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PROCESS OF AND APPARATUS FOR CONCENTRATING METALLIFEROUS ORES.

APPLICATION FILED JUNE 25, 1909.

984,633.

Patented Feb. 21, 1911.

2 SHEETS—SHEET 1.

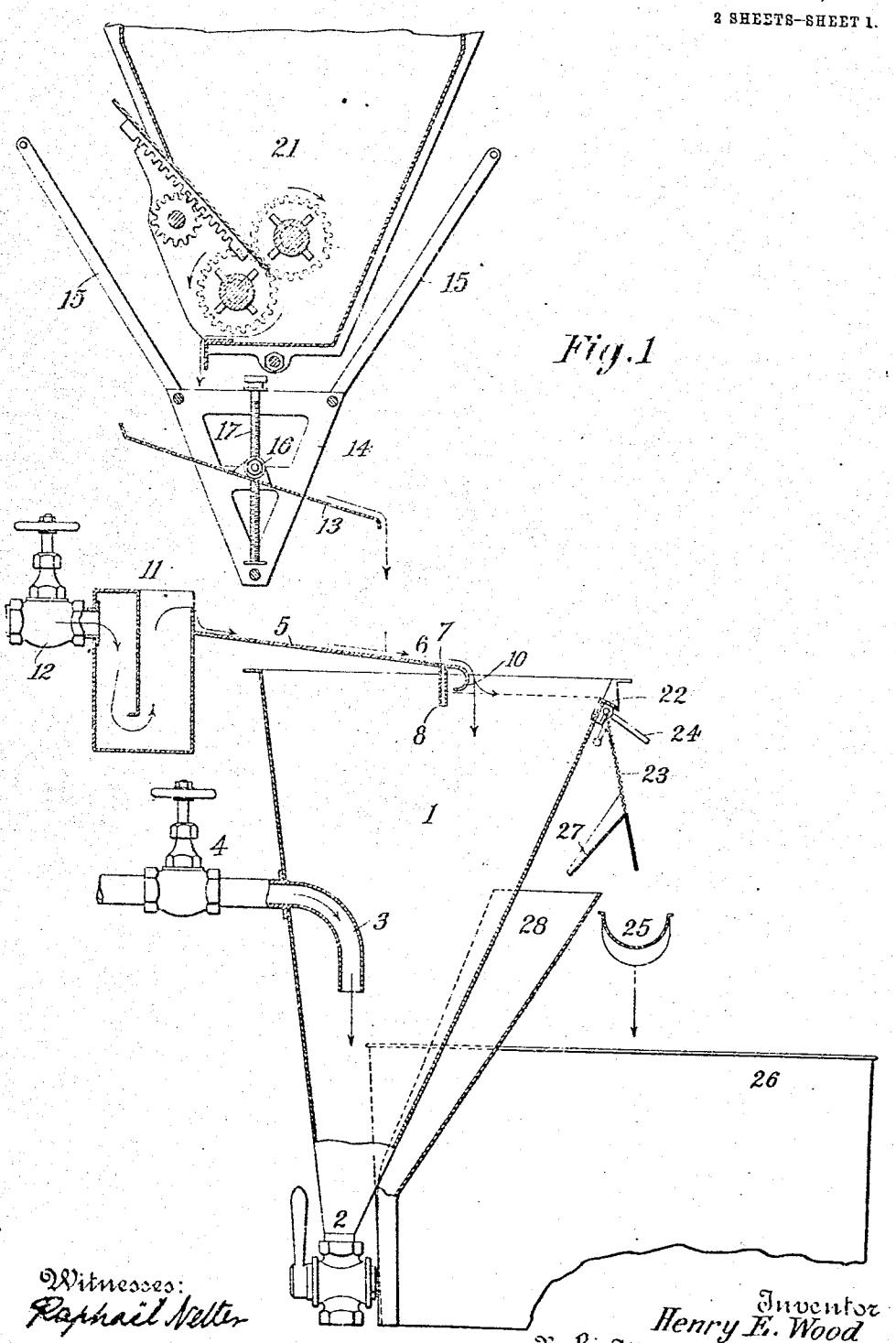

Fig. 1

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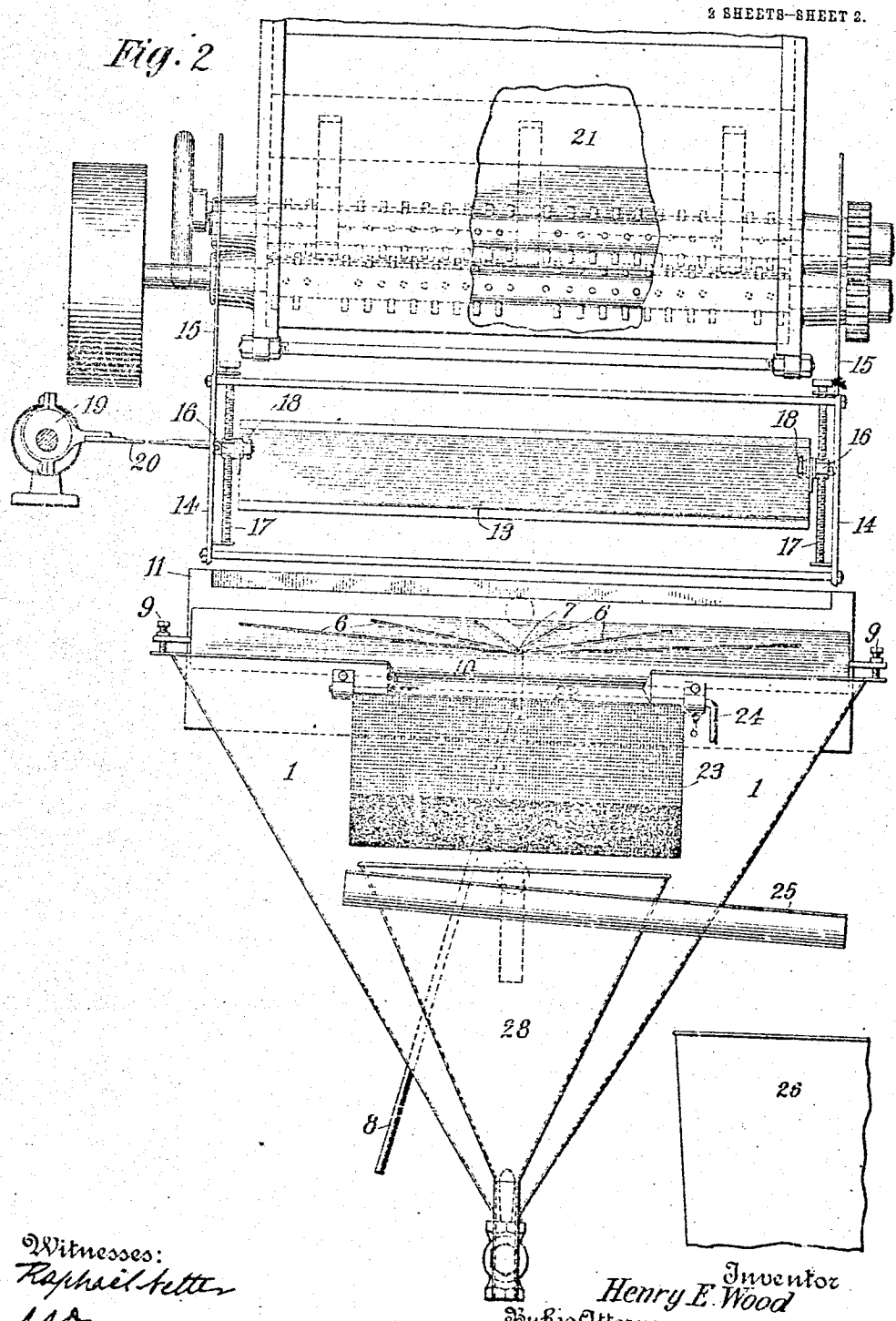
2 SHEETS—SHEET 2.

Fig. 2



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PROCESS OF AND APPARATUS FOR CONCENTRATING METALLIFEROUS ORES.

984,633. Specification of Letters Patent. Patented Feb. 21, 1911.

Application filed June 25, 1909. Serial No. 504,236.

To all whom it may concern:

Be it known that I, HENRY E. WOOD, a citizen of the United States, residing at Denver, in the county of Denver and State of Colorado, have invented certain new and useful Improvements in Processes of and Apparatus for Concentrating Metalliferous Ores, of which the following is a full, clear, and exact description.

