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(71) Applicant: **TECHNOLOGICAL RESOURCES PTY LIMITED** [AU/AU]; 123 Albert Street, Brisbane, queensland 4000 (AU).

(72) Inventors: **CHIN, Eugene Chji-Hueh**; 95 Bungaree Road, Wilson, Western Australia 6107 (AU). **ANDERSON, Rohan**; c/- Level 7, 15-17 William Street, Perth, Western Australia 6000 (AU). **BOX, John Clarence**; c/- Level 7, 15-17 William Street, Perth, Western Australia 6000 (AU).

(74) Agent: **GRIFFITH HACK**; Level 19, 109 St Georges Terrace, Perth, Western Australia 6000 (AU).

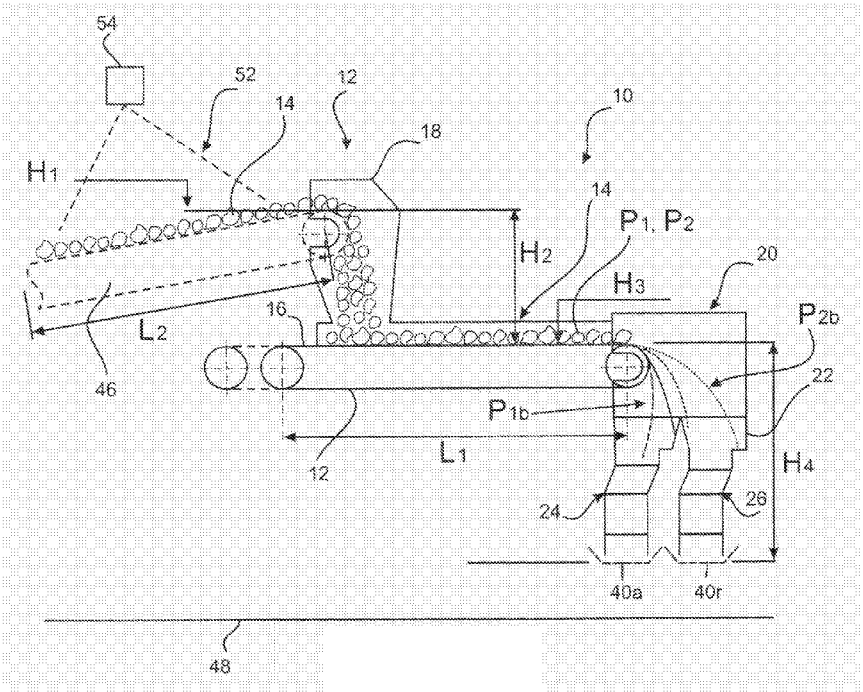
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(54) Title: MINED MATERIAL BULK SORTING SYSTEM AND METHOD



(57) Abstract: A system and method provide a plurality of flow paths for mined material and facilitates a variation in launch or discharge velocity of the mined material to control or vary the trajectory of the mined material into free space to follow respective flow paths on the basis of an assessed bulk characteristic of a segment of the mined material. The variation in velocity results in the segments having physically separated down stream flow paths. The separation in flow paths enables different segments of material with different characteristics to be sorted and separated into respective stock piles.

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MINED MATERIAL BULK SORTING SYSTEM AND METHOD

TECHNICAL FIELD

A system and method are disclosed for bulk sorting of mined material.

BACKGROUND ART

Applicant's prior international publication no. WO 2011/150464 discloses a method and apparatus for sorting mined material. This publication discloses the general concept of bulk sorting on the basis of a measured characteristic of a segment of mined material rather than on a particle by particle basis. The present disclosure seeks to provide an enhancement to the method and system disclosed in international publication no. WO 2011/150464.

The above reference to the background art does not constitute an admission that the art forms a part of the common general knowledge of a person of ordinary skill in the art. The above reference is also not intended to limit the application of the system and method as disclosed herein.

SUMMARY OF THE DISCLOSURE

In broad terms the present disclosure is for a system and method that provides a plurality of flow paths for mined material and facilitates a variation in launch or discharge velocity of the mined material to control or vary the trajectory of the mined material into free space to follow respective flow paths on the basis of an assessed bulk characteristic of a segment of the mined material. The bulk characteristic may for example be grade of the segment.

The term " mined material" throughout the specification is intended to include material that is mined irrespective of whether or not (a) the material has need subjected to any form of diversion or sorting subsequent to being mined; or (b) has been stockpiled for a period of time. Thus for example the mined material can include mined material that has been passed through a crusher; or other processing equipment including one or more screens for the purpose of fractionation on the basis of particle size. It may also of course comprise the total tonnage of raw mined material which has not been subjected to any processing, diversion or sorting. This form of mined material is sometimes known or designated as primary mined material.

The mined material may be any form of mined material derived from either an open cut mine or an underground mine. The substantive mineral in the mined material is of no significance. Nevertheless the system and method are operable in relation to the mining of iron ore.

The disclosed method and system are also particular although no exclusively operable in relation to mined material being material which has been mined and subjected only to primary crushing. The primary crushing of mined material may produce for example material having particle sizes ranging from dust through to rocks and boulders having a size of about 300mm – 350mm. Although not limited to such an application, the system and method are suited to bulk sorting of mined material having a particle size distribution in the range of P_{95} 300mm-350mm. By way of brief explanation and example P_{95} 300mm means that the mined material has a size distribution where 95% of the mass of the particles in the material have a size smaller than 300mm. In this context, the term "particle" is understood in a broad sense to include, by way of example, any one or more of large and small rocks, large and small stones, sand like particles, fines and dust.

The disclosed method and system are also operable in relation to mined material that has been screening to produce two or more size fraction streams of mined material. In the event that the mined material is initially sorted by way of size fractions embodiments of the disclosed system and method may (a) be performed in relation to the individual streams or (b) be performed in relation to only one of the streams with a sorting decision made in relation to that one stream being applied to the other(s).

In the context of this specification the term "segment" or "segments" of mined material is to be understood to be any suitable amounts of material having regard to the relevant factors for the mined material. The relevant factors may include the type of mined material, such as iron ore, copper-containing ore, etc, and the capacities of the presentation, grade analysis, and diversion system incorporated in the sorting system and method.

The segments of mined material may be the same size or different sizes.

The size of the segments of mined material may be determined on the basis of the mass of the segments. For example, in the case of iron ore, the size of the segment may be at least 20 tonne and typically at least 100 tonne.

The size of the segments of the mined material may be determined on the basis of the amount of mined material that passes an analysis or grading zone on a transport system in a given time period. For example, in the case of iron ore, the time period may be the amount of iron ore transported on a transport system for a 30 second period of time moved at rates of up to 2,500 – 3,5000 tonnes/hr.

The size of the segments of the mined material may be determined on the basis of the amount of mined material that passes an analysis or grading zone and is assessed as having on average a particular grade. While the assessed average grade remains the same the material pertains to the same segment so that the segment may continuously increase in size. This will continue until the average grade of material in the zone is assessed as having a different grade. This then forms the demarcation between segments. In this way the segments may be of variable size/volume rather than of fixed sized or volume.

The size of the segments of the mined material may be determined on the basis of the type of mining equipment used to handle the ore. For example, in a situation where a mine operates on a drill and blast basis and material is moved by excavators and trucks, the size of the segments may be determined on the basis of the load capacity of the excavators that load mined material into the trucks and/or the load capacity of the trucks. By way of further example, in the situation where a mine operates on a surface mining basis, with the mined material being excavated from a pit floor and transferred to an in-pit conveyor, the size of the segments may be determined on the basis of supply hoppers for the conveyors. In a further arrangement where mined material is transferred directly following mining, or after stock piling, to a crusher (primary or otherwise), the segment may be commensurate with either the capacity of the crusher, or the rate of feed of the mined material to the crusher so as to maintain a continuous flow of mined material through the crusher.

In one embodiment a segment may comprise a single particle of mined material. This embodiment may be beneficial and have enhanced practicality in the event that each particle is of size at the high end of the normal particle size distribution range, for example particles in the order of 300mm-350mm.

The term "grade" in the context of the present specification is understood to mean the concentration of one or more element(s) or mineral(s) or mineral assemblage of interest in the mined material. Grade analysis may be performed by any appropriate analyser having the capability to grade for the element or mineral of interest. One possible grade analyser is a prompt gamma neutron activation analyser (PGNAA). A further possible grade analyser may be based on the magnetic resonance response to ore radiated with RF radiation as described in the CSIRO publication "Resourceful" Issue 2 November 2012 pp8,9. Another possible form of analyser is a laser induced breakdown spectrometer. However embodiments of the invention are not limited to a specific type of analyser but rather simply to an analyser that is able to detect for a target mineral or element of interest.

In a first aspect there is disclosed a mined material bulk sorting system comprising:

a plurality of mutually divergent flow paths along which one or more segments of the mined material can traverse, the plurality of flows paths having a section in common along which all segments traverse and downstream thereof respective mutually divergent sections that extend through free space; and

a segment launch system arranged to launch a segment at one of a plurality of different velocities in accordance with an assessed grade of that segment so that a launched segment flows along one of the divergent sections commensurate with the assessed grade.

In one embodiment the segment launch system comprises a variable speed conveyor by which the segments are traversed along the common section of the flow paths.

In one embodiment the mined material bulk sorting system is arranged to vary speed of the variable speed conveyor to enable launching of respective segments into one of the plurality of mutually divergent sections of the flow paths.

