CONVENTION

AUSTRALIA
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REQUEST FOR A STANDARD PATENT
AND NOTICE OF ENTITLEMENT

The Applicant identified below requests the grant of a patent to the nominated person identified below for an invention described in the accompanying standard complete patent specification.

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[54]Invention Title:
SORTING PROCESS AND APPARATUS

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[31,33,32]
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Applicant states the following:
1. The nominated person is the assignee of the actual inventor(s).
2. The nominated person is
   - the applicant
   - the assignee of the applicant
   - authorised to make this application by the applicant
   of the basic application.
3. The basic application(s) was/were the first made in a convention country in respect of the invention.

The nominated person is not an opponent or eligible person described in Section 33-36 of the Act.

26 March 1993
De Beers Industrial Diamond Division (Proprietary) Limited
By PHILLIPS ORMONDE & FITZPATRICK
Patent Attorneys
By
Our Ref: 323423
5999q
A method of sorting a particulate mass according to the oleophilicity of the particles of the mass, the method comprising the steps of treating the particles of the mass with an oil-containing substance in such a manner that oleophilic particles of the mass are at least partially coated with the substance, causing a material having specific properties to become associated with the coated particles, and sorting the particles according to whether they exhibit the specific properties.

2.
A method according to claim 1 wherein the material having specific properties is a material having magnetic properties and the particles are sorted in a magnetic separator.
3.
A method according to claim 2 wherein the particles are treated by causing them to pass through a body of a molten oil-containing substance.
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COMPLETE SPECIFICATION
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Name of Applicant:  
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Invention Title:  
SORTING PROCESS AND APPARATUS

Our Ref : 323423
POF Code: 1503/78726

The following statement is a full description of this invention, including the best method of performing it known to applicant(s):
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Complete Specification for the invention entitled:
SORTING PROCESS AND APPARATUS

Our Ref: IRN 323423

The following statement is a full description of this invention, including the best method of performing it known to applicant(s):
BACKGROUND TO THE INVENTION

THIS invention relates to a sorting process and apparatus. In particular, the invention relates to a process and apparatus for sorting particles according to their oleophilicity.

In one application of the invention, it may be used to sort diamond particles, which have oleophilic properties, from non-diamond or gangue particles which are not oleophilic, in a diamond bearing gravel.

Grease tables have already been used to separate diamond particles from gangue particles. These utilised a continuous layer of grease to which diamond particles would stick by virtue of the contact angles subtended at their contacting surfaces.
SUMMARY OF THE INVENTION

A first aspect of the invention provides a method of sorting a particulate mass according to the oleophilicity of the particles of the mass, the method comprising the steps of treating the particles of the mass with an oil-containing substance in such a manner that oleophilic particles of the mass are at least partially coated with the substance, causing a material having specific properties to become associated with the coated particles, and sorting the particles according to whether they exhibit the specific properties.

In one version of the invention, the material having specific properties is a material having magnetic properties and the particles are sorted in a magnetic separator. The particles may, for instance, be treated by causing them to pass through a body of a molten oil-containing substance. Preferably, this version of the invention includes the following steps:

- treating the particles of the mass with a molten, oil-containing substance so that oleophilic particles are at least partially coated with the substance;
- exposing the particles to a particulate, magnetic material so that magnetic particles adhere to the coatings of the coated particles, and
- sorting the particles into magnetic and non-magnetic fractions in a magnetic separator.
The method may include the further step, after exposure of the particles to the magnetic material and prior to sorting, of subjecting the particles to a low temperature to congeal the coatings of the coated particles and adhere the magnetic particles firmly thereto.

In another version of the invention, the material which is caused to adhere to the coated particles is a gas, typically air. This version of the invention preferably includes the following steps:

- the particles are introduced into the upper end of a body of liquid and are allowed to settle in the body of liquid,

- a molten oil-containing substance in droplet form and air bubbles are caused to rise in the body of liquid in opposition to the settling particles,

- oleophilic particles are allowed to acquire an at least partial coating of the oil-containing substance,

- air bubbles are allowed to adhere to the coatings of the coated particles, thereby to increase the buoyancy of those particles, and

- the particles are sorted according to their buoyancy.

