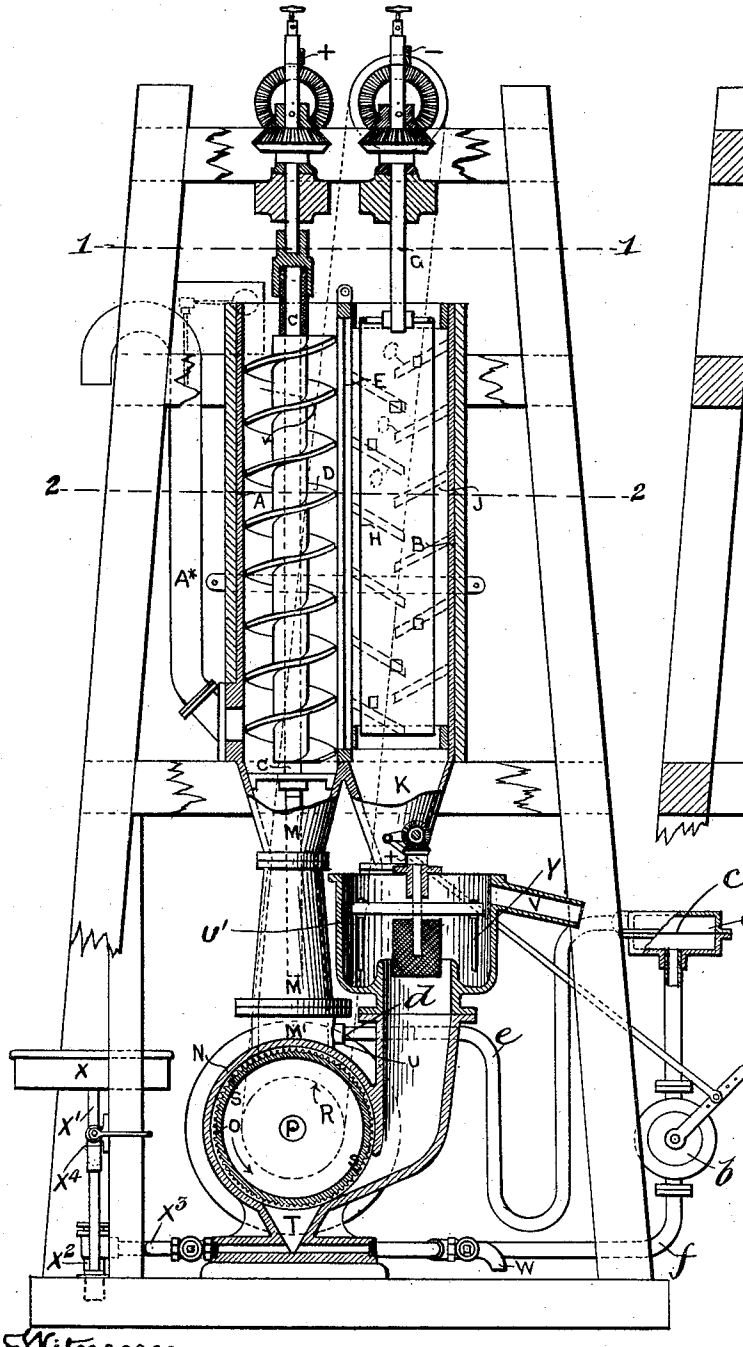
(No Model.)

G. J. ATKINS.

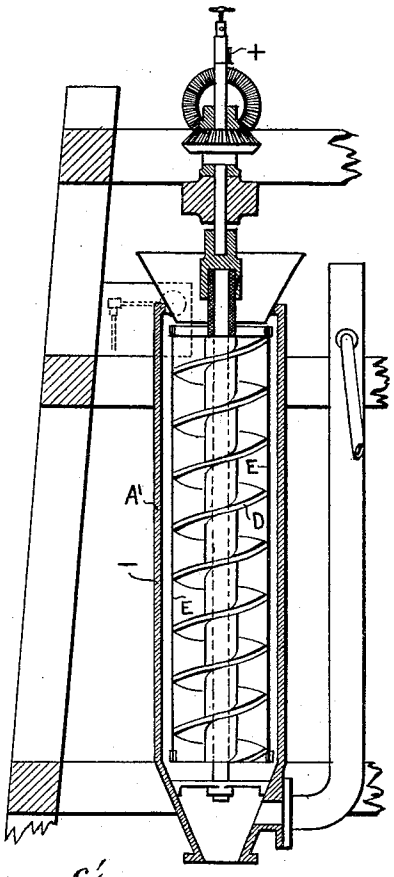
PROCESS OF SEPARATING GOLD OR OTHER METALS FROM THEIR ORES.