In one embodiment the plurality of flow paths is provided at least in part by a discharge chute configured to enclose a length of each flow part.

In one embodiment the discharge chute comprises a plurality of separate chutes one for each of the flow paths, each of the separate chutes defining a part of a respective flow path.

In one embodiment each of the separate chutes has a respective inlet wherein the inlets are laterally spaced from each other.

In one embodiment the system comprises at an end of each of the separate chutes a respective underlying conveyor arranged to convey material flowing through a corresponding separate chute to a respective remote location.

In one embodiment the discharge chute comprises an energy dissipation system arranged to dissipate kinetic energy from a segment after discharge from the segment launch system.

In one embodiment the energy dissipation system comprises one or more rock boxes or ledges disposed in the discharge chute.

In one embodiment the energy dissipation system comprises one or more rock boxes or ledges disposed in one or more of the separate chutes.

In one embodiment the variable speed conveyor is capable of providing a variation in launch velocity of segments of different assessed grade sufficient to create a lateral separation distance of respective divergent sections of the flow paths of at least 50 mm at a vertical drop distance from the variable speed conveyor upstream of the inlets.

In one embodiment the variable speed conveyor is capable of providing a variation in launch velocity of segments of different assessed grade sufficient to create a lateral separation

distance of respective divergent sections of the flow paths of between about 50mm-450mm at a vertical drop distance from the variable speed conveyor upstream of the inlets.

In one embodiment the vertical drop distance is between 1m-2m from an upper run of the variable speed conveyor.

In one embodiment the embodiment the variable speed conveyor is capable of providing a differential in launch velocity of segments of different assessed grade of between 1-2m/s.

In one embodiment the variable speed conveyor has a length in the range of about 8m-20m.

In one embodiment the variable speed conveyor has a length of about 8m.

In one embodiment the segment launch system is arranged to enable a load carrying capacity of up to about 3000 tonnes per hour (TPH) and in any event at least about 1000-1200 TPH of the mined material.

In one embodiment the variable speed conveyor is configured to have a troughing angle of between 35° and 45°. In this or alternate embodiments the variable speed conveyor may have a width of up to 2 meters within which to accommodate the troughing angle.

In one embodiment a vertical distance between the variable speed conveyor and the end of a separate chute in the discharge chute is in the order of about 4m.

In one embodiment the segment launch system comprises part of a transport system which is arranged to transport one or more segments of the mined material through an analysis zone in which grade of the one or more segments is assessed while the one or more segments are being transported through the zone.

In one embodiment the transport system comprises a conveyor arranged to transport a segment through the analysis zone.

In one embodiment the conveyor is arranged to transport the segment to the variable speed conveyor.

In one embodiment the conveyor is juxtaposed relative to the variable speed conveyor such that a segment transported by and discharged from the conveyor drops a vertical distance of between 1m-3m to reach the variable speed conveyor.

In one embodiment the vertical distance is between 1.5m – 2.5m.

In one embodiment the system comprises a feed chute arranged to confine the material discharged from the conveyor and direct the material onto the variable speed conveyor. In this embodiment the feed chute comprises an energy dissipation system arranged to dissipate kinetic energy from material after discharge from the conveyor. In this embodiment the energy dissipation system may comprise one or more rock boxes or ledges disposed in the feed chute.

In one embodiment the conveyor is arrange to provide a vertical lift of between 8-10m above a datum level.

In one embodiment the variable speed conveyor is located such that a common section of the flow paths is disposed at a vertical height of between 5m-9m above the datum.

In one embodiment the mined material bulk sorting system comprises a mined material grade analyser operable to assess a grade of a segment of material passing the analysis zone.

In one embodiment the analysis zone is extends along a length of the conveyor.

In one embodiment the mined material bulk sorting system comprises skirt boards extending along opposite sides of the variable speed conveyor.

In a second aspect there is provided a mined material bulk sorting system comprising:

a discharge chute having a plurality of mutually spaced flow paths each flow path provided with a respective inlet and wherein the inlets are mutually spaced from each other;

a mined material grade analyser operable to assess the grade of successive segments of the mined material; and,

a transport system arranged to transport the successive segments to: an analysis zone enabling the grade analyser to assess the grade of the segments; and subsequently to the diversion system;

the analyser operatively associated with the transport system to facilitate a variation in speed of the transport system to control trajectory of the segments discharged from the transport system into one of the flow paths on the basis of the assessed grade of the segments.

In one embodiment the transport system comprises a conveyor and a variable speed conveyor downstream of the conveyor, the conveyor arranged to transport the or each segment to the analysis zone and towards the variable speed conveyor.

In one embodiment the variable speed conveyor is arranged to receive segments transported by the conveyor and transport the or each segment to the discharge chute.

In one embodiment the analyser is arrange to facilitate a variation in speed of the variable speed conveyor to thereby control the trajectory of the or each segment.

In one embodiment the transport system is arranged to enable a variation of transport of a segment of up to 2m/s.

In one embodiment the variable speed conveyor is arranged to enable a variation in velocity of transport of a segment of up to 2m/s.

In one embodiment of either aspect each flow path comprises a corresponding pathway through which a segment can flow to a corresponding outgoing conveyor arranged to convey that segment to a discharge location.

In one embodiment of either aspect mined material bulk sorting system is arranged to transport the or each segment comprising particles having a particle size up to about 300mm-350mm.

In a third aspect there is disclosed a method of bulk sorting mined material comprising:

discharging or launching, at one of a plurality of different velocities, a segment of the mined material to fall through free space wherein the plurality of different velocities are selected on a basis of an assessed grade of the segment and wherein the plurality of different velocities is such that segments discharged or launched at different ones of the velocities follow mutually divergent flow paths.

In one embodiment the method comprises setting the plurality of different velocities so as to cause a lateral separation between the mutually divergent flow paths of at least 50 mm after segments fall a designated vertical distance through the free space.

In one embodiment the method comprises setting the plurality of different velocities so as to cause a lateral separation between the mutually divergent flow paths of between 50mm to 450mm after segments fall a designated vertical distance through the free space.

In one embodiment the plurality of different velocities is selected so as to cause the lateral separation at a vertical fall distance of 1m-2m.

In one embodiment the method comprises varying the discharge or launch velocities by between 1-2m/s for segments of different assessed grade.

In one embodiment the method comprises transporting a segment of material a distance of between about 8m-20m before discharging or launching the segment into free space.

In one embodiment the method comprises discharging or launching the mined material as one or more segments at a rate of up to 3000 tonnes per hour (TPH).

In one embodiment the method comprises discharging or launching the mined material as one or more segments at a rate of 1000-1200 tonnes per hour (TPH).

In one embodiment the method comprises transporting the mined material through an analysis zone in which grade of the material is assessed while being transported through the zone.

In one embodiment the method comprises demarcating one segment from an adjacent segment when there is a change in the average grade of material in the analysis zone.

In one embodiment the method comprises transporting the material at a constant velocity through the analysis zone.

In one embodiment the method comprises after the material has passed through the analysis zone displacing the material by a vertical distance of between 1m-3m prior to discharging or launching segments at respective ones of the plurality of different velocities commensurate with the assessed grade of the segment.

In one embodiment the method comprises elevating the material by a total vertical distance from a datum of 8m-10m prior to discharging or launching the material as part of a segment into free space.

In one embodiment the method comprises confining the segments of material in a discharge chute for at least a portion of their flow paths that extent through the free space.

In one embodiment the method comprises arranging the discharge chute to have a plurality of separate chutes one for each of the flow paths and spacing the separate chutes from each other such that substantially all of the material in a segment flows into a separate chute corresponding to the assessed grade of that segment, the separate chutes defining a part of a respective flow path.

In one embodiment the method comprises confining the material in a feed chute after the material has passed through the analysis zone and displacing by the vertical distance of between 1m-3m prior to discharging or launching segments.

In one embodiment of the method the mined material is a metal ore.

In one embodiment of the method the mined material is metal ore having a particle size distribution in the order of P_{95} 300mm-350mm.

In one embodiment the method comprises subjecting the metal ore to crushing prior the discharging or launching of segments of the material.

In one embodiment method comprises confining the segments of material in a discharge chute for at least a portion of their flow paths that extent through the free space.

In one embodiment the method comprises arranging the discharge chute to comprise a plurality of separate chutes one for each of the flow paths and spacing respective inlets of the separate chutes such that substantially all of the material in a segment flows into the inlet of a separate chute corresponding to the assessed grade of that segment, the separate chutes defining a part of a respective flow path.

In one embodiment the method comprises dissipating kinetic energy of the segment while flowing through the discharge chute.

In a fourth aspect there is disclosed a mined material bulk sorting system comprising:

a particle size sorting system arranged to sort a feed of particles into a plurality of different size fraction streams;

for each size fraction feed stream: a plurality of mutually divergent flow paths along which one or more segments of the mined material in that feed stream can traverse, the plurality of flows paths having a section in common along which all segments traverse and downstream thereof respective mutually divergent sections that extend through free space; and a segment launch system arranged to launch a segment at one of a plurality of different velocities;

wherein the respective segment launch systems for the feed streams are controlled together to launch all of the respective corresponding segments at one of a plurality of different velocities in accordance with an assessed grade of any one of the respective corresponding segments so that each of the respective corresponding segments is of substantially the same size and launched to flow along one of the divergent sections commensurate with the assessed grade.

