle of liquor can be extracted from the slimes, no matter how talcy or clayey they may be. When the supply of liquor originally supplied to the pulp becomes exhausted, then water is turned on through the bore *a* of the shaft and the remaining liquor in the pulp is thoroughly washed therefrom. When the extraction is completed, the plugs *j j′* may be replaced, water introduced into the barrel to form the pulp into slush, the plug *g′* removed from the opening *g* and the pulp discharged from the barrel, a new charge introduced, and the operation is repeated.

Now, having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination set forth of a casing provided with discharge-openings for filtered liquid and closed by removable closures; a lining of filtering material within the casing, having a space between it and the casing; means for introducing pulp into and removing it from the filter-lined chamber; a housing surrounding the cylinder and arranged to catch the filtered liquor discharged from the openings when the casing is revolved; and means for rotating the casing at a high rate of speed.

2. The combination set forth of a rotatable barrel; a lining of filtering material arranged in the barrel and to leave a space between such lining and the walls of the barrel; an opening for introducing inside of the filter-lining, material to be treated; a closure for such opening; a suitable opening leading through the wall of the barrel into the space between the barrel and the filtering material; a removable closure for such opening; a housing surrounding the cylinder and arranged to

catch the filtered liquor discharged through the opening when the casing is rotated; and means for rotating the barrel at a high rate of speed.

3. In combination, a shaft with a longitudinal bore; a barrel mounted upon such shaft; a cathode and an anode plate arranged upon such shaft and insulated from each other; an electrical conductor passing through the bore of the shaft and connected with one of the plates; means for supplying electricity to the other plate; means for introducing material to be treated into and removing it from the barrel; and means for rotating the barrel.

4. In combination, a shaft provided with a longitudinal bore and having one end closed by means of a plug insulated from the shaft; a source of electricity connected with the plug; a series of anodes mounted upon the shaft and insulated therefrom; an electrical connection between the plug and each of the anodes; a series of cathodes mounted upon and electrically connected with the shaft; suitable means for supplying electricity to the shaft and the cathodes; a barrel arranged upon the shaft and inclosing the anodes and cathodes; a lining of filtering material arranged inside the barrel; an opening for introducing inside of the filtering-lining the material to be treated; discharge-openings arranged to allow the discharge from the barrel of the liquid which passes through the filter; and means for rotating the barrel.

5. The combination set forth of a shaft provided with a longitudinal bore; a barrel arranged on the shaft; series of anode and cathode disks arranged upon the shaft, the anodes being insulated therefrom; an insulated electrical connection passing through the bore of the shaft and arranged to electrize the anodes; a source of electrical energy; means for supplying electricity to the shaft and the cathodes; suitable means for introducing steam or water into the bore, such bore being provided with passages opening through the shaft into the barrel; a lining of filtering material arranged inside the barrel with a space between it and the walls of the barrel; an opening arranged to allow the material to be treated to be introduced into and removed from the barrel; openings arranged to allow the filtered liquid to escape from the barrel; and means for rotating the barrel.

6. An appliance for saving precious metals comprising a rotatable barrel having arranged therein and resting against the wall of the barrel, a lining of filtering material, and provided in such wall with an outlet for filtered liquor; a removable closure for the outlet; cathode and anode plates arranged in the barrel and adapted to pass a current of electricity through the material in the barrel; and a housing surrounding the barrel to catch the filtered liquor discharged from the outlet when the barrel is rotated at a high rate of speed.

7. In an appliance for saving precious metals, the combination set forth of a rotatable casing provided with a discharge-opening; a removable closure for such opening; a lining of coarse wire-netting arranged inside the cylinder; a lining of fine wire-netting arranged inside the first lining; a layer of filtering material arranged inside the fine netting; a fine wire-netting arranged inside the filtering material; a lining of coarse wire-netting arranged inside the fine netting; and means for rotating the barrel at a high rate of speed.

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