March 16, 1926. 1,576,690

G. ULLRICH

PROCESS AND APPARATUS FOR WET MAGNETIC SEPARATION

Filed Sept. 28, 1923

Fig. 4

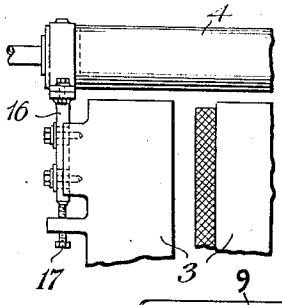


Fig. 1

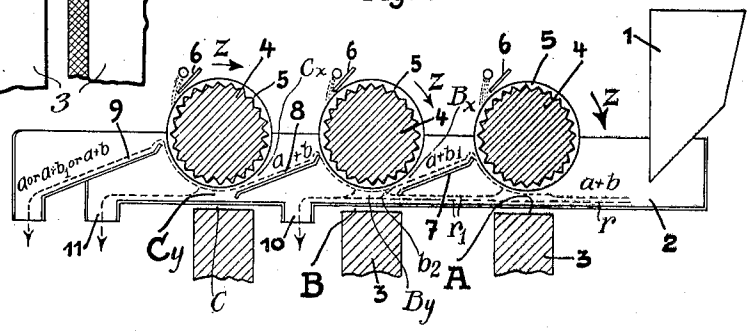


Fig. 2

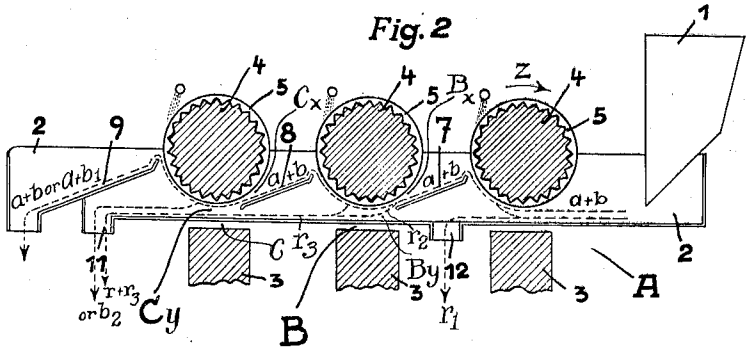
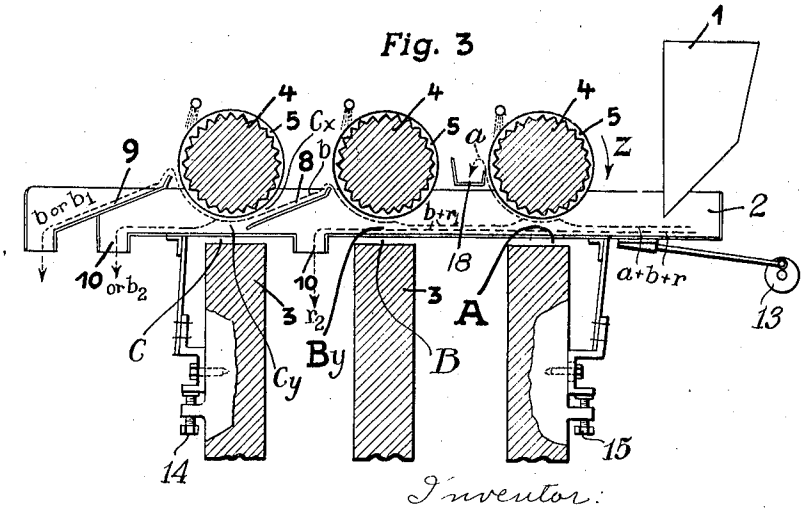


Fig. 3



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UNITED STATES PATENT OFFICE.

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PROCESS AND APPARATUS FOR WET MAGNETIC SEPARATION.

Application filed September 28, 1923. Serial No. 665,465.

To all whom it may concern:

Be it known that I, GEORG ULLRICH, engineer, citizen of the German Empire, residing at Nr. 2 Winterfeldstrasse, Magdeburg, Germany, have invented certain new and useful Improvements in Processes and Apparatus for Wet Magnetic Separation, of which the following is a specification.