No. 484,869. Patented Oct. 25, 1892.

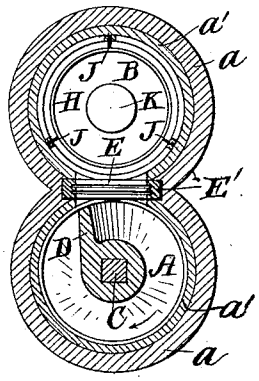
—FIG. 1—



—FIG. 1*—



—FIG. 2.—



Witnesses.
[illegible]
W. A. Marshall

Inventor
Geo. J. Atkins

UNITED STATES PATENT OFFICE.

GEORGE J. ATKINS, OF LONDON, ENGLAND.

PROCESS OF SEPARATING GOLD AND OTHER METALS FROM THEIR ORES.

SPECIFICATION forming part of Letters Patent No. 484,869, dated October 25, 1892.

Application filed April 28, 1891. Serial No. 390,865. (No specimens.) Patented in England September 28, 1886, No. 12,295; in France November 24, 1887, No. 187,179; in Germany November 27, 1887, No. 45,774; in Cape of Good Hope December 9, 1887, No. 425; in Natal December 19, 1887; in Canada December 20, 1887, No. 28,212; in Victoria December 21, 1887, No. 5,523; in New South Wales December 22, 1887, No. 403; in South Australia December 24, 1887, No. 931; in Queensland December 29, 1887, No. 373; in Tasmania December 29, 1887, No. 520/10; in New Zealand January 4, 1888, No. 2,722; in India January 4, 1888, No. 235; in Spain April 27, 1888, Nos. 12,412 and 7,697; in Austria-Hungary May 13, 1888, No. 11,502 and No. 49,944, and in Transvaal November 22, 1889, No. 140.

To all whom it may concern:

Be it known that I, GEORGE JONES ATKINS, electrician, a subject of the Queen of Great Britain, residing at Tottenham, London, in the county of Middlesex and Kingdom of England, have invented a new or Improved Process of Separating Gold and other Metals from Their Ores, (for which I have received Letters Patent in England, No. 12,295, dated September 28, 1886; in France, No. 187,179, dated November 24, 1887; in Germany, No. 45,774, dated November 27, 1887; in Austria-Hungary, No. 49,944 and No. 11,502, dated May 13, 1888; in Spain, Nos. 12,412 and 7,697, dated April 27, 1888; in Canada, No. 28,212, dated December 20, 1887; in India, No. 235, dated January 4, 1888; in Cape of Good Hope, No. 425, dated December 9, 1887; in Natal, dated December 19, 1887; in Queensland, No. 373, dated December 29, 1887; in Tasmania, No. 520/10, dated December 29, 1887; in New Zealand, No. 2,722, dated January 4, 1888; in Victoria, No. 5,523, dated December 21, 1887; in New South Wales, No. 403, dated December 22, 1887; in South Australia, No. 931, dated December 24, 1887, and in Transvaal, No. 140, dated November 22, 1889,) of which the following is a specification.

This invention has for its object the separation of gold, silver, and other metals from their ores; and it consists in subjecting crushed or pulverized ore to electrolytic action in an electrolytic apparatus provided with devices by which the said ore is retarded in its descent through the said apparatus, so as to keep the particles of ore in motion in the electrolytic solution for a sufficient period of time to allow the electro-chemical action—such as oxidation, chlorinization, or treatment with cyanogen, for example—to take place, and in then subjecting the ore so treated to the action of mercury in an amalgamating apparatus which is electrically connected with the cathode-pole of the said electrolytic apparatus.

In the drawings hereto annexed, Figure 1 is a vertical section of an electrolytic and amalgamating apparatus suitable for carrying my new or improved process into effect. Fig. 1* is a similar section of a modified form of the electrolytic part of such apparatus, and Fig. 2 is a horizontal section on the line 2 2 of Fig. 1.

