UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PROCESS OF SEPARATING ORES.

SPECIFICATION forming part of Letters Patent No. 564,423, dated July 21, 1896.

Application filed July 2, 1892. Serial No. 438,816. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Separating Ores, (Case No. 956,) of which the following is a specification.

The object of my invention is to improve the process described in my Patent No. 465,250, for the separation of copper pyrites from iron pyrites, whereby a more complete and effective separation will be accomplished and the process will be made applicable to ores in which the percentage of copper pyrites is very small. In the working of the process of my patent referred to I have found that no matter how accurately the temperature was regulated some of the copper particles failed to become magnetic, while some of the iron particles became magnetic during the first heating, and the results produced by the magnetic separator were, therefore, imperfect. This made the process unavailable for pyritiferous ores containing a very small percentage of copper pyrites, because with such ores the separation must be an approximately perfect one to make the recovery of the copper constituent of the ore a commercial success. By prolonged experiment and investigation I have discovered the cause of the imperfect result referred to in the working of the process of my patent, and have been able, by the application of a simple remedy, to overcome the difficulty.

I have found that at the temperature which is required to oxidize the atom of sulfur in the copper pyrites and produce the magnetic condition, the sulfur of the iron pyrites is also oxidized. While this oxidation proceeds simultaneously, owing to the fact that the sulfur of the copper pyrites is either oxidizable at a lower temperature or oxidizes more rapidly than the sulfur of the iron pyrites, there is a differential action which can be taken advantage of to secure the separation of the copper pyrites from the iron pyrites by the process described in my patent, but there is no well-defined line of demarcation between the temperature required to oxidize the sulfur of the copper pyrites and that required to oxidize the sulfur of the iron pyrites, independent of other conditions. In most pyritiferous ores the iron and copper pyrites, as well as the other minerals, are generally distributed throughout the mass, but in most cases, if the ore is crushed to that degree of fineness that it will pass through a screen having thirty meshes to the linear inch, the particles of copper pyrites will be mechanically separated from the iron pyrites, as well as from the other minerals. Such crushed material, however, obviously includes particles widely differing in bulk, surface, and weight, since it will include particles which just barely pass through the screen, as well as particles which, if separated out, would be so small as to form an impalpable powder. If we assume that the copper pyrites becomes, at a certain temperature and after a certain interval of time, four times as magnetic as the iron pyrites, and that the magnetic separator has a power to lift the particles in which the magnetic part of each particle is equal in weight to the non-magnetic part, then it follows that the small particles of iron pyrites will reach this magnetic condition as soon as the larger particles of copper pyrites, and that the operation of the magnetic separator would produce an imperfect result. This will be made clear by consideration of the case of definite particles, as shown by the following table, in which six cubes are given, which it is assumed correspond with particles of copper and iron pyrites that are to be found in the crushed ore:

Cube No.	Size in one dimension, given in thousandths of an inch.	Surface, given in thousandths of a square inch.	Weight, in grains.
1	2	24	4
2	4	96	16
3	6	216	36
4	8	384	64
5	10	600	100
6	12	864	144

Assuming that the copper pyrites becomes, at a certain temperature and after a certain interval of time, four times as magnetic as the iron pyrites, it is evident that when cube No. 1 of copper pyrites becomes one-half magnetic, cube No. 2 of copper pyrites will not be sufficiently magnetic to be affected by the separator. Although the surface of the larger

cube will be magnetic all over and the cube will actually have three and one-half times as much magnetic material, yet, since its weight is four times that of cube No. 1, it will not be lifted by the separator. If I keep the heat up for a longer period I may succeed in reaching the point where the copper-pyrites cubes 1, 2, and 3 will be acted on by the separator, but when I continue the heat until the copper cube No. 4 is sufficiently magnetic then the iron cube No. 1 will become sufficiently magnetic to be attracted by the separator, and so on throughout the series, the result being the imperfect separation already referred to.

The difficulty might be overcome to a certain extent by the grinding of the entire material to a great degree of fineness—for instance, to that point where it would all pass through a screen having two hundred meshes to the linear inch; but such grinding would make the process impracticable on account of the increased expense.