Either version of the invention can be used to sort diamonds from other particles.
A second aspect of the invention provides an apparatus for sorting a particulate mass according to the oleophilicity of the particles of the mass, the apparatus comprising:

- means for treating the particles of the particulate mass with an oil-containing substance so that oleophilic particles acquire an at least partial coating of the oil-containing substance,

- means thereafter for causing the treated particles to contact a material having specific properties, and

- means for sorting the particles according to whether or not they exhibit the specific properties.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which Figures 1 and 2 diagrammatically illustrate two embodiments of the invention.

DESCRIPTION OF EMBODIMENTS

The illustrated embodiments can be used to sort diamond particles from gangue particles in a diamond-bearing gravel, the gravel typically being one recovered from diamond mining activities.
Figure 1 shows a vessel 10 containing, in a central region thereof, an aqueous magnetite suspension 12 which is recycled in a closed circuit 14 by means of a pump 16. A volume 18 of clear water lies above the suspension 12 and a further volume 20 of clear water lies beneath the suspension.

Floating on the upper surface of the upper volume 18 of water is a layer 22 of molten petroleum jelly. The molten state of the layer 22 is maintained by a suitable heating coil or the like (not shown). The numeral 24 indicates a feed stream of wet gravel which has been preheated to a temperature, in this case of around 80°C, but in any case higher than the congealing point of the petroleum jelly in the layer 22. The feed stream sinks through the layer 22 and oleophilic particles in the feed stream, primarily diamond particles, acquire an at least partial coating of molten jelly during their passage through that layer.

Having sunk through the layer 22, the particles gravitate through the suspension 12. Magnetite particles become embedded in the jelly coatings of the relevant particles, i.e. the oleophilic particles 24. There is no such embedment in the essentially non-oleophilic, uncoated particles 26.

Having gravitated through the suspension 12, the particles enter the lower volume 20 of water, which is cooled by any appropriate means to a temperature below the congealing point of the petroleum jelly. During their gravitational passage through the lower volume of water, the jelly coatings congeal to adhere the embedded particles securely to the oleophilic particles 24.
From the lower end of the vessel 10, the particles 24 and 26 are transferred to a magnetic separator, indicated generally with the numeral 28. The magnetic separator, which may be of conventional type, separates the particles into a magnetic fraction, composed of particles 24 and a non-magnetic fraction composed of particles 26. It will be appreciated that the process can operate substantially continuously with magnetic, i.e. primarily diamond particles, reporting in the magnetic fraction and non-magnetic, i.e. gangue particles, reporting in the non-magnetic fraction.

It will also be appreciated that passage of the particles through the suspension 12 and subsequent water volume will wash any weakly adhering jelly from the non oleophilic particles. Although petroleum jelly has been specifically mentioned, it will also be appreciated that many other oil-containing substances could also be used to provide the required coating on the oleophilic particles. Heating of the layer 22 may or may not be required, depending on the prevailing ambient temperature, to ensure that the layer exists in liquid form. Similarly, cooling of the water volume may or may not be required, depending on the ambient temperature and choice of substance used in the layer 22.

It will furthermore be understood that the particles may initially be preheated to avoid premature congealing of the jelly in the layer 22 before the particles reach the suspension 12.

In the example described above, the particles are treated with an oil-containing substance, i.e. the jelly, so that the oleophilic particles, i.e. the diamonds, are at least partially coated with that substance. A material
having specific properties, in this case a magnetic material in the form of magnetite, is then caused to adhere to the coated particles. Particle sorting can then take place on the basis of whether or not the particles exhibit magnetic properties.

Figure 2 illustrates a second embodiment of the invention. In this case, there is a vessel 100 containing liquid 102 in the form of water or an aqueous suspension. Fine particles are introduced into the liquid 102 through a feeder 104. Molten grease or another oil-containing substance is injected into the lower end of the vessel 100 through nozzles 106. The grease rises in the liquid 102 in droplet form in counter-current flow to the particles as the particles settle in the liquid.

Collision of the grease droplets with the settling particles causes the oleophilic particles 103, i.e. diamonds, to acquire an at least partial coating of grease, while non-oleophilic particles 105 are not so coated. The grease which rises to the surface of the liquid 102 can be withdrawn by suitable means and then recirculated through a circuit 108 containing a heater 110 that maintains the grease temperature high enough for it to remain the required molten state.