This apparatus forms the subject of certain other applications for patents in the United States filed at same time as this present application, Serial Nos. 390,864 and 390,866. The crushed or pulverized ore is fed from a hopper or other receptacle into a vertical chamber A, (see Fig. 1,) which forms the anode-compartment of the electrolytic apparatus. Revolving vertically in this anode-chamber is a shaft C, carrying a broad-bladed screw D, composed of carbon, lead, or any other suitable material which is a conductor of electricity but is not soluble in the electrolytic solution employed. The edge of this screw approaches as near to the sides of the compartment A as possible, but preferably without touching them. On one side of the anode-chamber A is provided a filter E, of woven matting, flannel, felt, porous plate, or other suitable well-known material or combination of materials, which, while preventing the passage of the gangue into the cathode-compartment B, still allows a free circulation of the electrolyte between the anode and cathode compartments.

The cathode-compartment B is provided with a cathode-cylinder H, of copper or other suitable conductive material, preferably mounted on a rotating shaft G.

J are india-rubber or other flexible scrapers secured in the cathode-compartment B for the purpose of removing the spongy or pulverulent deposit of metal from the revolving cathode-cylinder H as it is formed thereon. This spongy or pulverulent deposit is collected at the bottom of tho cathode-compartment B and is periodically removed therefrom through the opening K.

The anode-screw D is connected electrically by any suitable means with the positive pole of a dynamo or other source of electricity and the cathode-cylinder H with the negative pole

of same. As the screw D revolves in the anode-compartment A in the direction of the arrow it causes the crushed or pulverized ore to be retarded in its descent in opposition to the action of gravity, (which latter tends to cause it to descend along the upper inclined surface of the screw D,) so as to delay the descent of the particles of ore in the electrolytic solution and to keep them in contact with the anode-screw for a sufficient length of time to allow the process of oxidation, chlorinization, or other action on the ore (according to the character of the solution employed) to be effected by the anions liberated at the anode.

Instead of rotating the screw D in the direction indicated by the arrow in Fig. 1 it may be rotated in the opposite direction in cases where the electrolytic action on the ore is sufficiently rapid to admit of it. In some cases the screw D may remain stationary and the ore be caused to flow or roll down on the upper surface of its thread by the action of the solution introduced at the top of the anode-compartment, such solution passing down through the anode-compartment and flowing off therefrom by the pipe A*, to be again returned to the top of the anode-compartment by a pump or otherwise, the gangue and any metal remaining therein passing away from the anode-compartment through the passage M, as hereinafter more fully described.

In some cases I substitute for the screw D in the anode-compartment a series of inclined ledges or shelves so arranged that the ore in passing from the top to the bottom of the anode-compartment is caused to fall from one to the other of such ledges or shelves, which are composed of material similar to that employed for the said screw D, and, like it, act as the insoluble part of the positive or anode pole of the electrolytic apparatus. After having been freed more or less in the anode-compartment A from those metals which have been dissolved in the electrolytic solution the pulverized ore, still containing the coarser particles of gold, and in some cases silver as well, passes to the lower part of the anode-compartment, which lower part is preferably tapered and opens into the pipe or passage M, leading to an amalgamating apparatus which consists of a horizontal cylinder N, of cast-iron or slate, for example, with closed ends and containing a revolving drum O, carried by the shaft P, revolving in stuffing-boxes and driven by a pulley R. The periphery and sides or ends of the drum O fit more or less closely the interior of the cylinder N. Grooves or channels S are formed across the periphery of the drum O, preferably in a more or less oblique direction, and the spaces thus formed, as well as the clearance-spaces between the drum and the cylinder, are filled with mercury high enough to cover the corrugations in the surface of the drum O, so that the ore falls from the electrolytic apparatus directly onto the surface of the mercury, a well or sump T for a reserve of mercury being also preferably provided at the bottom of the cylinder N.

The crushed or pulverized ore is introduced from the above-mentioned electrolytic apparatus into the amalgamator through the passage M′ at one end of the cylinder N, enters the grooves or channels in the periphery of the drum O, and is carried down by the revolution of the said drum in the direction of the arrow to the lower part of the cylinder N, through the mercury therein, and rises at the other side as the drum continues its revolution, the oblique position of the grooves causing it to gradually make its way to the opposite end of the drum after being carried round and round therein several times through the mercury, and it finally escapes from the grooves or channels in the periphery of the drum by rising, on account of its inferior density, through the mercury at an outlet-passage U at the opposite end of the cylinder N and passes away by the spout V, any gold or silver being retained in the mercury, which is periodically or continuously drawn off through the tap W and the gold and silver separated from it in the usual way; or the pulverized ore may be delivered from the electrolytic apparatus into a tank or other vessel or place where it may be desired to deliver the ore that has been treated in the electrolytic apparatus.