I have found that the difficulty can be overcome by taking the ore which has been crushed to that point where the particles of copper pyrites are mechanically freed and then separating the material into several lots having particles of approximately the same size. Where the preliminary crushing is carried to that extent that the material will all pass through a thirty-mesh screen, I have secured good results by dividing the material into eight different lots by means of screening it successively through screens of forty, fifty, seventy, ninety, one hundred and ten, one hundred and forty, one hundred and sixty, and two hundred mesh. The particles that fail to pass through the forty-mesh screen will form one lot; those which pass through the forty-mesh screen but fail to pass through the fifty-mesh screen will form another lot or group, and so on, the particles rejected by each screen forming a separate lot or group. In this way the particles of each lot or group will vary but little from each other in bulk, surface, and weight. Each lot or group of separated material is then heated separately in a heating-chamber, which is preferably a closed chamber capable of permitting a slight access of air, which chamber may be rotated, if found necessary, to prevent the fusion together of the particles. Under these conditions the oxidation of the extra atom of sulfur of the copper-pyrites particles can be so accurately controlled that the whole of them can be made sufficiently magnetic to be acted on by the magnetic separator before the iron-pyrites particles reach that condition. The temperature and period of heating are easily ascertainable by a trial with a magnet where the variation in the sizes of the particles is slight, and the interval between the time when the copper-pyrites particles are sufficiently magnetic to be separated and the time when the iron-pyrites particles commence to be sufficiently magnetic to interfere with the proper separation of the copper-pyrites particles is great enough to enable several color tests to be made by the furnace-man to ascertain if all the copper pyrites have been made magnetic. The difference is so marked where the particles are divided into lots or groups, according to my present invention, that a fine regulation of the temperature is not required, nor does the process need the attention of especially expert persons.

After each lot or group of material has been heated, as described, so as to make the copper-pyrites particles magnetic, the material is passed through a magnetic separator, as described in my patent, and the copper is withdrawn and subjected to treatment by any of the well-known processes.

After the copper-pyrites particles have been eliminated, the remaining ore, which may contain gold, galena, or other metallic ore than iron, is again heated, preferably in lots, as before described, until the iron-pyrites particles become sufficiently magnetic, when, by passing the material through a magnetic separator, the iron-pyrites particles will be withdrawn, leaving the gold, galena, or other ore to be treated by any appropriate process.

While I prefer to heat the ore containing the iron pyrites, after the copper pyrites has been withdrawn, in lots or groups, yet this is not essential, since the iron-pyrites particles retain their magnetic properties at a high heat if very little air is allowed access to the furnace, but the process is a more certain and more perfect one where the second heating is, like the first heating, carried on with lots of material having particles of approximately the same size.

The ores with which I have, up to the present time, used my process are of such a character that the copper pyrites gives off its sulfur more readily or at a lower temperature than the iron pyrites, and becomes magnetic first, but if ores should be found containing copper and iron pyrites in which the iron pyrites gives off its sulfur more rapidly or at a lower temperature than the copper pyrites my process would be applicable thereto, the only difference being that the iron pyrites would be extracted at the first separation and the copper pyrites at the second separation; but the process, when so modified, would come within the scope of my invention.

What I claim is—

1. The process of separating copper pyrites from iron pyrites, consisting in separating a crushed ore, containing both pyrites, into different lots, each containing particles of approximately the same size, and then heating the lots of material separately to make the copper pyrites magnetic, while the iron pyrites remains non-magnetic, and subsequently separating the copper pyrites by magnetic action, substantially as set forth.

2. The process of treating ores containing copper and iron pyrites and other non-magnetic metallic ore, consisting in first crushing

the ore, then separating it into several lots, each with particles of approximately the same size, then heating the ore until the copper pyrites becomes magnetic, while the iron pyrites remains non-magnetic, then separating the copper pyrites from the rest of the ore by a magnetic separator, then heating the tailings to make the iron pyrites magnetic, and then separating the iron pyrites from the remaining non-magnetic ore by a magnetic separator, substantially as described.

3. The process of treating ores containing copper and iron pyrites and other non-magnetic metallic ore, consisting in first crushing the ore, then separating it into several lots, each with particles of approximately the same size, then heating the ore until the copper pyrites becomes magnetic, while the iron pyrites remains non-magnetic, then separating the copper pyrites from the rest of the ore by a magnetic separator, then heating the tailings in separate lots, each containing particles of approximately the same size, to make the iron pyrites magnetic, and then separating the iron pyrites from the remaining non-magnetic ore by a magnetic separator, substantially as set forth.

This specification signed and witnessed this 27th day of June, 1892.

THOS. A. EDISON.

Witnesses:
RICHARD N. DYER,
JOHN F. RANDOLPH.