It is well known that the surface of a liquid possesses certain distinctive properties different from those within the liquid, and that it acts like a thin elastic membrane, under tension in all directions, and tending constantly to contract. The surface film of a liquid has, therefore, the capability of supporting certain substances above it, if they are in a finely divided state, even though they may be of greater density than the liquid itself. Thus, if a mixture of finely comminuted dry material be distributed upon the surface of a liquid, some of the particles may penetrate the surface film and pass into the body of the liquid, while others may remain suspended for an indefinite time upon the surface film. The buoyant power of the surface of liquids is thus selective with regard to certain substances. This property of the surface tension of liquids has been taken advantage of in various processes for the selective separation of mixtures of finely divided materials. For example in separating particles of graphite from crushed rock or sand, the principle is very generally applied by feeding the mixture in a dry state upon the moving surface stratum of a body of water, permitting the sand and fine particles of rock to sink into the lower quiescent stratum, while the particles of graphite, which have a highly water repellent property, are floated off into a separate receptacle or launder. It has also been proposed to apply the same broad principle to the concentration of metalliferous ores, and the recognition of the fact that particles of metal such as are present in crushed ores possess relatively less of that water repellent property that causes them to remain suspended upon the surface film of water, has led to the proposal and application of various and in many cases substantially different methods from those obtaining in the recovery of graphite, in order to compensate for the lack of such property. For example, mechanical devices or special processes have been employed for bringing the metal particles to and maintaining them on the surface, and various substances have been utilized which by attachment to or union with such particles would have a tendency to increase their buoyancy. So far as I am aware, however, and my familiarity with commercial conditons in this art enables me to so state with no little assurance, no process or apparatus heretofore devised and based upon this principle, has proved commercially successful or practicable, the meager results being due to failure to observe and provide for the proper maintenance of those conditions in practice under which alone the principle is theoretically feasible.

The subject of my present application is an apparatus for the selective separation of finely divided materials, chiefly designed for the concentration of metalliferous ores, but applicable generally to similar purposes, which depends primarily upon the utilization of the surface film tension of liquids, and which realizes the possibilities of such principle to an extent that renders it highly efficient and commercially valuable.

In carrying out my invention I use the apparatus illustrated in the accompanying drawings, in which—

Figure 1 is a view partly in vertical central section and partly in side elevation of my apparatus complete. Fig. 2 is a front view of the same.

The numeral 1 indicates a tank or receptacle tapering toward the bottom, preferably in the form of an inverted split cone, and having at its contracted end a valve controlled outlet 2. Entering the side of said tank is a water supply pipe 3 opening downward in the tank and provided with a controlling valve 4.

Above the tank 1 is supported a plate or table 5 of glass or other suitable material such as wood, iron or steel, which contains in its upper surface a series of shallow converging grooves 6, leading to a trap-hole 7 of comparatively small diameter, extended by a pipe 8 into, through or below the tank 1. The table 5 is slightly inclined toward the tank 1, and its lower edge 10 projects over the same, extending to within a few inches of the lip or spillway 22, and being curved downwardly or rounded as shown. In Fig. 1 this table is shown as rigidly secured to the tank 11, but it is preferable to provide for a variation of the angle of inclination with respect to the level of water

in the tank 1. I have indicated a means for accomplishing this in Fig. 2, where 9, 9 represent set screws passing through arms extending from the ends of the table, near its forward edge, and resting upon the flanges or edges of the tank 1. If the upper or rear edge of the table is hinged or flexibly connected with the tank 11, its angle of inclination may be varied by the proper adjustment of the screws 9.

A tank 11 connected by a valve controlled pipe 12 with a water supply, and provided with a suitable spillway, is used to deliver upon the inclined plate 5, a sheet of water of uniform but regulable thickness.

Above the plate 5 is a device for feeding upon the surface of the water flowing over said table, a finely comminuted material in a dried state, and as I have found that the manner in which such material is delivered or fed is of great practical importance, I have devised a special device for the purpose. This consists, essentially, of a laterally vibrating feed plate 13, adjustable vertically as a whole, and also about a horizontal axis whereby its distance above the plate 5, as also its angle of inclination with respect thereto may be varied. The necessary movements and adjustments are secured by using a supporting frame 14 suspended by bars 15, from a suitable fixed support, and mounting the plate 13 on pivotal bearings in blocks or nuts 16, surrounding threaded standard 17, supported on the frame with the capability of being turned to raise or lower the said blocks. One edge of the plate 13 is connected to frame 14 by an adjustable rod or similar device 18, by which its inclination may be varied as desired.

The frame is vibrated by any suitable means, such as an eccentric 19, with a strap connected by a rod 20, with the side of the frame.

In conjunction with the feed plate above described I employ any suitable device for delivering the finely comminuted material upon the higher end of the plate. This device is illustrated conventionally at 21, and should be capable of delivering the material continuously at a uniform rate.

