UNITED STATES PATENT OFFICE.

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METHOD OF EXTRACTING URANIUM, VANADIUM, AND RADIUM FROM ORES AND OTHER MATERIAL CONTAINING THE SAME.

1,095,377. Specification of Letters Patent. Patented May 5, 1914.

No Drawing. Application filed January 20, 1913. Serial No. 743,230.

To all whom it may concern:

Be it known that I, JOACHIM H. BURFEIND, a citizen of the United States, residing at Nucla, in the county of Montrose and State of Colorado, have invented certain new and useful Improvements in Methods of Extracting Uranium, Vanadium, and Radium from Ores and other Material Containing the Same; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make use of the same.

My invention relates to the extraction of uranium, vanadium and radium from ores and other material containing uranium, vanadium and radium or either of them.

The process forming my invention is applicable to most ores in their natural state without a preliminary roasting or burning of the same although in other cases—as, for instance in ores carrying sulfids or much organic matter—a preliminary roasting or burning may be necessary.

Inasmuch as my invention has its chief field of usefulness in the extraction of uranium, vanadium and radium from ores requiring no preliminary roasting or burning the process will be described more particularly in its application to ores of that character.

The object of the process, as usual in the art, is to finally obtain the uranium, vanadium and radium in a commercial form; but the main or principal features of the process which constitute my invention are, briefly, first the subjection of the ores (either with or without previous roasting or burning of the same, depending upon the character of the ore) to the action of sulfurous acid (as gas or in solution) to dissolve out the uranium and vanadium and to separate the radium bearing part from the worthless gangue, and, second, the separating of the solution containing the uranium and vanadium and the radium bearing part from the worthless gangue, and, third, the separating of the solution containing the uranium and vanadium from the undissolved part containing the radium values, and, fourth, the heating of the solution thus obtained to drive off the excess of sulfurous acid and form a precipitate containing uranium and vanadium, which may be subjected to any desired after treatment or not, as may be required.

The sulfurous acid may be obtained from roasting furnaces or from the direct burning of sulfur or in other ways, as well understood in the art.

I am aware that sulfuric acid has been commonly used in extracting uranium and vanadium from its ores; but the advantages in the use of sulfurous acid are very many. Sulfuric acid can seldom be bought in localities where uranium and vanadium ores are found at less than three cents per pound, and in such localities frequently "roast fumes" can be had at a nominal cost, but where there are no "roast fumes or gases" and it is necessary to burn sulfur instead my method of treatment of ores or other material, above referred to, is still much cheaper. In places where sulfuric acid costs three cents per pound sulfur will cost about the same usually less, and a pound of sulfur in the form of sulfurous acid will extract three times as much uranium and vanadium as sulfuric acid. It (sulfurous acid) being a much weaker acid than sulfuric acid, does not attack so vigorously the other metallic contents contained in the ores or material treated, thus not fouling the solution as much as when sulfuric acid is used. When using an excess of sulfurous acid it is not wasted but the excess used is recovered and used again for dissolving more uranium and vanadium from fresh charges as will be shown later on, while the excess used of sulfuric acid is not only wasted but consumes an extra amount of the precipitant (soda for instance) and also contaminates the product when lime is used as the precipitant. Neither does it (sulfurous acid) attack the vessels or implements of the plant to the same extent as the stronger acid (sulfuric acid) would do and so for the same reason it is much easier and cheaper to reduce the uranium and vanadium obtained from the ores and other material after treatment with sulfurous acid than it would be to reduce the uranium and vanadium obtained by sulfuric acid, either by using soda or lime or other precipitants.

My method of treatment is carried out as follows: (A) Sulfurous acid is used in the form of gas. The ore or other material (crude, roasted or burned) is crushed to