X is a reservoir, at the bottom of which is a pipe X′, opening into a chamber X^2, connected by a pipe X^3 with the mercury in the cylinder N. The lower end of the pipe X′ passes through a stuffing-box at the top of the chamber X^2, so that the said pipe X′, with the reservoir X, may be raised and lowered within certain limits by means of the bevel-gearing X^4, operated by a crank-handle. The bevel-wheel X^4 is screw-threaded internally, and the pipe X′ is screwed through it, so that as the crank-handle is turned in one direction or the other the bevel-wheel X^4 is rotated likewise in its bearing and acts as a nut upon the screwed part of the pipe X′, raising or lowering the same with the reservoir X. When it is desired to increase the quantity of mercury in the amalgamating apparatus, so as to produce a greater head of mercury, and thereby to retard the flow of ore from the electrolytic apparatus or other source of supply, the reservoir X and pipe X′ are raised and more or less of the mercury flows from the reservoir X into the cylinder N, and when it is desired to reduce the quantity of mercury in the amalgamating apparatus, so as to produce a lesser head of mercury, and thereby to increase the flow of ore from the electrolytic apparatus or other source of supply, the reservoir X and the pipe X′ are lowered and more or less of the mercury flows from the cylinder N into the reservoir X.

Sometimes the mass of gangue issuing at the outlet-passage U from the amalgamating apparatus is in the form of a stiff paste, and thereby does not pass away freely or carries

with it some of the mercury. In order to facilitate its passage out of the apparatus and to prevent it from carrying mercury with it, a rotary stirrer Y may be employed, revolving in the hopper U′ at the upper end of the outlet-passage U and driven by a belt from the shaft P or by other suitable means.

It will be understood that mercury may be introduced into and withdrawn from the amalgamator continuously, if necessary. For example, it may be taken by a pipe *f* from the bottom of the sump T and pumped by the pump *b*, which may be of any suitable kind, through a straining-box *c*, furnished with wash-leather or other suitable strainer *c′*, and then allowed to flow back into the upper part of the inlet *d* of the amalgamator through a pipe *e*. A by-pass may be provided to allow of the removal of the strainer containing the amalgam without interfering with the circulation of the mercury. It will now be understood that, the electrolytic compartments A B having been filled with one of the usual well-known electrolytic solutions, according to the nature of the ore to be acted on and the result to be obtained, such as a solution of sodium chloride, sodium sulphate, potassium cyanide, or ferro-cyanide of potassium, for example, the ore to be treated, after having been crushed or pulverized in the usual way, is introduced gradually and continuously through a hopper or other feeding device into the top of the anode-compartment A or A′. The ore falls onto the retarding-screw D, and gravity causes it to roll down the inclined surface of the screw-thread; but as the latter is rotated, preferably, in the direction which tends to raise the said ore toward the top of the anode-compartment the passage of the ore from the top thereof to the bottom through the electrolytic solution is retarded and the whole of the ore is kept for a considerable time in contact with the anode-pole, so as to form a more or less soluble portion thereof, while every particle is exposed to the action of the anions there generated. The effect of this is that by the time the ore has reached the bottom of the anode-compartment all or part of the baser metals have been dissolved and the gold left in or mixed with the gangue is in a free condition, ready to be removed therefrom by the subsequent amalgamation process. The cations resulting from the solution of the metals in the anode-compartment A pass through the partition or filter E into the cathode-compartment B and are there deposited upon the cathode-cylinder H as a pulverulent metallic deposit, which is scraped off the cylinder H by the scrapers J, as above described, and ultimately falls to the bottom of the cathode-compartment, whence it is removed from time to time or continuously for subsequent treatment or disposal, according to its nature and other circumstances. The ore, with the gold or silver, or both, having reached the bottom of the anode-compartment, passes to the amalgamating cylinder N or is otherwise dealt with, as before explained.

It will be seen from the above description that the process is practically a continuous one—that is to say, a stream of crushed ore is supplied continuously to the anode-compartment, the baser metals are removed from the surface of the gold as it passes through the anode-compartment, and the remaining ore and gold and silver may pass on to an amalgamating apparatus, where the gold and silver may be separated from the gangue in the manner well understood.

