

A process and device for sorting waste, in particular mixed building waste.

5 The invention relates to a process for sorting at least partially recycleable waste such as mixed building waste or the like, where light fractions such as wood, synthetic materials, also suspended matter such as paper etc. can be sorted out from a further processable heavy inert fraction. The invention also relates to a corresponding device for carrying out this process.

10 In present times, waste such as mixed building waste, rubble, old glass etc. is no longer stored in a disposal site as previously, rathermore it is extensively recycled, and only the non-recycleable remainder is disposed of in a suitable manner (circulation commercial law). Mixed building waste from both above and below ground construction contains in addition to a
15 recycleable heavy inert fraction (building stone, cement, plaster remains, concrete and sand), also metal parts, wood, synthetic material waste likewise suspended matter like insulating material, sheeting and paper. These components must be carefully sorted so as to be able to at least recycle the
20 largest part of same, e.g. as road building material.

Previous sorting plants for sorting mixed building waste had a considerable space requirement, and sorting resulted in various stages, extensively by hand.

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A device for sorting rubble in particular is known from DE-A-37 08 180, where after crushing, the rubble is separated into four fractions by a shaking screen. There subsequently results an air separation of the three largest screened-out
30 fractions through a transverse incoming flow of air. However, on using a shaking screen, the problem of fine material appears, in particular as mixed building waste, which leads in particular

with moist waste, to the blocking up of such screens, so that after a short period of time, such screens have to be cleaned manually. In addition, no separation of light fractions such as wood from the coarse fraction result, merely light suspended matter is sucked up by the air separation.

A process and devices are known from US-A-3,680,694 for separating objects of differing elasticity. One is here concerned in particular with sorting fruit, e.g. apples, so as to differentiate ripe from unripe fruit. Here a vibration trough is used whose oscillating frequency is adjusted to the objects to be sorted.

A device for separating a mixture of material is known from EP-A-218 822, which operates with a vibro-groove. By mounting two unbalance motors displaced from one another, a separation of the round and flat material results on the basis of the differing friction between the two materials.

Finally a process and device for separating loose material is known from EP-A-628 351 which operates with a shaking screen onto which the loose material is made fluid. By means of suction, the light fraction is sucked up, and furthermore fluidisation is supported through ventilation from below. However this process is only suitable when the material to be sorted is not inclined to cake together, which however is almost always the case with mixed building waste, especially when the material is moist or is frozen in a damp state.

The present invention is based on the task of suggesting a process and device for sorting waste, in particular mixed building waste having fine components and also in a moist state, whereby it is possible to extensively manage without manual help, and whereby the corresponding device can be installed in the smallest space, so as to be able to carry out sorting if necessary with a mobile plant on the spot.

The process according to the present invention is characterised by the following process steps:

- a) supplying waste of a specific maximum grain size, respectively crushing the waste to one such grain size,
- 5 b) separating waste into small fraction and coarse fraction in a vibration separating tube,
- c) clean the small fraction obtained for the purpose of obtaining a heavy, recyclable inert fraction, using additional air and exhaust air for separating out floating particles and,
- 10 d) separating the coarse fraction by a separation cascade into light fraction and recyclable, heavy inert fraction.

With the solution according to the invention, the solution lies not only in the use of waste of a specific maximum grain size, or in corresponding previous crushing, and subsequent separation
15 in a separation cascade into light fraction and recyclable heavy inert fraction with corresponding air flow support, rathermore it is above all important that it is recognised that effective separation in the series connected separation cascade into light
20 fraction and heavy inert fraction is only possible if the introduced material has previously been freed from small fractions. Should the material supplied to the separating cascade contain too large an amount of small fractions, then the separation result will unsatisfactorily break down.

25 Advantageously with the process according to the invention, the separation of coarse fraction in the separation cascade into light fraction and heavy fraction is supported by additional air and exhaust air for the removal of light fraction. However, the
30 use of additional air and exhaust air in the separation cascade leads to problems if the fine particles are not previously removed from the supplied material, as the heavy recyclable fine materials can also be removed at the same time.