In a fifth aspect there is disclosed mined material bulk sorting system comprising:

a particle size sorting system arranged to sort a feed of particles into a plurality of different size fraction feed streams;

for each size fraction feed stream: a plurality of mutually divergent flow paths along which one or more segments of the mined material in that feed stream can traverse, the plurality of flows paths having a section in common along which all segments traverse and downstream thereof respective mutually divergent sections that extend through free space; and a segment launch system arranged to launch a segment at one of a plurality of different velocities;

wherein the respective launch systems for the feed streams are controlled independently of each other to launch respective corresponding segments at one of a plurality of different velocities in accordance with a assessed grade of material in the corresponding segment so that each of the respective corresponding segments is launched to flow along one of the divergent sections commensurate with its assessed grade.

In a sixth aspect there is disclosed a method of bulk sorting mined material comprising:

sorting a feed stream of minded material into a plurality different size fraction feed streams;

for each size fraction feed stream: discharging or launching, at one of a plurality of different velocities, a segment of the mined material of that feed stream to fall through free space wherein the velocities are selected such that segments discharged or launched at different ones of the velocities follow mutually divergent flow paths;

wherein the size and the launch or discharge velocity of the segments for all of the feed streams is determined on a basis of an assessed grade of the segment of any one of the feed streams.

In a seventh aspect there is disclosed a method of bulk sorting mined material comprising:

sorting a feed stream of minded material into a plurality different size fraction feed streams;

for each size fraction feed stream: discharging or launching, at one of a plurality of different velocities, a segment of the mined material of that feed stream to fall through free space wherein the velocities are selected such that segments discharged or launched at different ones of the velocities follow mutually divergent flow paths;

wherein the size and the launch or discharge velocity of segments of mined material for each of the feed streams is determined independently of each other on a basis of an assessed grade of each segment.

BRIEF DESCRIPTION OF THE DRAWINGS

Notwithstanding any other forms which may fall within the scope of the apparatus and method as set forth in the Summary, specific embodiments will now be described, by way of example only, with reference to the accompanying drawings in which:

Figures 1a and 1b provide a schematic representation of a principle of operation of an embodiment of a mined material bulk sorting system;

Figure 2 is a schematic representation of a mined material bulk sorting system which utilises the operating principle shown in Figures 1a and 1b;

Figure 3 is a schematic representation in section view of a variable speed conveyor incorporated in the system shown in Figure 2;

Figure 4 is an enlarged view of a discharge chute incorporated in the system shown in Figure 2;

Figure 5 is a flowsheet depicting steps in one embodiment of the method of the of bulk sorting mined material;

Figure 6a is a schematic representation of a second embodiment of mined material bulk sorting system; and

Figure 6b is a schematic representation of a third embodiment of the mined material bulk sorting system.

DESCRIPTION OF EMBODIMENT(S)

Figures 1a and 1b depict a general principle behind embodiments of the disclosed mined material bulk sorting system 10 (shown in Figure 2) and method (shown in Figure 4). Figures 1a and 1b depict a trajectory profile or envelope for mined material launched into free space by the same conveyor 12 but travelling at different speeds. Thus the conveyor is a variable speed conveyor ("VSC") and is hereinafter referred to as VSC 12. In Figure 1b the VSC 12 is travelling at a speed greater than that than in Figure 1a. For example Figure 1a may represent a segment of material being launched from VSC 12 at a speed of about 1.25m/second while in Figure 1b a comparable segment is being launched or discharged at a speed of about 2.4m/second.

The trajectory profile in Figure 1a may be defined by an envelope having an inner boundary b1 and an outer boundary b2. In Figure 1b, the trajectory profile of the segment is defined by an envelope having an inner boundary b3 and an outer boundary b4. It will be noted that the two trajectory profiles or envelopes are spaced by different lateral distances from a common vertical datum line Y. The difference in lateral spacing is such that the two trajectory envelopes do not overlap. In particular a lateral distance X2 of the envelope boundary b2 in Figure 1 is less than the lateral distance X3 from the envelope boundary b3 in Figure 1b. This difference between X2 and X3 provides a physical separation of segments launched from the VSC 12 at different velocities. This then enables a separation or sorting of segments.

The speed at which the VSC 12 transports and subsequently launches a segment of material into free space is dependent on an assessed grade of the material within the segment. The assessed grade is an average grade of the material within the segment. For example a segment of material which is analysed as having on average an "accept" grade may be carried by the conveyor at the first speed V1such that the material when launched or discharged a VSC 12 follows the trajectory envelope of Figure 1a. On the other hand a different segment of material assessed as having on average a "reject" grade is conveyed at a higher speed V2 so that when launched or discharged from the VSC 12 follows the trajectory enveloped shown in Figure 1b.

All of the material passing through the system 10 follows a particular flow path P. The flow path has at least two portions or sections. A first portion or section is constrained and determined by the physical configuration of the VSC 12. This portion of the flow path is in essence identical to the path of an upper run of the VSC 12. Accordingly the first portion is common to each flow path P. However the flow path P also has a contiguous second portion or

section where the segment is launched from the VSC 12 and falls through free space. The second portions are divergent when the material is launched at different velocities.

Figure 1a depicts a first flow path P1 having a first portion P1a which is constrained to the physical path of travel of an upper run of the VSC 12. The flow path P1 also has a second contiguous portion P1b being the path of the segment when falling through free space after being launched or discharged from VSC 12. The portion P1b is defined by the trajectory envelope bound by the inner and outer boundaries b1 and b2.

Figure 1b shows the flow path P2 for a segment of material travelling on the VSC 12 but at a different (higher) velocity. The flow path P2 also has a first portion or section P2a and a second portion P2b. It will be recognised that the portion P2a is constrained by and identical to the path of the upper run of the VSC 12. This is of course common with or identical to the flow path portion P1a at least upstream of a location on the VSC 12 where the material leaves the VSC 12 at the higher of the respective velocities. However the portion of the flow path P2b diverges from the portion P1b. It is the mutually divergent path portions P1b and P2b arising from different launch speeds that facilitate embodiments of the system 10 and method 100. This will now be explained in greater detail with reference to Figure 2.

Figure 2 illustrates an embodiment of a mined material bulk sorting system 10 which incorporates the principles described above in relation to Figures 1a and 1b regarding the difference in trajectory of material launched or otherwise discharged from an end of a VSC 12. The system 10 comprises a plurality of flow paths, in this instance two flow paths, P1 and P2 along which one or more segments of mined material can traverse. The flow paths P1 and P2 have a respective section in common namely P1a and P2a along which all segments of mined material traverse. Downstream of the common sections P1a and P2b the paths P1 and P2 have mutually divergent sections namely P1b and P2b that extend through free space. In this embodiment a VSC 12 constitutes a segment launch system which is arranged to launch segments of the material 12 at one of a plurality of different velocities in accordance with an assessed grade of that segment of material 12. The plurality of velocities are arranged so that the segments launched or discharged from the end of VSC 12 follow one of the divergent sections P1b or P2b of the flow paths P1, P2 in accordance with the assessed grade. In this embodiment material having an “accept” grade is ejected at a velocity V1 so as to follow the divergent path section P1b. A segment of material 12 having a “reject” grade is discharged or launched from the VSC 12 at a velocity $V2 > V1$ so as to follow the divergent flow path section P2b. In this way the mined material 12 is sorted into two different grades.

The VSC 12 is configured and orientated so that the common sections P1a and P2a of the flow paths is horizontal. To this end, the VSC 12 has an upper run 16 that receives material

14 from a feed chute 18 and traverses the material 14 horizontally to a discharged chute 20. Figure 3 depicts the cross sectional area of the upper run 16 loaded with the material 14 when being traversed from the feed chute 18 to the discharge chute 20. The upper run 16 is shaped so that the material 14 held thereon has a substantially trapezoidal cross sectional shape. The trapezoid has a width W along one edge opposite sides of each of a length p. The VSC 12 is arranged so that dimensions of W and p and troughing angle λ provide sufficient area to enable a designed through put of the system 10. Examples of these dimensions are provided later in this description.

A discharge end of the VSC 12 extends into the discharge chute 20. The discharge chute 20 confines the material 14 to flow within one of the two paths P1 and P2 in accordance with the launch velocity. Discharge chute 20 is substantially enclosed to also minimize and reduce dust emission.

The chute 20 has an upstream portion 22 dimensioned to accommodate the divergent sections P1b and P2b of the flow paths P1 and P2. Downstream of the section 22 are two separate chutes namely an accept chute 24a and a reject chute 24r. Material 14 which is assessed as having the accept grade falls substantially exclusively in the path P1b and subsequently through the accept chute 24a. Material 14 assessed as having a reject grade is launched from the VSC 12 at a higher velocity and follows the flow path portion P2b so as to fall substantially exclusively into and through the reject chute 24r. The accept chute 24a has a notional inlet 28a while the reject chute has an adjacent notional inlet 28r. The inlets 28a and 28r are separated by a ridge 32 formed by the meeting of walls 34 and 36 of the chutes 24a and 24r respectively.

The discharge chute 20 is configured so that at least part of the flow paths P1 and P2 is confined within the chute 20. Indeed, the chute 20 is configured so that a portion of the common paths P1a and P2a is confined to the upstream portion 22 while a downstream portion of each of the divergent sections P1b and P2b of the flow paths are confined to the accept chute 24a and the reject chute 24r respectively. Further, the variation in speed of the VSC 12 is arranged to ensure that a spacing S (see Figure 4) between the respective trajectory envelopes of paths P1b and P2b, coupled with the location of the ridge 32 ensures that material 14 flowing in the path P1 substantially only enters the inlet 28a of the accept chute 24a, while material 14 flowing through the path P2 falls substantially exclusively into the inlet 28r of the reject chute 24r.