The present invention relates to a process for the magnetic separation of material on a plurality of separating rolls, according to which the material unattracted by the first roll, as well as the material which is attracted, is subjected to the further separating action of rolls arranged one after the other. The purpose of the invention is to separate strong and weak magnetic ores irrespective of whether they are in a natural condition or have been previously treated, for instance roasted, and to obtain the greatest possible concentration and yield. This is achieved by conducting the material through the field gaps of a series of highly concentrated fields of force, the separated material and residues resulting from the action of the first field being subjected separately to the action of the succeeding fields, whereby the subsequent further separation of the magnetic material and of the residues takes place in the same fields but in different zones thereof. For the purpose of extracting the magnetic constituents of the raw ore in a high measure or according to different magnetic grades, the density of the fields may be varied from one another throughout or in part and may also be adjustable.

In the accompanying drawings, Figs. 1 to 3 illustrate three forms of separating plants for carrying out the present process, while Fig. 4 illustrates means for adjusting the rolls.

The constructional forms illustrated in Figs. 1 to 3 have the following in common:

From a hopper 1 the raw material is fed to a feed table 2, to which a vibrating movement is imparted, for instance, by means of the drive gear 13, Fig. 3. By means of the set-screws 14, 15, Fig. 3 the table 2 is adjustable to different heights and may also be suitably inclined longitudinally. In the examples illustrated, three separating rolls are provided. The magnet system of each separating place consists of a pole 3 and a magnetically induced roll 4. The latter rotates in a fixed drum 5 and may be toothed or grooved for obtaining a better magnetic effect. For the purpose of regulating the strength of the magnetic fields, the rolls or the counterpoles, or both, may be vertically adjustable. Fig. 4 illustrates means for accomplishing this displacement of the rolls. The rolls 4, as shown, are supported at both ends on standards 16 which are displaceable in guideways on the poles by means of set-screws 17. Means for elevating the poles are well known in the magnetic separator art. Means for adjusting the parts, for instance the rolls, along the feed table is especially desirable in wet separating process in which a film is used, and such means may be provided, as shown in my U. S. Patent No. 1,543,534.

The strength of each separating place can be adapted to the kind of material to be separated at each place.

The rotational speed of the single rolls or drums may be different; for instance, the second roll may rotate more rapidly than the first. In this manner, the layer of ore on the drum will be thinner and thereby a better separation and concentration will be obtained.

According to the drawings, the rolls are disposed at equal heights, but they may be disposed at different heights. This is requisite especially when the feed table is adapted to be longitudinally inclined. In known manner, the system as a whole may be adapted for longitudinal inclination.

The first step of the separating process up to complete first separation at the separating place A is common to all the constructional forms described below. The magnetic material separated at the point A rises on the drum 5 under the influence of the roll 4, rotating in the direction of the arrow *z*. It finally reaches a weak zone, with the drum 5, and falls from the drum or may be easily removed. With a fixed drum, a guide 6 may be conveniently provided for removing the material from the separating surface.

The residue from the separating point A, that is, the material not attracted at this point, remains on the feed table. After the first separation, the magnetic material and residues take independent courses through

succeeding separating places in which they are separated in different zones.

The course of the magnetic material is indicated in the drawings in broken lines, while the course of the residues is designated in dot and dash lines. The invention is not affected if between two separating points either the residue or an intermediate grade of magnetic material is withdrawn from the separator. If this is done, for special purposes, with the magnetic material or residues obtained at the first point of separation, the one retained will be again separated into two such divisions at the next point of separation and these will be independently conducted to the next separating point and there separated in different zones. Many forms of apparatus are adapted to carry out this process.

The following process, among others, is possible with the apparatus according to Fig. 1.