35 Whilst separation of the small fraction in the waste results in a (first) vibration separation tube, cleaning of the small fraction obtained according to an advantageous formation of the



process in a particularly effective way is possible if the small fraction obtained from the first vibration separation tube is supplied to a second vibration separation tube, where a further separation into fine grain and coarse grain results, that then the fine grain is recycled whilst the coarse grain is cleansed of suspended particles in the region of the outlet section of the second vibration separation tube by means of a jet of air and air suction. This second vibration separation tube has the task in particular of shunting off the fine grain so that subsequently the coarse grain can be effectively cleansed by means of a jet of air and air suction without the heavy fine grain being taken with it.

Whilst the inventive process usefully operates effectively with a waste grain size being less than 60-80mm, preferably 45mm, for the effective operation of the separation cascade, small fraction having a grain size of about 0-10mm should be previously removed. The further separation of small fractions into two vibration separation tubes operates effectively with a fine grain size of 0-3mm and a coarse grain size of 3-10mm. Further advantageous arrangements of the inventive process are to be found in the sub-claims.

A plant for the preparation of rubble is known from DE-C-39 14 205 which comprises inorganic and organic components. A fine grain separation medium is mixed in as an additive to the broken rubble, and the mixture is fed to a vibrating conveyor. The additive is so-adjusted that the organic components float on the surface in the operating vibrating conveyor. The organic components are removed from the vibrating conveyor, and the remaining rubble which is freed from organic components is recycled.

Although vibrating conveyors are known in themselves, the process according to the invention is carried out effectively by using a separation cascade which is characterised by a plurality of rounded-off trough-like shaped containers, open at the top,

one edge of which is higher than the other edge, and which are arranged displaced transversely to the trough longitudinal axis in the horizontal plane, one above another, whereby the higher edge of the higher arranged container is arranged approximately over the centre of the underlying container, and are joined together in one unit, flexibly suspended and are driven by at least one rotating unbalance motor so that the heavy inert fraction falls over the higher edge and the respective light fraction is separated out over the other edge.

A particularly advantageous embodiment is so-constructed that the trough-shaped containers are arranged between two perpendicular side walls, which are connected to one another by horizontal, stable connecting cross-pieces to a rigid whole, and that the whole is oscillatingly suspended over springs on a framework. Advantageously, an air inlet jet blowing essentially over the whole trough width of the separation cascade, approximately horizontally to the respective higher edge, and likewise a suction exhaust jet extending essentially over the whole trough width of the separation cascade, approximately horizontally from the respective lower edge, are arranged for the removal of the suspended material. Further advantageous arrangements of the separation cascade for carrying out the process are likewise to be found in the sub-claims.

Finally the invention also relates to an advantageous device for carrying out the process in the particular construction of a vibration separation tube. The vibration separation tube has an approximately cylindrical cross-section, likewise an inlet opening and an outlet opening from which the coarse fraction can be extracted. The vibration separation tube is displaced in oscillation through a vibration motor opposite the horizontal line about a vertical or pointed angle directed upwards in the transverse direction, and in the region just in front of the outlet opening opposite the lowest point of the floor of the vibration separation tube a removal opening for the small fraction is arranged displaced (staggered) from that side,

which is located opposite the base in the upward direction of oscillation. In addition to the (first) vibration separation tube, a second vibration separation tube is advantageously provided of approximately the same construction, to which the separated small fraction from the first vibration separation tube is supplied, and this is split into fine grain and coarse grain.

In the region of the outlet opening of the second vibration separation tube additional air is introduced, and exhaust air transporting the suspended particles contained in the coarse grain is sucked out. Further advantageous arrangements of the device having vibration separation tubes are to be found in the sub-claims.

Finally the whole device is so-constructed in an advantageous way that essentially all the equipment is arranged in one or more transportable containers. Where reprocessing of exhaust air takes place with a gravity separator which preferably has one or more cyclone separators, then the whole device is effectively divided between two containers, where the gravity separator likewise the necessary additional equipment such as blowers for producing additional air are arranged in one of the containers, and in the other container there is the remaining equipment, without however the equipment for crushing the mixed building waste.