The chute 20 also includes an energy dissipation system arranged to dissipate kinetic energy from segments of material 14 after discharge from the VSC 12. The energy dissipation system is the form of rock boxes 38a and 38r (hereinafter referred to in general as “rock boxes

38"). The rock boxes 38 are provided in each of the accept chute 24a and reject chute 24r near but downstream of the respective inlets 28a and 28r. The rock boxes 38 are located so that a substantial volume of material flowing in the respective flow paths P1 and P2 initially lands in the rock boxes thereby dissipating energy prior to falling further down the respective chutes. The general idea of the energy dissipation system is to minimize the impact force of particles of the material 14 on respective conveyors 40a and 40r at a downstream open end of the respective chutes 24a and 24r. The conveyors 40a and 40r transfer the material falling within the respective chutes to respective locations for stockpiling or further processing.

It will be further noted particularly from Figure 4 that each of the chutes 24a and 24r is formed with an intermediate section 42a and 42r respectively that is skewed or tapered in a direction toward the VSC 12 and opposite the common path portions P1a and P2a. This creates tapered surfaces 44a and 44r that may act as impact surfaces for material falling within the respective flow paths P1 and P2. Impacting on these surfaces further assists in dissipating energy prior to particles of material landing on the respective underlying conveyors 40a and 40r.

Returning to Figure 2, the feed chute 18 is arranged to be fed with a supply of mined material 14 via an inclined conveyor 46. The conveyor 46 conveys the material 14 at a constant velocity. It also elevates or lifts the material from a datum level 48 which may for example be ground level. The lift or elevation provided to the material 14 prior to discharge into the feeding chute 18 is designated as height H1 from the datum level 48. This elevation provides the free space drop for the material 14 when discharged from the VSC 12 to thereby create the divergent flow path portions P1b and P2b.

The purpose of the feed chute 18 is to transfer the material 14 from the conveyor 46 onto the VSC 12 in a relatively controlled manner minimising impact and thus damage onto the VSC 12. To this end the feed chute 18 may be provided with an energy dissipation system which may for example comprise one or more rock boxes or ledges (not shown) to reduce impact energy of particles constituting the material 14. In this particular depicted embodiment skirt boards 50 are provided on opposite sides of the upper run 16 of the VSC 12 adjacent to and downstream of the feeding chute 18. The skirt boards 50 assist in minimising generation of dust and confining the material to the VSC 12. In this embodiment the skirt boards 50 extend for the full length from the feeding chute 18 to the discharge chute 20. The vertical drop from the conveyor 46 to the VSC 12 is represented by a height H2. Thus the height of the upper run 16 of the VSC 12 from the datum 48 is a height H3 which equals H1 – H2. The vertical drop from the upper run 16 to the respective conveyors 40a and 40r is a height H4.

The speed at which the VSC 12 runs for any particular segment of material 14 is depended upon an assessed grade of the material 14. In this embodiment assessment of grade is performed while the material 14 is transported by the conveyor 46. The conveyor 46 transports the material 14 from a supply through or past an analysis zone 52 on route to the VSC 12 and discharge chute 20. The analysis zone 52 is representative of a volume or span of material 14 that can be analysed at any instant in time by a grade analyser 54 while the material 14 is being transported on the conveyor 46.

In this embodiment the analyser 54 continuously analyses the material 14 in the analysis zone 52. The analysis conducted by the analyser 54 is for the full depth and width of material 14 being traversed by the conveyor 46. The analyser 54 determines an average grade of the material 14 in the zone 52 at any one instant. In this particular embodiment the analyser 54 is arranged to categorise a segment of material (being the amount of material 14 within the zone 52) into one of two grades, namely the "accept" grade and the "reject" grade. Assessment of grade is communicated electronically to a controller for the VSC 12 to thereby vary the speed of the VSC 12. This consequently causes the material 14 in any one segment to follow the path P1 or P2 depending on the assessed grade.

When embodiments of the system 10 are utilized for the sorting of mined iron ore there is an expectation that a change in specific grade will occur relatively slowly and the change will be between mutually adjacent grades. Whilst this embodiment describes the provision of only two flow paths P1 and P2 and the assessment of two grades, embodiments may be easily extended to three or more grades requiring three or more divergent flow paths P. To provide further context, in the event of drill and blast mining of iron ore, the expectation is that there will be no, or at most one, change of grade when subjecting a load of a fully laden haul truck which may carry between 190T to 240T of material to the system 10 for sorting.

To assist in accelerating or decelerating the VSC 12 in a timely fashion so as to direct segments of assessed grade material into the corresponding flow paths P1 or P2 it is desirable for the VSC 12 to be a shorter length than the conveyor 46. Thus embodiments of the system 10 may be constructed so that the VSC has a length L1 and the conveyor 46 has a length L2 where $L1 < L2$. To provide context to embodiments of the system 12 when used in relation to the sorting of bulk mined iron ore reference is made to Table 1 below. In this example, the system 12 is operable to transport or process the material 14 at a rate of between 1,000T/hour to 1,200T/hr with the conveyor 46 operating at a speed of 2m/second. The mined material may have a particle sized distribution in the order of P_{95} 350mn.

In Table 1 the design parameters for five embodiments of system 10 are provided. The design parameters which characterize the different embodiments are as follows:

(a) speeds V1 and V2 of the VSC 12 corresponding to assessed "accept" grade material and "reject" grade material respectively;

(b) length L1 of the VSC 12;

(c) the drop height H2 from the conveyor 46 to the VSC 12;

(d) the height H3 of the upper run 16 of the VSC 12 from the datum 48;

(e) maximum height H1 of the conveyor 46 from the datum level 48;

(f) trajectory separation distance S (see in particular Figure 2) between the trajectory envelopes for the paths P1 and P2;

(g) cross sectional area dimensions W and p for the mined material 14 on the upper run 16 of the VSC 12 in order to achieve the desired through put of 1,000T/hr – 1,200T/hr;

(h) the height H4 being the vertical drop height/distance from the VSC12 to the bottom/end of the separate chutes 40a and 40r; and

(i) the troughing angle λ of the VSC 12 as depicted in Figure 3.

In the above described context the separation distance S is achieved at a vertical drop distance of between about 1m-2m from the upper run of the VSC 12. In one realization of the system 10 a low voltage squirrel cage induction motor may be coupled via a speed reduction gear box to drive the VSC 12. A variable speed drive (VDS – not shown) is also provided to control the speed of induction motor. The VSD can be arranged to provide a high degree of "ride–through" capability when there is a supply voltage dip. VSD can also provide maximum operating flexibility during start up, trips, electrical transients, ambient swings, turndown, etc. and facilitate smooth start of the VSC 12 from rest. It is envisaged that a diesel generator set supply power to the VDS. The VSC 12 may have a width of up to about 2m in order to accommodate the desired troughing angle.

Design Parameters	Emb.1	Emb. 2	Emb. 3	Emb. 4	Emb. 5
(a) Speed of VSC 12 V1 and V2	2 and 3 m/s	1.25 and 2.4 m/s	1.75 and 3 m/s	2 and 4 m/s	1.25 and 2.4 m/s
(b) Length of VSC 12 L1	20 m	15 m	11 m	11 m	8 m
(c) Drop height H2 from primary conveyor 46 to VSC 12	1.5 m	2.5 m	2.5 m	2.5 m	2.5 m
(d) Drop height H3 of VSC 12 from ground	8.5 m	5.5 m	5.5 m	5.5 m	5.5 m
(e) Max primary conveyor height H1 from ground level	10 m	8 m	8 m	8 m	8 m
(f) Trajectory separation distance S	50 mm	431 mm	280 mm	421 mm	431 mm
(g) W and p values (Refer Fig 3)	452 mm and 243 mm	452 mm and 243 mm	700 mm and 220 mm	700 mm and 190 mm	700 mm and 190 mm
(h) Height H4	6000mm	4000mm	4000mm	4000mm	4000mm
(i) Troughing angle λ	35°- 45°	35°- 45°	35°- 45°	35°- 45°	35°- 45°

TABLE 1

Figure 5 depicts a flow chart for one embodiment of the method 100 for bulk sorting of mined material 14. In a very broad sense, the method 100 comprises discharging or launching the mined material to fall through free space at one of a plurality different velocities on a basis of an assessed grade of the material so that the discharged or launched material follows one of a plurality of mutually divergent flow paths in the free space commensurate with the assessed grade. The material is discharged to flow along any particular flow path as one or more segments of material in the manner as hereinbefore described.

Figure 5 depict some steps in this method 100 in a more detailed manner together with some precursor steps. The method 100 utilised precursor steps 102 and 104. At step 102 the mined material 14 is traversed through the analysis zone 52 by conveyor 46. At step 104 an assessment is made of the grade of the mined material 18. Also at step 104 subsequent to an assessment being made of the grade of the material, the analyser 54 provides a signal either directly or via an intervening controller or processor (not shown) to vary the velocity of the VSC 12 and consequently the material 14 to provide the mined material with the velocity required to fall or otherwise flow along the corresponding flow path P1 or P2. The step 106 is representative of the interaction between the analyser 54 and the VSC 12 to effect such a change in velocity of material. For a two grade bulk sorting systems these speeds are shown as V1 and V2.