In the forward side of the tank 1, and slightly below the level of the remaining sides is an inclined lip or plate 22, over which the water, overflowing from the tank 1, passes. Immediately under said lip or spillway is a screen 23 of wire gauze or other like foraminous material, inclining abruptly but supported in such manner that its angle of inclination may be varied by means of an adjusting screw or handle 24. The lower end of the screen 23 lies over a trough 25 or tank 26, and a plate 27 inclined at an opposite angle and secured to the under side of the screen near its lower end projects over a tank or receptacle 28.

Stated in general terms, the theory and mode of operation of the apparatus above described are as follows: The tank 1 is filled with water and the supply regulated so as to maintain a slight overflow. Water is also admitted to the tank 11 at a rate sufficient to maintain over the table or plate 5 a steadily flowing sheet or stratum which enters the tank 1 with sufficient momentum to carry it across the relatively quiescent body of water therein to the spillway 22, but at such an angle as to avoid the formation of a ripple or break in the surface film at the line of intersection between the descending sheet and the surface of the water in tank 1 which would impair the continuity and buoyant property of the said film. This may be done by adjusting the end of the plate 5, slightly above the normal level of the water in said tank, or preferably, as shown, by curving the end of the table so that it extends slightly below the surface when the apparatus is in operation. When the above described conditions have been established, finely comminuted ore in a dried state is delivered upon the vibrating plate 13, over which it descends and from the lower end of which it is delivered in a uniform stream upon the surface of the water flowing over the plate 5, and at substantially right angles to the current of the surface film. As the material is delivered upon the moving surface film, the gangue sinks immediately into the water while the metalliferous particles, or a large proportion of the same remain suspended upon the surface. All of the wetted particles which sink are carried down the plate by the current, but I have observed that the heavier wetted non-floating particles which are chiefly metalliferous, move more slowly than the lighter particles of gangue material. I therefore find it advantageous to provide the grooves 6, converging toward a trap hole 7, as by this means a large proportion of the wetted or non-floating concentrates may be deflected toward the trap-hole and thus recovered while the lighter particles follow a straighter path toward the tank 1. It will be understood that the discharge flow through the trap hole should never be such as to sensibly disturb the surface film over the plate 5. The descending sheet of water, in addition to its load of floating particles, therefore, carries down those particles which have sunk into it and are not intercepted by the trap, and also a certain proportion of finer and lighter particles which are held in suspension. When it reaches the body of water in the tank with this charge or load, the heavier submerged particles sink at once in the quiescent water, but the rate of movement of the surface stream or stratum is sufficiently retarded to permit a very large proportion of the suspended particles which

would otherwise be carried over the spillway to sink into the lower and more quiescent stratum of water beneath that which, by reason of its acquired momentum, flows steadily across the tank to be discharged over the spillway. The adjustment of conditions and arrangement of parts should not, however, be such as to permit such a pronounced slowing down of the surface stratum as would allow an objectionable accumulation or overcrowding of the floating particles, which are conveyed out of the tank by the moving surface film and over the spillway from which they may be delivered or collected in any convenient manner.

Although the separation of the values from the gangue is mainly effected prior to the discharge of the moving surface film over the spillway, it is not complete, for the reason that many very fine particles are carried over the spillway in suspension in the surface stratum. An additional and important separation or concentration is effected by the screen 23, which has a peculiar function wholly distinct from that of an ordinary strainer, filter or sieve.

The discharge or overflow from tank 1, is in the form of a sheet of water with an unbroken or undisturbed upper surface film. The screen is set in nearly a vertical position and this descending stream is allowed to fall upon it at such an angle that the upper surface film will be practically split off from the sheet. A portion of the water passes through the screen, but as the inclination of the latter is such as to prevent the formation of ripples on the upper surface, the floating particles are not drawn below the surface film nor carried through the interstices of the screen. Such water as reaches the screen, however, closes each mesh with a thin sheet which presents therefore a double surface film. Values which may penetrate the upper surface film or which may be in suspension between the two films will have a tendency to travel between them, while the gangue will pass freely through the under film. Thus, while a portion of the water and the greater part of the gangue and lighter wetted particles in the discharge pass through the screen, the floating particles and values in suspension therein will be carried down with the remainder of the water into the tank 28. To further facilitate this operation, I note the outline of the falling stream of water under conditions of normal operation, and paint the screen solid approximately up to the point where the surface film intersects the screen. This avoids the loss of finely divided wet mineral slimes which would have a tendency to pass through the screen but which are permitted to pass at once over the painted or solid portion of the screen.