Further advantageous arrangements of the invention are to be found in the sub-claims.

The invention will now be described by way of example with the aid of the accompanying drawings:

Figure 1 is a schematic representation in the form of a flow diagram of the inventive device, provided as an example for sorting mixed building waste;

Figure 2 is a representation of a separation device, constructed as a separation cascade for separating the mixed building waste into a heavy, recyclable inert fraction and a light fraction to be divided out.

Figure 3 is a schematic representation of a part of the separation device according to Figure 2 as well as two additional representations A and B;

5 Figure 4 is a plan view of a device arranged in two containers in schematic representation, with another construction for separating the small fraction;

10 Figure 5 is a schematic representation of the oscillating forces acting on a vibration separation tube of the device according to Figure 4;

Figures A,B & C are schematic sectional representations corresponding to sections A,B & C of Figure 4 and

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Figures A,B & C are schematic section representations of sections A,B,& C of the second separation tube in Figure 4.

20 The device shown in Figure 1 for sorting mixed building waste or the like will be described as follows, and wherein the corresponding process steps and features are found in particular.

25 The mixed building waste to be sorted is fed into a feed hopper 1 and arrives via vibration conveyor 2 in an impact crusher 3, so as to prepare the mixed building waste into a workable grain size of about 60-80mm maximum, preferably 45mm. For this the impact crusher 3 has a gap width of 60-80mm, preferably 45mm. These given dimensions are however only valid for the thickness dimensions of wood, due to its fibrous structure, pieces which are larger in length are allowed through in an impact crusher having a longitudinal gap outlet, e.g up to 300mm in length. It is of course possible to carry out this preparation of the mixed building waste outside the plant.

35 The mixed building waste restricted to a grain size smaller than 60-80mm or 45mm now arrives on a conveyor belt 4, on which a magnetic separator 13 is arranged. Iron and steel parts are

screened out with this magnetic separator and diverted (arrow 15). The material freed from iron parts arrives from conveyor belt 4 into a vibration separation tube 5, wherein a separation of small fraction 16a of below about 10mm grain size and coarse fraction 16b above about 10mm grain size results. The small fraction 16a arrives in a further separation device 6, which is driven by an unbalance motor 9. Here a separation into heavy fraction 6a and light fraction 6b results. The separation process is supported by additional air and exhaust air, whereby the additional air is supplied by an air inlet jet 10, and the exhaust air including the light fraction 6b is sucked off through exhaust jet 11. The heavy fraction 6a is freed from other material in so far that it can be recycled as building material. The light fraction 6b in the exhaust air is supplied to a gravity separator 8 which will be explained later in more detail.

The coarse fraction 16b obtained in separation tube 5 arrives into a further separation device 7 via a conveyor belt 14. In the representation in Figure 1, conveyor belt 14 shown top left over the joined together points A, shows its continuation in the left centre area.

The separation device 7 is constructed as a separation cascade, and contains in the described example three cascade-like trough-shaped containers 7a, 7b, 7c arranged one above the other, which are driven by an unbalance motor 9 in a common framework. Each of these trough-shaped containers 7a, 7b, 7c has a first higher edge 17a and a second lower arranged edge 17b. The higher edge 17a of the upper container is located approximately over the central area of the underlying container 7b, and the higher edge 17a of container 7b is located approximately over the central area of the underlying container 7c. All three containers contain an air inlet jet 10 in the region of the higher edge 17a extending over the whole width, and an exhaust jet 11 in the region of the lower edge 17b, likewise extending over the whole width.