At step 108, the mined material 14 is discharged from the VSC 12 to flow in one of the paths P1 and P2 in accordance with the assessed grade. At step 110, the material 14 flows through the accept or reject chutes 24a or 24r in accordance with the measured grade and subsequently is transported by related conveyors 40a and 40r for further processing or stockpiling. Accordingly the mined material 14 is sorted into a number of fractions equal to the number of designated grades of material.

Whilst a number of specific embodiments of the system and method have been described it should be appreciated that the system and method may be embodied in many other forms. For example, the system and method described provide examples of bulk sorting of mined material into two or three fractions. However the method and system may be readily modified to provide a finer degree of sorting by arranging the analyser to make measurements to enable assessment of more than three grades. Further, the velocity of transport of the mined material 14 on the VSC 12 and indeed the primary conveyor 46 is not limited to the velocities described herein above. These velocities will generally be controlled and determined by the nature of the mined material 14 subjected to bulk sorting. Where the mined material 14 has particularly large particle sizes, for example P_{95} of 350mm, relatively slow speeds are practical in terms of the power requirements for transport of such particles and the ability to accelerate or decelerate the VSC 12 with sufficient time to ensure that the transported particle in any specific segment is brought to its designated discharge velocity when it reaches the downstream discharge end of the VSC 12 to ensure its trajectory will cause it to fall in the flow-path P1, P2 commensurate with its measured grade. In a further variation, the system 10 may be modified to enable in-use sampling either for an initial period after commissioning of the system 10, or indeed for the whole service life. This may be achieved by incorporating a sampling device in the feed chute 18 to enable a sample of the material 14 to be collected and tested to verify that the grade provided by the analyser 54 is correct. A simple form of sampling device may be a slit in the chute 18 through which particles of a particular size can fall for collection and subsequent testing. The slit may be provided with for example a hydraulically controlled gate so that sampling can be conducted when required by selectively opening and subsequently closing the gate.

Also in the above described embodiments the speed of the VSC 12 is higher for the material assessed as having the reject grade than for the accept grade. However this made be reversed. Indeed to reduce power consumption the system 10 may be arranged so that speed of the VSC 12 is set to the lower speed for the grade that is considered most likely to constitute the greatest volume of material during any run cycle of the system 10.

In the embodiments described above the mined material has not been subjected to any prior sorting. However in other embodiments the system and method may be applied to mined material that has been subjected to some pre-sorting for example on the basis of particle size. Two examples of such embodiments are depicted in Figures 6a and 6b. In these embodiments the same reference numbers will be used to denote the same features as in the embodiments descried with reference to Figures 2-5.

Figure 6a depicts a system 10a for bulk sorting of mined material. In the system 10a the mined material 14 is transported via a conveyor 200 to a particle size sorting system 202. The particle size sorting system 202 may for example comprise a screen. The screen in this embodiment is arranged to sort the material 14 into two product streams on the basis of particle size. For example, the system 202 may divide the material 14 into two size fractions of say 0-200mm; and over 200mm. The 0-200mm size fraction is hereinafter referred to as the "X size fraction" while the over 200mm size fraction will herein after be referred to as the "Y size fraction". The X and Y size fractions are now transported on respective primary conveyors 46X and 46Y at constant speed to respective feed chutes 18X and 18Y. In this embodiment the X-size fraction is subjected to grade analysis by an analyser 54X. The analyser 54X assess average grade of the X-size fraction material within the corresponding analysis zone 52X at any one instant.

As with the previous embodiments the analyser 54X is arranged to categorise a segment of material into an accept grade or a reject grade. The assessment of grade is communicated electronically to a corresponding VSC 12X. The speed of the VSC 12X varies in accordance with the grade assessment in same manner as described above in relation to the system 10. Accordingly the X-size fraction material is discharged or launched from VSC 12X at one of two different velocities to follow respective flow paths depending on the assessed grade. The material being launched or discharged from the VSC 12X flows through a discharge chute 20A having trajectories in accordance with the assessed grades and passing through corresponding accept and reject chutes (not shown) as per the chutes shown in Figure 2.

The Y-size fraction is similarly transported via a primary conveyer 46Y, through a feed chute 18Y, and onto a corresponding VSC 12Y to the discharge chute 20A. In this embodiment, VSC 12Y is a "slave" conveyor and run at the same velocity as the conveyor 12X. Thus, the grade analysis performed on the X-size fraction by the analyser 54X also determines the discharge or launch of speed of the Y-size fraction material from the VSC 12Y.

In summary, in the embodiment 10A the assessment of grade of one size fraction of the material 14 is used as the grade determination of the other size fraction. Although in this embodiment, the grade assessment is performed on the X-size fraction, in an alternate

embodiment the grade assessment could be performed on the Y-size fraction and applied to the X-size fraction by making the VSC 12X a "slave" to the VSC 12Y. In practice in this embodiment notwithstanding the material 14 is subjected to pre-sorting on the basis of size, the volume of a segment in comparison with the system 10 would remain the same. Further the segments notwithstanding that they may be laterally spaced from each other at the point of discharge, will follow substantially parallel flow paths.

Figure 6B depicts a further embodiment in which different size fractions are separately subjected to grade analysis so that changes in grade of the different size fraction portions is determined independently of each other. Accordingly in this embodiment the segment size for the different particle size fractions may be different.

The structure of a system 10B differs from the system 10A only by way of the provision of a second and independent grade analyser 54B and the provision of separate discharge chutes 20X and 20Y.

The material 14 is conveyed along conveyer 200 to a sorting system 202. The system 202 sorts the material into two size fractions on the basis of particle size as described hereinabove. Thereafter the X-size and Y-size fractions are processed and sorted independently of each other. In particular the X-size fraction is conveyed along a primary conveyer 46X and analysed by a corresponding grade analyser 54X. The material subsequently passes through a feed chute 18X to a VSC 12X and thereafter discharged into chute 20X. The speed of the VSC 12X is determined by the grade as assessed by the analyser 54X. The Y-size fraction is independently conveyed along primary conveyor 46Y through the feed chute 18Y onto a VSC 12Y and to a discharge chute 20Y. The grade of the Y-size fraction is assessed by the analyser 54Y. The assessed grade is then used to control the speed of the VSC 12Y and thereby determine the trajectory and flow path of segments of the Y-size fraction discharged or launched from the VSC 12Y.

All such modifications and variations in the above described preferred embodiments together with others that would be obvious to persons of ordinary skill in the art are deemed to be within the scope of the present disclosure.

In the claims which follow, and in the preceding description, except where the context requires otherwise due to express language or necessary implication, the word "comprise" and variations such as "comprises" or "comprising" are used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the apparatus and method as disclosed herein.

CLAIMS

1. A mined material bulk sorting system comprising:

a plurality of mutually divergent flow paths along which one or more segments of the mined material can traverse, the plurality of flows paths having a section in common along which all segments traverse and downstream thereof respective mutually divergent sections that extend through free space; and

a segment launch system arranged to launch a segment at one of a plurality of different velocities in accordance with an assessed grade of that segment so that a launched segment flows along one of the divergent sections commensurate with the assessed grade.

2. The mined material bulk sorting system according to claim 1 wherein the segment launch system comprises a variable speed conveyor by which the segments are traversed along the common section of the flow paths.

3. The mined material bulk sorting system according to claim 2 wherein the bulk sorting system is arranged to vary speed of the variable speed conveyor to enable launching of respective segments into one of the plurality of mutually divergent sections of the flow paths.

4. The mined material bulk sorting system according to any one of claims 1 – 3 wherein the plurality of flow paths is provided at least in part by a discharge chute configured to enclose a length of each flow part.

5. The mined material bulk sorting system according to claim 4 wherein the discharge chute comprises a plurality of separate chutes one for each of the flow paths, each of the separate chutes defining a part of a respective flow path.

6. The mined material bulk sorting system according to claim 5 wherein each of the separate chutes has a respective inlet wherein the inlets are laterally spaced from each other.

7. The mined material bulk sorting system according to claim 6 comprising, at an end of each of the separate chutes, a respective underlying conveyor arranged to convey material flowing through a corresponding separate chute to a respective remote location.

8. The mined material bulk sorting system according to any one of claims claim 4-7 wherein the discharge chute comprises an energy dissipation system arranged to dissipate kinetic energy from a segment after discharge from the segment launch system.

9. The mined material bulk sorting system according to claim 8 wherein the energy dissipation system comprises one or more rock boxes or ledges disposed in the discharge chute.

10. The mined material bulk sorting system according to claim 8 wherein the energy dissipation system comprises one or more rock boxes or ledges disposed in one or more of the separate chutes.

11. The mined material bulk sorting system according to any one of claims 2-10 wherein the variable speed conveyor is capable of providing a variation in launch velocity of segments of different assessed grade sufficient to create a lateral separation distance of respective divergent sections of the flow paths of at least 50 mm at a vertical drop distance from the variable speed conveyor upstream of the inlets.

12. The mined material bulk sorting system according to any one of claims 2-10 wherein the variable speed conveyor is capable of providing a variation in launch velocity of segments of different assessed grade sufficient to create a lateral separation distance of respective divergent sections of the flow paths of between about 50mm-450mm at a vertical drop distance from the variable speed conveyor upstream of the inlets.