The highly magnetic material a, the weakly magnetic material b, and the non-magnetic material r, are first conducted through the field gap of a highly concentrated field of force A, formed by a fixed magnet pole 3 and an armature roll 4 rotating above same. The highly magnetic material a and a portion b^1 of the weakly magnetic material are attracted to the roll 4. The residues r^1, consisting of weakly magnetic and non-magnetic material, and the attracted particles $a+b^1$ are conducted to the next field of force B, but in different courses. The path of the particles $a+b^1$ is shown in broken lines in the drawings, while the path of the residues r^1 is designated in dot and dash lines. A second separation of the magnetic particles and residues takes place in the same field B, but in zones of different strength of this field. Thus, the magnetic material is subjected to the action of zone x which is weaker than zone y serving for treating the residues. The field at B y must be stronger than the field at A for the purpose of withdrawing the weakly magnetic material b^2 yet remaining in the residues r^1. This leaves the residue r^2. At the secondary treatment of the magnetic mixture in zone B x, a residue r^3 falls and unites with r^2 on the feed table 2. The particles $a+b^1$ again attracted at x to the armature roll pass with the rotating drum into the separating zone B y and unite there with the attracted weakly magnetic material. The particles a and b (b^1+b^2) are subjected to another separating action in zone x of the third separating place C, the residues r^2 and r^3 being previously led off at 10. The field C may be as strong as field B, or weaker, as required. In the first instance, only a further separation or purification of the entire magnetic constituent $a+b$ is effected, the product being then led off over the apron 9. In the second instance, according to the strength of the field, either only the highly magnetic particles will be attracted and discharged on the apron 9 while the weakly magnetic particles will pass off at 11, or also a portion of the weakly magnetic particles, for instance b^1, will be discharged on the apron 9, while the remainder b^2 will pass off at 11.

The following process is possible with the modification according to Fig. 2:

The field at A is the strongest and will attract all the magnetic particles. The residue r^1 escapes between A and B at 12. The fields B and C are weaker than field A. The non-metallic particles removed with the magnetic particles, are liberated as residues r^2 in zone B x and eventually as r^3 after leaving zone B y. The field C may be weaker than the field B; in this case, by regulation of the field strength, the grade of magnetic material removed on apron 9 may be exactly controlled. The residues r^2 r^3 are discharged at 11, as well as the weakly magnetic particles b^2, which cannot be utilized or are worthless. This process is designed for a highly magnetic material of simple composition.

The separating process according to Fig. 3 is as follows:

If, for example, granite, zinc, lead, or quartz ore, is to be treated as is often the case in Australia, the process may be so conducted that in the first field A the more highly magnetic ore a is attracted, field A being weaker than the field following it. The material retained on the drum at A is led from the apparatus by means of a trough 18, for instance.

In the second field, B, which is stronger than A, the weak zinc blende b, remaining in the residues of field A, is removed and this is also repeated in the third field C, while the residues from field B are discharged at 10. During the repeating action at C, in addition to purifying the magnetic material, it may naturally also be classified in different grades as regards magnetic permeability (b^1 and b^2).

It is essential for all the described modifications of the process, that the material to be separated be led through several, preferably different, highly concentrated fields of force, and that the magnetic material and residues resulting from the first separating action be conducted in different paths, but through the same fields whereby the separation of the magnetic particles from the residues takes place in different zones of different strength of these fields.

I claim:

1. The process of magnetic separation consisting in passing the material to be separated through a plurality of magnetic fields, freeing the magnetic material attracted in

one of said fields and the resultant unattracted residues from external magnetic influence, and passing said magnetic material and residues in superposed layers into the influence of a succeeding magnetic field.

2. The process of magnetic separation in multiple roll separators consisting in passing the material to be separated through the magnetic fields of said rolls, said fields being highly concentrated, freeing the magnetic material attracted in one of said fields and the resultant unattracted residues from external magnetic influence, and passing said magnetic material and residues independently of each other in superposed layers into the influence of a succeeding magnetic field in different zones thereof.

3. Apparatus for magnetic separation comprising a plurality of magnetic devices, means for passing the material to be separated into the field of one of said magnetic devices, means for separately removing the resultant magnetic material and residues from said field and means for delivering said magnetic material and residues into the field of a succeeding magnetic device in superposed layers.

4. A magnetic separator comprising a plurality of fixed magnet poles, respective magnetic separator rolls adjacent said poles, a feed table extending through the field gaps existing between said rolls and said poles, and aprons arranged between said rolls above said feed table whereby the material to be separated being passed along said table the magnetic particles attracted by the first roll and deposited on its cooperating apron are delivered thereby to the next magnetic field, the residues unattracted by said first roll being delivered by said feed table to said next magnetic field in a different zone thereof from said magnetic particles.

In testimony whereof the foregoing specification is signed.

GEORG ULLRICH.