As Figures 2 & 3 show, the whole arrangement having three trough-shaped containers 7a,7b,7c which is driven by the already mentioned unbalance motor 9, is supported over springs 12 on an understructure 24. The coarse fraction 16b which falls into upper container 7a, transported via conveyor belt 14 (see Fig.1), is separated by vibration into a heavy and a light fraction, where the light fraction 19 is divided out over lower edge 17b. One is here concerned with coarse parts such as pieces of wood and the like. The heavier fraction falls into the underlying trough-shaped container 7b. Here again there results a separation into heavy fraction and light fraction, and where the heavy fraction falls into the underlying container 7c. The same also continues for container 7c. The light fractions from containers 7b and 7c are sucked out together with the exhaust air via jets 11, as they are of a smaller grain, and arrive through a connection 20 in the already mentioned gravity separator 8. The heavy fraction 18 from the lowest container 7c is now free from all lightweight material and can be reused as building material, if necessary after a further crushing process.

Gravity separator 8 shown in Figure 1 serves to separate exhaust jet air 11 inclusive of the light fraction 6b accumulated therein, coming from separation device 6, likewise exhaust jet air 11 inclusive of the light fraction (smaller parts) accumulated therein, coming via conduit 20 from separation cascade 7 into reusable clean air 8b and divided out light fraction 8a. Clean air 8b is supplied again to the air inlet jet 10 by means of a corresponding blower (not shown in Figure 4).

Figure 2 shows the construction of separation cascade 7 in side-view. It shows the trough shaped containers 7a,7b,7c, already schematically represented in Figure 1, suspended in an arrangement of two side walls 25 and connecting cross members 26a,26b,26c, securely connecting these with one another. The whole arrangement is supported by means of springs 12 on a framework 24 and leads - driven by one or more unbalance

motors 9 - to an oscillation, as is illustrated in more detail in Figure 3. The to-be-separated, pre-treated mixed building waste arrives as coarse fraction 16b in the upper trough shaped container 7a. The respectively heavier fraction falls over the higher edge 17a into the underlying container 7b or 7c, whilst the light fraction is divided out over the respectively lower edge 17b (in the diagram of Figure 2) to the right. It is also to be noted as to how additional air via air inlet jets 10 is blown by a blower 23 over the higher edge 17a and is sucked out over the lower edge 17b. The exhaust air including the divided out light fraction then arrive via conduit 20 at gravity separator 8 (see Figure 1).

The number of cascade-like trough shaped containers 7a,7b,7c, arranged one above another, of the separation device can vary according to the composition of the waste. For mixed building waste, three containers 7a,7b,7c arranged one above another, have proved satisfactory. With other waste to be sorted, it is possible that only two trough shaped containers are sufficient. This depends above all on the consistency of the waste.

In the flow diagram according to Figure 1, the exact position and alignment of the unbalance motors in separation devices 6 or 7 is not shown so as not to damage the general plan. It is also not shown in the side view of separation device 7 according to Figure 2, rathermore this sits on the outer surfaces of both side walls 25 which are connected to one another by means of the transversely running connection cross members 26a,26b,26c. With this embodiment, preferably two unbalance motors are provided, which are arranged substantially in the dynamic centre of gravity of the whole arrangement of separation device 7, therefore somewhat in the region between the broken line drawn trough shaped containers 7a & 7b.

With the aid of Figure 3, the mode of operation of one such separation device will be more closely explained, where the trough shaped container 7c shown in Figure 3 either has a single container, e.g. for separation device 6, or one of the cascade-type containers 7a,7b,7c arranged one above another, of separation cascade 7.

For the unbalance motor 9 shown in the above area, no exact position is shown, merely its preferred alignment. The longitudinal or rotational axis B of the unbalance motor extends transversely to the longitudinal axis of the trough shaped container 7c, somewhat right angled to same. The longitudinal axis 9b is however inclined about a pointed angle 28 opposite the horizontal line 31 of the separation device, opposite which the height of edges 17a & 17b of container 7c is also defined, which amounts in the present example to about 30°. This angle has shown itself to be the best, however the device operates satisfactorily within a range of 20°-40°.