In some cases—as, for example, when treating ore containing a considerable quantity of silver—the ore which has been acted on in the anode-compartment A may be withdrawn from the bottom thereof and be introduced into the top of the cathode-compartment B, which may also be provided with a screw or other retarding device—such as a series of alternating and overlapping plates O (shown in dotted lines, Fig. 1)—similar to that in the anode-compartment instead of the cylinder H. The ore thus treated may then be withdrawn from the lower end of the cathode-compartment and be removed for subsequent treatment by amalgamation or otherwise in separate apparatus, or it may pass direct to amalgamating apparatus similar to that shown in Fig. 1, but placed at the bottom of the cathode-compartment instead of at the bottom of the anode-compartment, and proper means must be provided for conveying the ore acted on in the anode-compartment from the lower end thereof to the upper end of the cathode-compartment. This arrangement is applicable, for example, when treating ore containing sulphide of silver with a solution of chloride of sodium in the anode-compartment. The sulphide of silver is chlorinized in the anode-compartment, forming chloride of silver and liberating the sodium which appears at the cathode. Then by taking the gangue containing the chloride of silver from the lower end of the anode-compartment and passing it through the cathode-compartment the sodium at the cathode-pole combines with the chlorine of the chloride of silver, liberating the silver in the metallic state, which is separated from the gangue by passing it through the above-described or any other suitable amalgamating apparatus. Any of the baser metals—such as copper, iron, or zinc—deposited in the cathode-compartment will assist the action last described by combining with the chlorine of the chloride of silver, so as to liberate metallic silver, in the same way as the sodium.

In the arrangement of the electrolytic apparatus shown in Fig. 1* one compartment only is employed instead of two, as in Fig. 1. In this case the compartment A′ consists of a metal cylinder—of copper, for example—which forms the cathode-pole. The screw D, similar to that described in reference to Fig. 1, forms the anode-pole, and this is incased in

and surrounded by a porous partition or filter E, of canvas, flannel, felt, or other suitable filtering material, for preventing the gangue from reaching the cathode-pole and from falling over the edge of the screw. The ore after being treated in this electrolytic apparatus may be passed directly to an amalgamating apparatus similar to that shown in Fig. 1, placed at the lower end of the compartment A′.

In either of the arrangements above described the amalgamating apparatus is connected electrically with the cathode-pole of the electrolytic apparatus or with the positive pole of a dynamo or other source of electricity, whereby such amalgamating apparatus becomes part of the cathode-pole of such electrolytic apparatus, so as to prevent the corroding action of the electrolytic solution upon the said amalgamating apparatus when the same is formed of metal—such as cast-iron, for example—and upon the mercury contained therein when such solution is of a nature that would otherwise cause it to act upon them. This arrangement also preserves the mercury in a clean condition.

In Fig. 1, *a* represents a positive pole formed of a block of carbon or other suitable conducting substance placed in the mouth of the outlet U and insulated from the amalgamating apparatus, such block *a* being placed in electrical connection with the anode-pole of the electrolytic apparatus or with the negative pole of a dynamo or other source of electricity, the anode-pole D forming the positive pole at the inlet of the amalgamating apparatus. This electric connection of the amalgamating apparatus and of the mercury with the electrolytic apparatus causes the direct deposition in and amalgamation by the mercurial cathode of part of the gold and silver contained in the solution, the remainder of the gold and silver being deposited upon the cathode of the electrolytic apparatus, from whence it is removed, in the case of Fig. 1, to be afterward treated, or, as in Fig. 1*, falls into the mercury direct and is then amalgamated therewith. When a sodium solution is employed, a valuable sodium amalgam is formed in the amalgamator by the direct deposit of the sodium into the mercury.

I claim—

1. The continuous process of separating gold and other metals from their ores, which consists in passing such ore through the anode-compartment of an electrolytic apparatus in contact with the anode and retarding the descent of the ore in the said anode-compartment while such ore is kept in contact with the anode-pole of such compartment, so as to form a more or less soluble portion of such anode-pole, and then subjecting the ore to the process of amalgamation, substantially as and for the purpose set forth.

2. The continuous process of separating gold and other metals from their ores, which consists in passing such ore through the anode-compartment of an electrolytic apparatus, retarding the descent of the ore in the said anode-compartment while such ore is kept in contact with the anode-pole of such compartment, so as to form a more or less soluble portion of such anode-pole, then passing the ore through the cathode-compartment, in retarding the descent thereof in the said cathode-compartment, and then subjecting the ore to the process of amalgamation, substantially as and for the purpose set forth.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

GEORGE J. ATKINS.

Witnesses:

STEPHEN EDWARD GUNYON,
115 *Cannon Street, London, E. C.*

WILLIAM ANDREW MARSHALL,
50 *Londesborough Road, Stoke-Newington, N.*