Located adjacent the nozzles 106 is an air sparging head 112 through which air is injected into the vessel 100 simultaneously with injection of the grease. Thus air bubbles 113 rise through the liquid 102 along with the grease droplets. The air bubbles become attached to the grease-coated particles and increase the buoyancy of those particles.
The smaller particles become sufficiently buoyant to float to the top of the vessel where they can be removed as a diamond rich fraction. Heavier particles may not acquire sufficient buoyancy to float to the top of the vessel, and these particles continue to settle through the liquid onto a conveyor belt which takes them to a dedicated flotation cell where the more buoyant diamond particles are separated from the other particles.

In this example of the invention, therefore, air is caused to adhere to the coated particles to give those particles the specific property of increased buoyancy.

In a refinement of the Figure 2 technique, it would be possible to inject fine magnetite particles along with the air or grease. In this case, the coated particles acquire both increased buoyancy as a result of air bubble adherence and magnetic properties as a result of adherence of the magnetite. Both flotation and magnetic separation techniques can then be used to separate the diamond particles from the other particles.

In the last-mentioned version it may prove necessary to precondition the particle feed to remove lightly magnetic particles.

In each of the embodiments discussed above the particles are preconditioned if necessary to expose the surfaces of the diamond particles. This may, for instance, be done by attritioning the particles in an abrasive suspension such as a suspension of ferrosilicon.
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:—

1. A method of sorting a particulate mass according to the oleophilicity of the particles of the mass, the method comprising the steps of treating the particles of the mass with an oil-containing substance in such a manner that oleophilic particles of the mass are at least partially coated with the substance, causing a material having specific properties to become associated with the coated particles, and sorting the particles according to whether they exhibit the specific properties.

2. A method according to claim 1 wherein the material having specific properties is a material having magnetic properties and the particles are sorted in a magnetic separator.

3. A method according to claim 2 wherein the particles are treated by causing them to pass through a body of a molten oil-containing substance.
4. A method according to claim 1 which includes the following steps:

- treating the particles of the mass with a molten, oil-containing substance so that oleophilic particles are at least partially coated with the substance;

- exposing the particles to a particulate, magnetic material so that magnetic particles adhere to the coatings of the coated particles, and

- sorting the particles into magnetic and non-magnetic fractions in a magnetic separator.

5. A method according to claim 4 wherein, after exposure to the magnetic material and prior to sorting, the particles are subjected to a low temperature to congeal the coatings of the coated particles and adhere the magnetic particles firmly thereto.

6. A method according to claim 1 wherein the material which is caused to adhere to the coated particles is a gas.
7. A method according to claim 6 wherein the gas is air.

8. A method according to claim 6 or claim 7 wherein:

- the particles are introduced into the upper end of a body of liquid and are allowed to settle in the body of liquid,

- a molten oil-containing substance in droplet form and air bubbles are caused to rise in the body of liquid in opposition to the settling particles,

- oleophilic particles are allowed to acquire an at least partial coating of the oil-containing substance,

- air bubbles are allowed to adhere to the coatings of the coated particles, thereby to increase the buoyancy of those particles, and

- the particles are sorted according to their buoyancy.

9. A method according to any one of the preceding claims when used to sort diamonds from other particles.
10. An apparatus for sorting a particulate mass according to the oleophilicity of the particles of the mass, the apparatus comprising:

- means for treating the particles of the particulate mass with an oil-containing substance so that oleophilic particles acquire an at least partial coating of the oil-containing substance,

- means thereafter for causing the treated particles to contact a material having specific properties, and

- means for sorting the particles according to whether or not they exhibit the specific properties.

11. A method of sorting a particulate mass according to the oleophilicity of the particles of the mass substantially as herein described with reference to Figure 1 or Figure 2 of the accompanying drawings.

12. An apparatus for sorting a particulate mass according to the oleophilicity of the particles of the mass substantially as herein described with reference to Figure 1 or Figure 2 of the accompanying drawings.

DATED: 26th March, 1993
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ABSTRACT

The invention is concerned with a method sorting a particulate mass according to the oleophilicity of the particles of the mass. Firstly, the particles (24,26) of the mass are treated with an oil-containing substance (22) in such a manner that oleophilic particles (24) of the mass are at least partially coated with the substance (22). Next, the particles (24, 26) are exposed to a material (12) having specific properties so that the material adheres to the coated particles (24). Finally, the particles (24, 26) can be sorted according to whether they exhibit the specific properties.