The unbalance motor 9 produces an oscillation or shaking motion in the direction of the double arrow 30, which represents the operating line of unbalance motor 9. This operating line extends perpendicularly to the rotational or longitudinal axis 9b of the unbalance motor 9. As is schematically indicated in Figure 3, the oscillation in the direction of operating line 30 effects a fluidisation of the material contained in container 7c, and through the trough shaped, rounded off shape of container 7c there results a conveyor motion corresponding to the closed line 29 in Figure 3b, and thus a static rotation of material which is indicated as stone, wood and suspended material in Figure 3. With an insufficient amount of filling in container 7c, then the rotated material falls back onto the side opposite the higher edge 17a in container 7c. However on adding new material from above, it overflows on the upper edge 17a of container 7c and falls below as heavy inert fraction. The light materials (wood and suspended material) are transported to the centre of the trough shaped container 7c and with sufficient volume in

container 7c, are taken out from the lower side 17b and fall below. The particularly light suspended material is separated off by additional air (jet 10) and exhaust (receiving tube 11). They subsequently arrive at the gravity separator.

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It has already been mentioned earlier that in separation device 7 (see Figure 2) an unbalance motor is respectively arranged in the outer surface of both side walls 25. This is necessary to produce a sufficient oscillation output, and in addition, the oscillation energy is more evenly distributed. In such a case, one is concerned with two identical unbalance motors 9, which are arranged in identical angles 28 (see Figure 3) where however the rotational direction 9a (see Figure 3a) of both unbalance motors 9, seen from the same line of vision A, run in opposite directions to one another. This means therefore that the unbalance motor 9 shown in Figure 3 on the outer surface of side wall 25 from line of vision A, runs in a clockwise direction, whilst the not shown unbalance motor on the outer surface of the other side wall 25, from line of vision A, rotates anti-clockwise.

Subsequently a concrete embodiment of the inventive device should be described from Figure 4, where simultaneously another embodiment for pre-separation of fine fraction is given. The schematically represented device in Figure 1 for sorting mixed building waste is arranged in two containers 21 & 22, shown in broken lines. The representation here is likewise schematic. The embodiment shown in Figure 4 does not contain an impact crusher 3, rather the supplied mixed building waste is crushed outside the container to a grain size smaller than 60-80mm or 45mm. Whilst the first container 21 contains practically all the device equipment, the gravity separator 8 in the form of two cyclones is accommodated in container 22. Two blowers 23 are likewise arranged in container 22. It is possible through this division to keep the to-be-produced connections between the two containers 21 & 22 small, and they can be produced in a simple manner.

It can be seen in Figure 4 that the already prepared mixed building waste having a grain size of 60-80mm or 45mm is introduced at 1a, and is supplied to a first vibration separation tube 5 via a vibration conveyor 4. Here there results a separation into small and coarse fraction. The coarse fraction arrives at the separation cascade 7, comprised of three trough shaped containers arranged in a cascade, which are set in vibration by at least one unbalance motor in a framework. The heavy inert fraction 18 divided out by this arrives outside and is transported away by a schematically represented conveyor belt. The small fraction divided out from the first vibration separation tube arrives at a second vibration separation tube 6. The heavy fraction 6a is transported outwardly on a schematically represented conveyor belt.

The light fraction divided out in the separation cascade arrives at a container 19 for light material of a coarse nature via a schematically represented conveyor belt. Extracted material 8a divided out in the gravity separator is transported outwards via a schematically represented worm conveyor in a container 8a.

Following, a second embodiment of the device for pre-separation of the fine fraction should result from Figures 4,5,5a-5c and 6a-6c through the first vibration separation tube 5 and the further second vibration separation tube 6.

The functions of the two vibration separation tubes are somewhat similar, so that the schematic representation according to Figure 5 is correct for both vibration separation tubes and the sectional representations 6a-6c. The oscillation and shaking motions of the unbalance motors in the corresponding direction (see axial force introduction and transverse force introduction according to Figure 5) lead to an axial force operating line and a transverse force operating line, i.e. lead to a conveyor motion in the axial direction and to a transverse flow in the vibration separation tube. The transverse flow should be followingly explained from Figures 5a-5c. One is here concerned with three sections A,B,C of the vibration separation tube 5 in Figure 4.