Such water and gangue as pass through the screen flow over the plate 27, into a suitable tank or receptacle. The gangue which settles in tank 1, may be periodically or continuously drawn off at the bottom, and conveyed back to the tank 11, so that waste of material and loss of values are reduced to a minimum.

In all processes of wet concentration of ores at present in use, the presence of the intermingled fine material or slimes is a serious drawback to a clean concentration, and large losses of valuable mineral occur in the slimes, which escape into the tailings. By the use of my invention these losses are very largely avoided, the more prominent features of novelty by which such result is secured being the following: The surface film by means of which the initial separation is effected is preserved intact and unimpaired while such initial separation, a secondary separation, and subsequent settling and final separation are proceeding beneath such film. What is here designated secondary separation is accomplished in the manner above described by taking advantage of the slower rate of travel over the table of the heavier wetted and submerged metalliferous particles. The settling is accomplished by checking or retarding the movement of the surface stratum over a quiescent body of water, and the final separation by the screen and the operation of the double surface film produced by its use.

I would state that the character of the surface film upon which its selective action depends, may be modified in any desirable way, without departure from the invention. For example, a small quantity of oil or acid, or other substances will render the film more characteristically selective with regard to the particular particles which it will convey upon its moving surface, and thus extend the range, and permit of better control of its selectivity. It is moreover evident, from the position of the invention in the art and the nature of the appliances herein described as the best means now known to me for practicing the invention, that these latter may be very greatly modified in design and construction without departure from the novel principle which they involve.

What I claim is:

1. The process of recovering the values of metalliferous ores, which consists in feeding the ore in a finely divided state upon the surface of a body of water in a substantially quiescent state in a suitable receptacle, causing the upper or surface stratum of the body of water to flow laterally and discharge over the edge of the receptacle and then splitting off from the freely descending sheet of water at a point in its trajectory removed from point of overflow, the surface film with the particles supported thereon.

2. In an apparatus for concentrating ores,

the combination of a tank for containing a body of water and provided with a spillway, an inclined plate, means for maintaining a sheet of water continuously flowing over the same, the said plate being supported and arranged to deliver the sheet of water with its surface film unbroken and unimpaired upon the surface of the body of water in the tank, and directing it as a slowly moving surface stratum across the body of water and over the spillway, means for feeding the ore in a thoroughly dried and finely comminuted state in a uniform stream upon the sheet of water while on its way to the tank, and means for splitting off the surface film with the particles supported thereon from the column of water which discharges, at an angle to the vertical, from the tank.

3. In an apparatus for concentrating ores, the combination of a tank for containing a body of water and provided with a spillway, means for maintaining a surface stratum continuously moving across the body of water in said tank and over the spillway, means for feeding or delivering ore in a thoroughly dried and comminuted state upon the surface of the moving surface stratum, and means for splitting off the surface film with the particles supported thereon from the column of water which discharges, at an angle to the vertical, from the tank and delivering the same into a suitable receptacle.

4. The combination with an apparatus for concentrating ores by the selective separation of the values and gangue, by the surface film tension of liquids, of a perforated screen set obliquely to and in the path of the column of water which discharges from the apparatus so as to split off therefrom the surface film, and a receptacle for receiving the diverted film, with the particles supported thereon, as set forth.

5. The combination with an apparatus for concentrating ores by the selective separation of the values and gangue by the surface film tension of liquids, of a perforated screen set in an approximately vertical position to receive the discharged or overflowing surface stratum of water and so as to split off therefrom the upper surface film, a receptacle for receiving the values delivered from the screen, and a deflecting plate under the screen for receiving the water and particles that pass through the same, as set forth.

6. The combination with an apparatus for concentrating ores by the selective separation of the values and gangue by the surface film tension of liquids, of a perforated screen set in a nearly vertical position under the spillway of the settling tank, in position to receive the sheet of water flowing over the spillway and split off therefrom the upper surface film, means for directing the surface film with the values thereon into a receptacle, and a solid plate at an angle to and under the screen for deflecting into another receptacle the water and particles which pass through the screen, as set forth.

7. In an apparatus of the kind described, the combination with a settling tank of a perforated screen set under the spillway of said tank in a nearly vertical position to receive the descending sheet of water discharged over the spillway and having its meshes closed below the line of intersection therewith of the descending sheet of water, and an inclined deflecting plate supported under the screen, as set forth.

In testimony whereof I affix my signature in the presence of two subscribing witnesses.

HENRY E. WOOD.

Witnesses:
B. M. Wood,
Lucien I. Blake.