13. The mined material bulk sorting system according to claim 11 or 12 wherein the vertical drop distance is between 1m-2m from a an upper run of the variable speed conveyor.

14. The mined material bulk sorting system according to any one of claims 2-13 wherein the variable speed conveyor is capable of providing a differential in launch velocity of segments of different assessed grade of between 1-2m/s.

15. The mined material bulk sorting system according to any one of claims 2-14 wherein the variable speed conveyor has a length in the range of about 8m-20m.

16. The mined material bulk sorting system according to claim 15 wherein the variable speed conveyor has a length of about 8m.

17. The mined material bulk sorting system according to any one of claims 5-16 wherein a vertical distance between the variable speed conveyor and the end of a separate chute in the discharge chute is in the order of about 4m.

18. The mined material bulk sorting system according to any one of claims 2-17 wherein the segment launch system comprises part of a transport system arranged to transport the mined material through an analysis zone in which grade of the one or more segments of the material is assessed while the one or more segments are being transported through the zone.

19. The mined material bulk sorting system according to claim 18 wherein the transport system comprises a conveyor arranged to transport a segment through the analysis zone.

20. The mined material bulk sorting system according to claim 19 wherein the conveyor is arranged to transport a segment to the variable speed conveyor.

21. The mined material bulk sorting system according to claim 19 or 20 wherein the conveyor is juxtaposed relative to the variable speed conveyor such that a segment transported by and discharged from the conveyor drops a vertical distance of between 1m-3m to reach the variable speed conveyor.

22. The mined material bulk sorting system according to claim 21 wherein the vertical distance is between 1.5m - 2.5m.

23. The mined material bulk sorting system according to any one of claims 19-22 comprising a feed chute arranged to confine material discharged from the conveyor and direct the material onto the variable speed conveyor.

24. The mined material bulk sorting system according to claim 23 wherein the feed chute comprises an energy dissipation system arranged to dissipate kinetic energy from material after discharge from the conveyor.

25. The mined material bulk sorting system according to any one of claims 19-24 wherein the conveyor is arranged to discharge the mined material from a height of between 8-10m above a datum level.

26. The mined material bulk sorting system according to claim 25 wherein the variable speed conveyor is located such that a common section of the flow paths is disposed at a vertical height of between 5m-9m above the datum.

27. The mined material bulk sorting system according to any one of claims 18-26 comprising a mined material grade analyser operable to assess a grade of a segment of material passing the analysis zone.

28. The mined material bulk sorting system according to claim 27 wherein the analysis zone extends along a length of the conveyor.

29. The mined material bulk sorting system according to any one of claims 1-28 wherein the segment launch system is arranged to sort the mined material at a rate of up to 3000 tonnes per hour (TPH).

30. The mined material bulk sorting system according to any one of claims 2-29 comprising skirt boards extending along opposite sides of the variable speed conveyor.

31. The mined material bulk sorting system according to any one of claims 2-30 wherein the variable speed conveyor is configured to have a troughing angle of between 35° and 45°.

32. A method of bulk sorting mined material comprising:

discharging or launching, at one of a plurality of different velocities, a segment of the mined material to fall through free space wherein the plurality of different velocities are selected on a basis of an assessed grade of the segment and wherein the plurality of different velocities is such that segments discharged or launched at different ones of the velocities follow mutually divergent flow paths.

33. The method according to claim 32 comprising setting the plurality of different velocities so as to cause a lateral separation between the mutually divergent flow paths of at least 50 mm after segments fall a designated vertical distance through the free space.

34. The method according to claim 32 comprising setting the plurality of different velocities so as to cause a lateral separation between the mutually divergent flow paths of

between 50mm to 450mm after segments fall a designated vertical distance through the free space.

35. The method according to claim 33 or 34 wherein the plurality of different velocities is selected so as to cause the lateral separation at a vertical fall distance of 1m-2m.

36. The method according to any one of claims 32-35 comprises varying the discharge or launch velocities by between 1-2m/s for segments of different assessed grade.

37. The method according to any one of claims 32 to 36 comprising transporting a segment of material a distance of between about 8m-20m before discharging or launching the segment into free space.

38. The method according to any one of claims 32 to 37 comprising discharging or launching the mined material as one or more segments at a rate of 1000-1200 tonnes per hour (TPH).

39. The method according to any one of claims 32 to 38 comprising transporting the mined material through an analysis zone in which grade of the material is assessed while being transported through the zone.

40. The method according to claim 39 comprising demarcating one segment from an adjacent segment when there is a change in the average grade of material in the analysis zone.

41. The method according to claim 39 or 40 comprising transporting the material at a constant velocity through the analysis zone.

42. The method according to any one of claims 39-41 comprising after the material has passed through the analysis zone displacing the material by a vertical distance of between 1m-3m prior to discharging or launching segments at respective ones of the plurality of different velocities commensurate with the assessed grade of the segment.

43. The method according to any one of claims 32 to 42 comprising elevating the material by a total vertical distance from a datum of 8m-10m prior to discharging or launching the material as part of a segment into free space.

44. The method according to any one of claims 32 to 43 comprising confining the segments of material in a discharge chute for at least a portion of their flow paths that extent through the free space.

45. The method according to claim 44 comprising arranging the discharge chute to comprise a plurality of separate chutes one for each of the flow paths and spacing the separate chutes from each other such that substantially all of the material in a segment flows into a separate chute corresponding to the assessed grade of that segment, the separate chutes defining a part of a respective flow path.

46. The method according to any one of claims 42 to 45 comprises confining the material in a feed chute after the material has passed through the analysis zone and displacing by the vertical distance of between 1m-3m prior to discharging or launching segments.

47. The method according to any one of claims 32 to 46 when the mined material is a metal ore.

48. The method according to any one of claims 32 to 46 when the mined material is metal ore having a particle size distribution in the order of P_{95} 300mm-350mm.

49. The method according to claim 47 or 48 comprising subjecting the metal ore to crushing prior the discharging or launching of segments of the material.

50. A mined material bulk sorting system comprising:

a particle size sorting system arranged to sort a feed of particles into a plurality of different size fraction streams;

for each size fraction feed stream: a plurality of mutually divergent flow paths along which one or more segments of the mined material in that feed stream can traverse, the plurality of flows paths having a section in common along which all segments traverse and downstream thereof respective mutually divergent sections that extend through free space; and a segment launch system arranged to launch a segment at one of a plurality of different velocities;

wherein the respective segment launch systems for the feed streams are controlled together to launch all of the respective corresponding segments at one of a plurality of different velocities in accordance with an assessed grade of any one of the respective corresponding

segments so that each of the respective corresponding segments is of substantially the same size and launched to flow along one of the divergent sections commensurate with the assessed grade.

51. A mined material bulk sorting system comprising:

a particle size sorting system arranged to sort a feed of particles into a plurality of different size fraction feed streams;

for each size fraction feed stream: a plurality of mutually divergent flow paths along which one or more segments of the mined material in that feed stream can traverse, the plurality of flows paths having a section in common along which all segments traverse and downstream thereof respective mutually divergent sections that extend through free space; and a segment launch system arranged to launch a segment at one of a plurality of different velocities;

wherein the respective launch systems for the feed streams are controlled independently of each other to launch respective corresponding segments at one of a plurality of different velocities in accordance with a assessed grade of material in the corresponding segment so that each of the respective corresponding segments is launched to flow along one of the divergent sections commensurate with its assessed grade.

52. A method of bulk sorting mined material comprising:

sorting a feed stream of minded material into a plurality different size fraction feed streams;

for each size fraction feed stream: discharging or launching, at one of a plurality of different velocities, a segment of the mined material of that feed stream to fall through free space wherein the velocities are selected such that segments discharged or launched at different ones of the velocities follow mutually divergent flow paths;

wherein the size and the launch or discharge velocity of the segments for all of the feed streams is determined on a basis of an assessed grade of the segment of any one of the feed streams.

53. A method of bulk sorting mined material comprising:

sorting a feed stream of minded material into a plurality different size fraction feed streams;

for each size fraction feed stream: discharging or launching, at one of a plurality different velocities, a segment of the mined material of that feed stream to fall through free

space wherein the velocities are selected such that segments discharged or launched at different ones of the velocities follow mutually divergent flow paths;

wherein the size and the launch or discharge velocity of segments of mined material for each of the feed streams is determined independently of each other on a basis of an assessed grade of each segment.