At the inlet area or inlet orifice 51 (Fig.4) of the vibration separation tube 5 (see Fig.5a) there is the still unsorted mixed building waste having a maximum grain size of 60-80mm, preferably 45mm. The transverse flow is indicated by an arrow in Figure 5a.

5 There results a constant rotation of material from this transverse flow (see central area corresponding to Fig.5b) leading on the one hand to flushing out light material, and on the other, resulting within the heavy inert fraction, a dividing out into small fraction and coarse fraction. If the transverse
10 force is introduced in an angle 32 of e.g. 30° opposite the horizontal line 31, then an imaginary separating line extends between small fraction and coarse fraction (see Fig.5b) somewhat at right angles to the transverse force.

15 It can be seen from Figure 5b that particle-wise, the predominant amount of fine particle within the inert fraction is forced upwards in tube 5 far above the position which it could occupy through transverse accelerating power alone. By fluidising the small fraction, the coarse particles of the inert fraction on the
20 contrary find no hold within this main fraction and flow back into the centre of the tube (above floor 53). This multi-layered separation effect in vibration separation tube 5 is specific in addition to the pure inertia of the particles also through the differing friction co-efficients with adhesion and
25 motion. In particular, adhesion of individual grains to identical or similar size grain is essentially higher than with those of very differing grain size, this comes in particular from the higher surface that they touch. This leads to the fact that it is always the fraction which particle-wise is most represented
30 which is forced upwards on the wall.

It can be seen from Figures 5a-5c that no separation has taken place at the beginning of vibration separation tube 5, whilst in the central area (Fig.5b) an extensive separation is already
35 happening. Separation is then extensively concluded in the end area at the outlet orifice (see Fig.5c). Whilst outlet orifice 52 located in the region of the lowest point of floor 53 removes

coarse fraction 16b, the small fraction 16a (0-10mm) is removed through a lateral withdrawal orifice 54.

5 The function of the second vibration separation tube 6 (see Fig.4) is similar to that of vibration separation tube 5. Small fraction 16a (0-10) is located in the start area (see Fig.6a) at inlet orifice 61 of vibration separation device 6, which has been supplied from the lateral withdrawal orifice 54 of the first vibration separation tube 5. Even if the material located in
10 the area of Fig.6a is finer than material in area 5a, it would be shown as identical for diagrammatic reasons, although it is different. The same goes for Figures 6b & 6c.

15 Through the transverse force introduced into vibration separation tube 6, likewise in angle 32 of about 30° opposite horizontal line 31 (see Fig.6b), this again leads to a separation of fine grain 6f and coarse grain 6g according to the same physical principles as with vibration separation tube 5. Fine grain 6f contains for example a grain size of 0-3mm, whilst the coarse
20 grain 6g has a grain size of about 3-10mm. Above the coarse grain 6g there is also the floating light fraction 6b (suspended matter). However this distribution can be varied by altering differing parameters. Whilst fine grain 6f leaves vibration separation tube 6 again through a laterally arranged withdrawal
25 orifice 64, the coarse grain 6g arrives outside through outlet orifice 62 (similar to outlet orifice 52 in vibration separation tube 5).

30 Suspended matter 6b is removed from the area of coarse grain 6g by additional air 10 (indicated by broken line) and exhaust air 11, i.e. the coarse grain passing outlet orifice 62 is previously cleansed of suspended matter.

35 The air support for removing light and suspended material 6b at the outlet of second vibration separation tube 6 necessarily only takes place in the area of coarse grain 6g particles somewhat in the centre of floor 63, but not in the area of fine grain 6f,

otherwise the fine particles of fine grain 6 will likewise be partially taken with them. However with this fine grain 6f, one is concerned with heavy inert fraction particles, which exhaust air 11 should not be loaded with, rathermore this fraction should be recycled.

A flexible screen can be provided in the floor area of the second vibration separation tube 6, arranged substantially in the centre of the tube, so as to support the separation of fine sand particles in the vibration separation tube 6.