proper size usually about 30 mesh which fineness or coarseness will depend upon the nature of the ore or material. The crushed ore or material is charged into a vessel made out of wood or of such metals as resist the action of the solvent (sulfurous acid) and sufficient water is added. The amount of water required will vary as the material under treatment varies and must be determined in each case; usually 1 part of water to 1 part of ore or material will answer. While this mixture is agitated sulfurous acid gas is conducted into the mixture until the uranium and vanadium are dissolved and the part bearing the radium has separated from the gangue which latter is usually the case when the uranium and vanadium are in solution. The charge now consists of a solution containing the uranium and vanadium, an amorphous mud and the coarse gangue. By letting it settle a minute or longer, as may be required, the valueless heavy gangue settles to the bottom of the vessel, while the amorphous mud remains in suspension in the solution carrying the uranium and vanadium. Agitation is then stopped and the charging of sulfurous acid gas is discontinued. After permitting the mixture to settle for about one minute the solution carrying in suspension the radium bearing part is drawn off. A weak solution of sulfurous acid is then run in and the mixture is again agitated either by sulfurous acid gas, air or mechanically for a few minutes, allowed to settle for about one minute and the wash water is drawn off. This washing is repeated until the gangue is practically free from uranium, vanadium and radium. The solution is run through filter press in which the amorphous mud bearing the radium is retained. The wash waters are also run through a filter press so as to free them from the radium contents. The solution is run into a precipitating vessel while the wash waters are used for new charges instead of water used for the first charges. The solution is then heated until the excess of sulfurous acid gas has passed off. The sulfite salts of uranium and vanadium being insoluble in water are precipitated when the sulfurous acid which holds them in solution is driven off. But as during the operation some sulfates are formed which are soluble in water these will not be thus precipitated. At places where fuel is abundant and inexpensive the solution may be evaporated or the usual precipitants may be used. If lime is used as the precipitant then sufficient sulfurous acid should be left in the solution to retain excess used in solution as lime acid sulfite. The precipitate after drying is ready for shipment. The radium bearing part is removed from the filter press and after drying is also ready for shipment. The gangue, unless it contains other valuable ingredients is discarded. The excess of sulfurous acid, driven off by heating, is either allowed to be absorbed by water and then used to mix with fresh charges or it is directly charged into new charges with the other sulfurous acid gas. In either case it is reused for dissolving uranium and vanadium and for the separation of the radium bearing parts from the gangue. The wash waters containing some sulfurous acid and uranium and vanadium are, as already mentioned, used for making the proper mixture of the ore for treatment so that nothing is wasted.

(B) Sulfurous acid is used in the form of solution. This mode of treatment is not recommended when the ore or material to be treated contains radium values, but may be used at places where "roast fumes" are abundant and can be had for the taking of them and the ores carry only uranium and vanadium or either of them. The solution of sulfurous acid is made in any way well known in the art. The ore or material to be treated crude, roasted or burnt is crushed to suitable size, placed in a vat, preferably with a filter bottom, such as are used in the old Plattner process or in cyaniding. The sulfurous acid solution is then permitted to percolate through the charge until a test shows that all the uranium and vanadium or either of them, as the case may be, are in solution. The solution, if a good filter bottom is used, is clear and can be treated as shown under (A) after it leaves the filter press.

I do not give a description of mechanical appliances as they are to a certain extent well known and references may be found in U. S. Patent No. 702,582.

Radium. The amount of radium in ores liable to be treated by my method is so small that it is out of the range of chemical analysis. In what form radium exists in the ores is as far as I know unknown. The fact that it is in a soluble form is easily demonstrated by disolving the ore in, say, hydrochloric acid; after washing the insolubles well they will be nonradio-active showing that the radium is in solution. All ores containing uranium and radium that I have met with, contain also barium in a soluble form. Sulfurous acid (SO_2+XAq) dissolves this barium and forms barium sulfite ($BaSO_3$) soluble in SO_2+XAq. From results obtained I conclude that the SO_2+XAq also dissolves the radium present and that it is likewise soluble in the SO_2+XAq. Due to the presence of air durin the treatment of the ore by my method and possibly to secondary chemical reactions some sulfates are formed and of course the most insoluble ones first which will precipitate not being soluble in SO_2+XAq like barium sulfate.

The treatment of the ore by my method is conducted in the cold with continuous agitation and gradual formation of sulfates—the ideal conditions required to obtain the insoluble sulfates like barium sulfate in the amorphous condition and thus these amorphous sulfates enter the amorphous mud always formed when the ores in question are treated with acids. The fact that in practice the radium and barium is not found in the valueless gangue verifies to a certain extent above theory for if the ore was treated when hot with sulfuric acid the barium at least and most likely the radium also would precipitate instantaneously and be mixed with the worthless gangue. However, it does not matter whether this theory is correct or not for in practice no radium is found in the gangue the only part that is discarded when my method is used. Thus when the uranium and vanadium bearing solution together with the radium bearing amorphous mud is separated from the gangue as described all values in the ores are separated from the valueless gangue and after the amorphous mud is separated from the solution as described radium is separated from the uranium and vanadium.

Having described my invention, what I claim, and desire to secure by Letters Patent is—

The process of extracting uranium, vanadium and radium values from ores containing the same, which consists in the treating of the ore with an aqueous solution of sulfur dioxid, whereby the uranium and vanadium are dissolved and the radium bearing portion is converted into an amorphous mud and separating the values from the gangue as described.

In testimony whereof I have hereunto affixed my signature in presence of two witnesses.

JOACHIM H. BURFEIND.

Witnesses:
JOHN REINDL,
W. H. ATTLESEA.