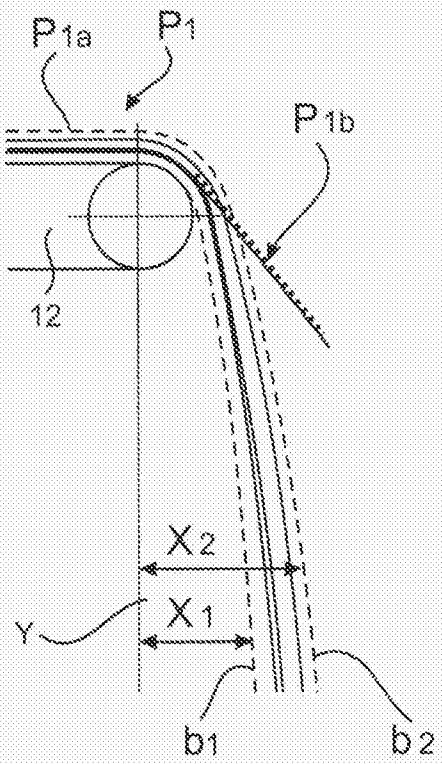


Figure 1a

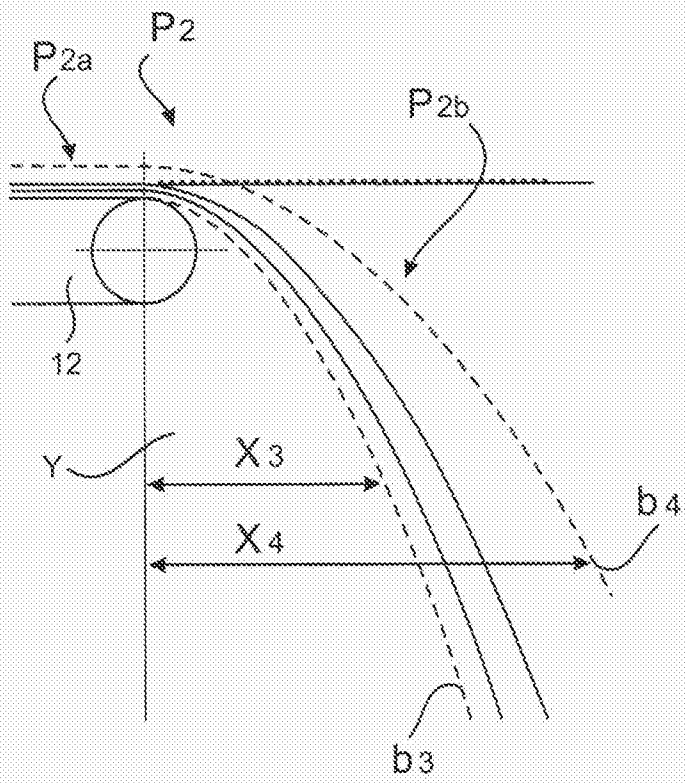
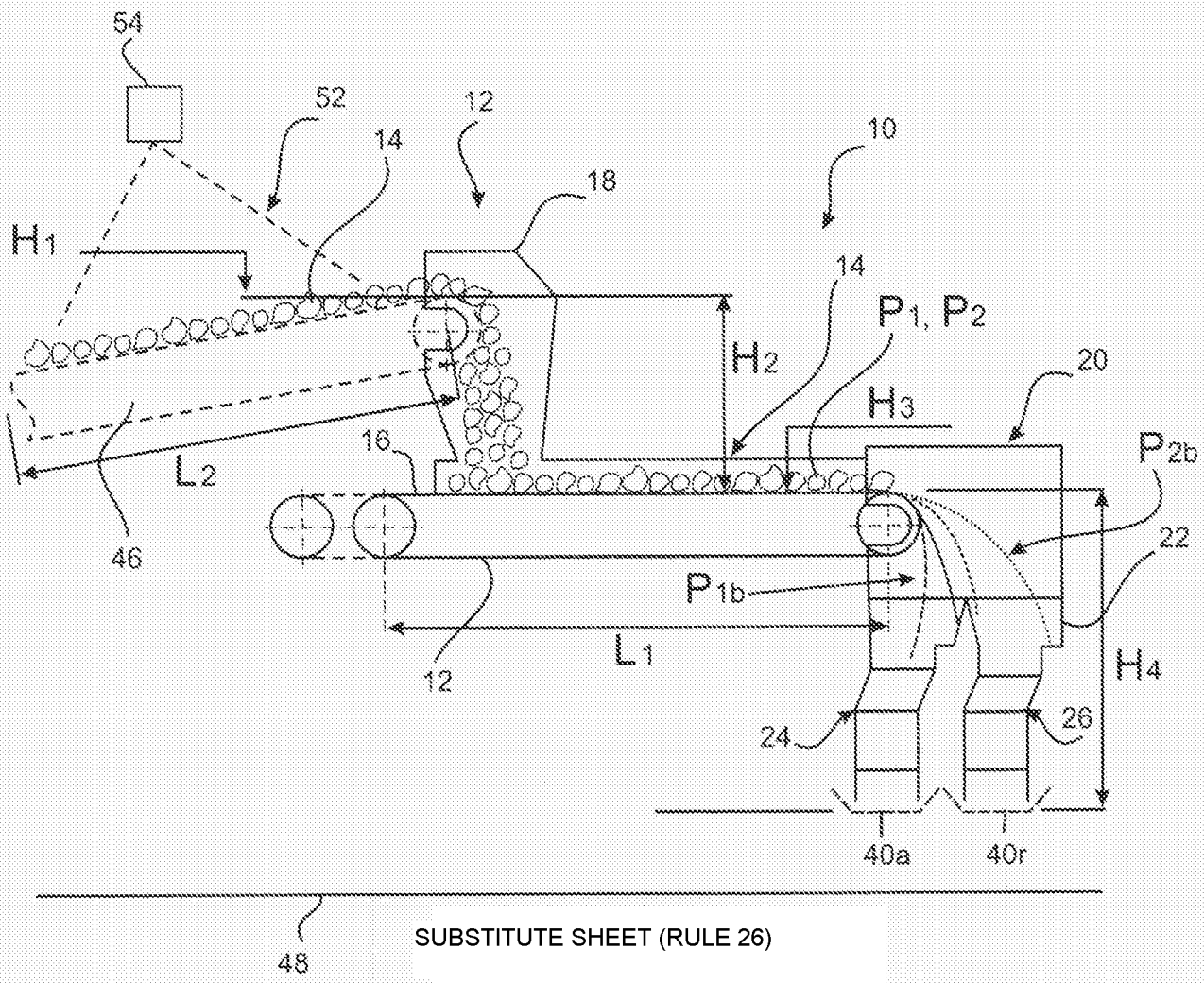


Figure 1b



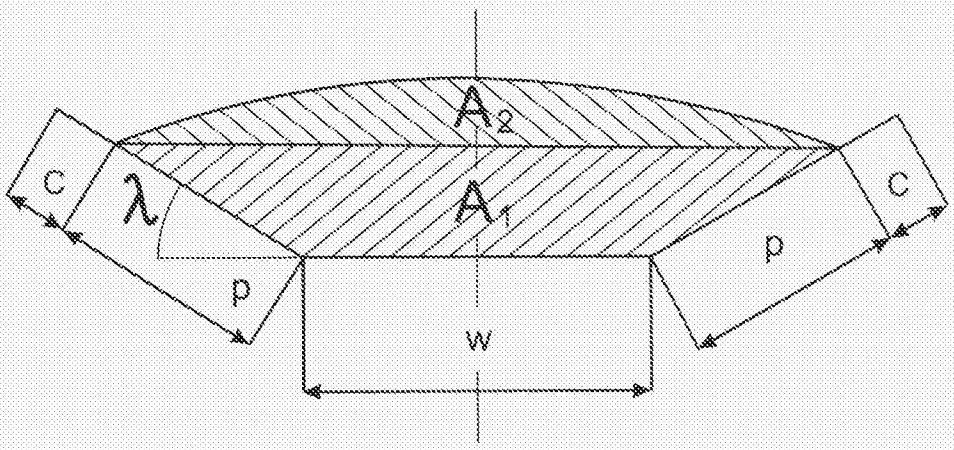
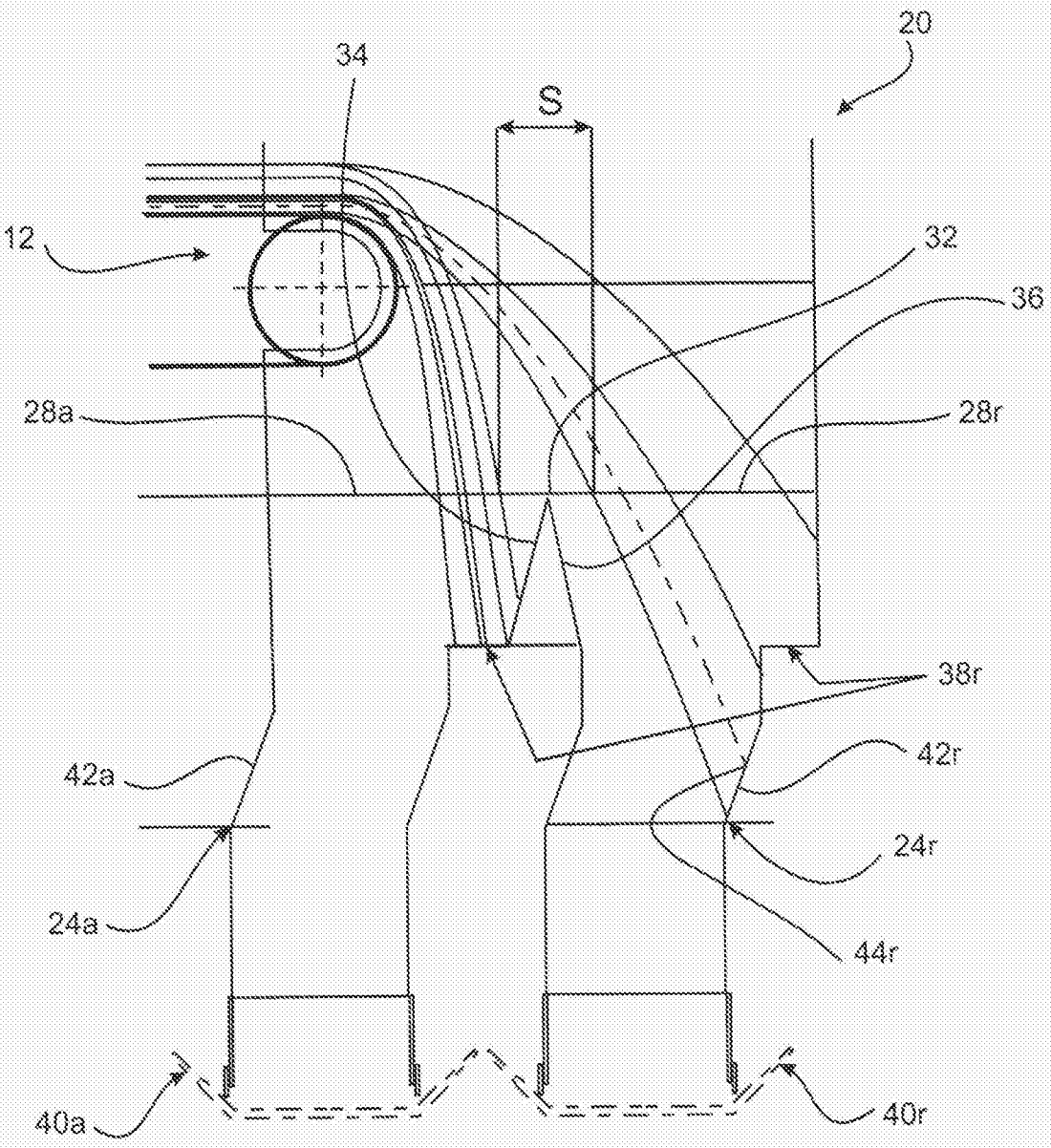

A2
A1
c
λ
p
w
p
c

Figure 3


20
34
S
12
32
36
28a
28r
38r
42a
42r
24r
24a
44r
40a
40r

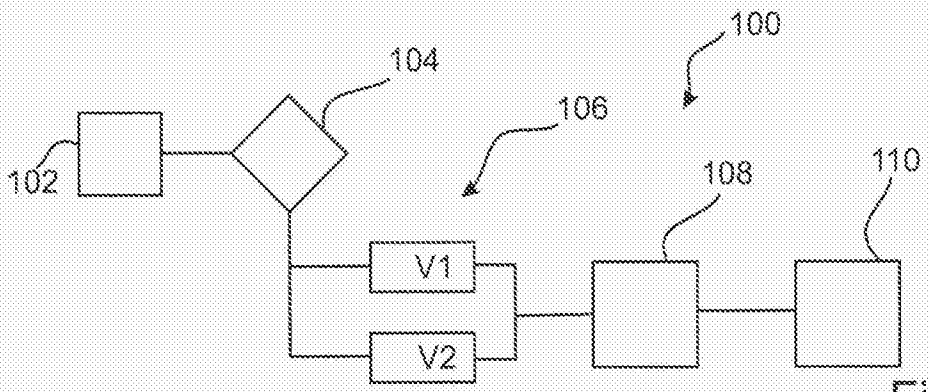


Figure 5

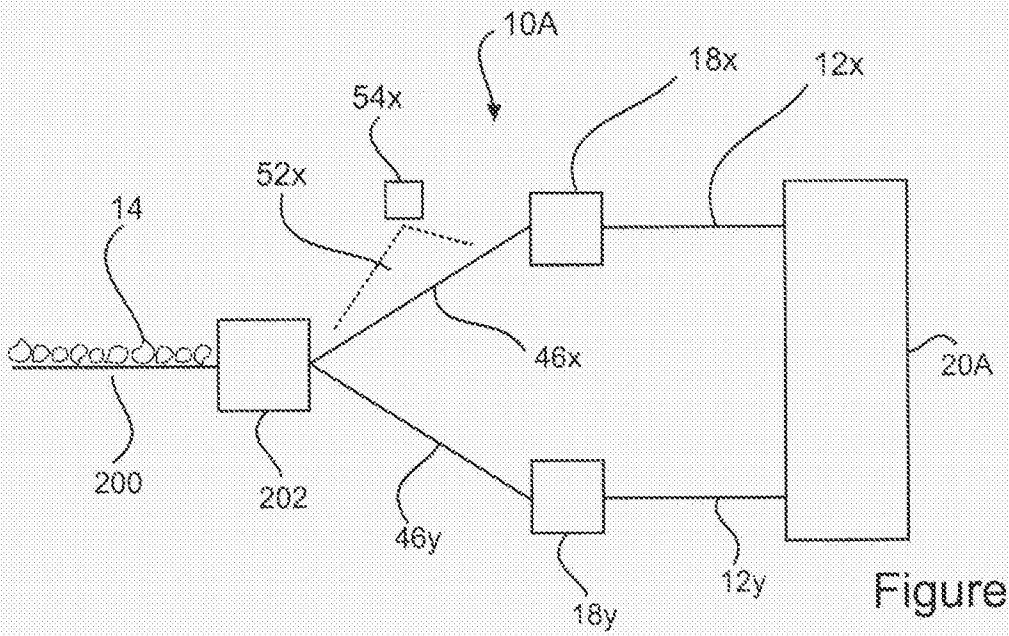


Figure 6a

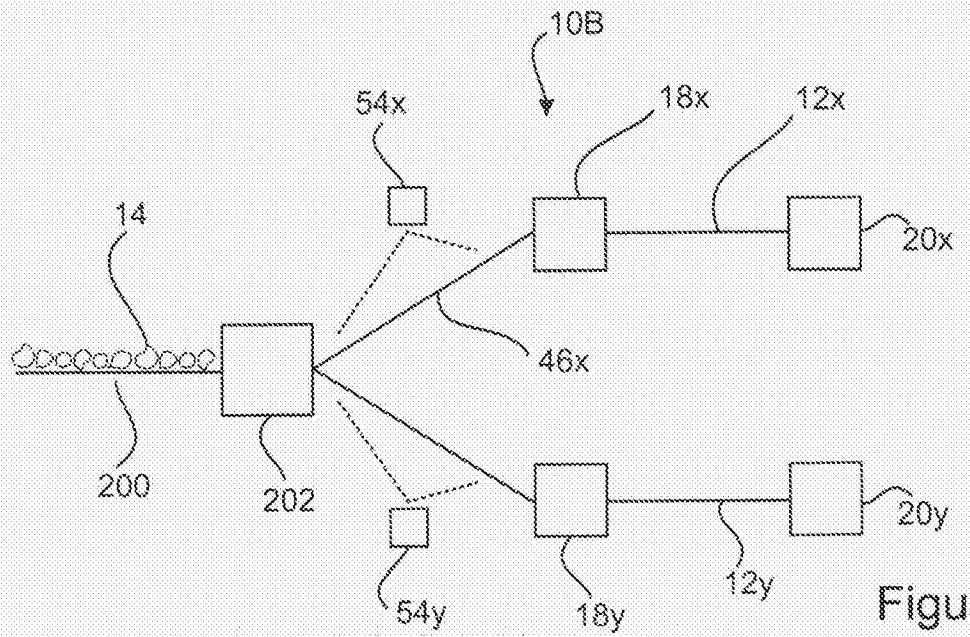


Figure 6b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2013/001458

A. CLASSIFICATION OF SUBJECT MATTER

B07B 13/00 (2006.01) G01N 23/222 (2006.01) B07C 5/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC: IC/CC (B07B 13/-, B07C 5/-, B02C 23/08, G01N 23/222) Using Keywords (DIVERSION, ANALYSIS, TRANSPORT, BULK, VARIATION, SPEED) and like terms

WPI, EPODOC: Using keywords (DIVERSION, ANALYSIS, TRANSPORT, BULK, VARIATION, SPEED, CONTROL, TRAJECTORY, ORE) and like terms

ESPACENET, WIPO, USPTO, GOOGLE PATENTS: Using Keywords (BULK, SORT, MINED, MATERIAL) and like terms

ESPACENET, WIPO, USPTO, GOOGLE PATENTS: Using Keywords (MATERIAL, SORT, PLURAL, FLOW, PATHS, LAUNCH, VELOCITY) and like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search	Date of mailing of the international search report
12 February 2014	12 February 2014

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
Email address: pct@ipaustralia.gov.au
Facsimile No.: +61 2 6283 7999

Authorised officer

Vijaya Mathe
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No. 0262256162

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2013/001458**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2011/150464 A1 (TECHNOLOGICAL RESOURCES PTY. LIMITED [AU]) 08 December 2011 abstract; claims 1 - 30	1 - 53
A	TONY HESELEV, 'Sound technology making waves', CSIRO Publication - RESOURCEFUL, Issue 2, November 2012, pages 8-9 (online Magazine) [Retrieved on 30 January 2013] Retrieved from the Internet <URL: http://www.csiro.au/Portals/Publications/Magazines/resourceful.aspx> pages 8 - 9	1 - 53
A	US 5732115 A (ATWELL et al.) 24 March 1998 abstract; claims 1 - 9	1 - 53
A	US 4702379 A (CLAYTON et al.) 27 October 1987 abstract; claims 1 - 8	1 - 53
A	WO 2011/026195 A1 (CURTIN UNIVERSITY OF TECHNOLOGY [AU]) 10 March 2011 abstract; claims 1 - 48	1 - 53

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2013/001458**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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		WO 2011026195 A1	10 Mar 2011

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.