C L A I M S

1. A process for sorting at least partially recycleable waste
5 such as mixed building waste or the like, where light fractions
such as wood, synthetics also suspended material such as paper
etc. are sorted out from a recyclable heavy inert fraction,
having the following process steps:

- 10 a) supplying waste of a specific maximum grain size respectively
crushing the waste to one such grain size,
b) separating waste into small fraction (16a) and coarse
fraction (16b) in a vibration separation tube (5),
c) clean the small fraction (16a) obtained, for the purpose of
obtaining a heavy, recyclable inert fraction (6a), using
15 additional air (10) and exhaust air (11) for separating out
floating particles (6b) and
d) separating the coarse fraction (16b) by a separation
cascade (7) into light fraction and recyclable, heavy inert
fraction.

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2. A process according to claim 1, characterised in that the
separation of coarse fraction (16b) into light fraction and heavy
fraction (18) in the separating cascade (7) is supported by
additional air (10) and exhaust air (11).

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3. A process according to claims 1 or 2, characterised in that
the small fraction (16a) obtained from the (first) vibration
separation tube (5) is supplied to a second vibration separation
tube (6), where a further separation into fine grain (6f) and
30 coarse grain (6g) results, that the fine grain (6f) is recycled
whilst the coarse grain (6g) is cleansed of suspended particles
(6b) in the region of the outlet section (62) of the second
vibration separation tube (6) by means of a jet of air (10) and
air suction (11), and is subsequently recycled as purified heavy
35 fraction (6a).



4. A process according to claims 1-3, characterised in that the exhaust air (11) from the separation cascade (7) and/or the exhaust air (11) extracted on cleansing the obtained coarse grain (6g) is reprocessed through a gravity separator (8) and is re-used as additional air (10).

5. A process according to any of the above claims, characterised in that the crushed waste is directed over a magnetic separator (13) before execution of step b).

6. A process according to any of claims 1-5, characterised in that the waste in step a) is supplied having a grain size of less than 60-80mm, preferably 45mm, or is crushed to one such grain size.

7. A process according to claim 6, characterised in that the crushing according to step a) is carried out with an impact crusher (3) having a gap width of less than 60-80mm, preferably 45mm.

8. A process according to any of claims 1-7, characterised in that small fractions (16a) in step b) having a grain size of 0-10 are separated out.

9. A process according to claim 3, characterised in that the small fraction (16a) supplied to the second vibration separation tube (6) is separated into fine grain (6f) having a grain size of approximately 0-3mm and coarse grain (6g) having a grain size of approximately 3-10mm.

10. A process according to claim 8, characterised in that the separation of fine grain (6f) is supported by a flexible screen.



11. A separation cascade for separating waste such as mixed building waste or the like of a maximum grain size, from which small fractions (16a) below a specific grain size have previously been separated into light fractions and recyclable heavy inert fractions (18), in particular according to step d) of the process according to claim 1, characterised by a plurality of rounded-off trough-like shaped containers (7a,7b,7c) open at the top, one edge (17a) of which is higher than the other edge (17b), and which are arranged displaced transversely to the trough longitudinal axis in the horizontal plane, one above another, whereby the higher edge (17a) of the higher arranged container (7a) is arranged approximately over the centre of the underlying container (7b) and are joined together in one unit, flexibly suspended, and are driven by at least one rotating unbalance motor (9), so that the heavy inert fraction falls over the higher edge (17a) and the respective light fraction is separated out over the other edge (17b).
12. A separation cascade according to claim 11, characterised in that the three trough-like containers (7a,7b,7c) are arranged one above another.
13. A separation cascade according to claims 11 or 12, characterised in that the rotation axis (9b) of the unbalance motor (9) extends transversely to the longitudinal axis of the trough-like containers (7a,7b,7c) and is inclined about a pointed angle (28) opposite the horizontal line (31) of containers (7a,7b,7c).
14. A separation cascade according to claim 13, characterised in that the angle amounts to 20°-40°, preferably 30°.
15. A separation cascade according to any of claims 11-14, characterised in that the unbalance motor (9) is arranged in the centre of gravity of the separation cascade (7).





16. A separation cascade according to any of claims 11-15, characterised in that the trough shaped containers (7a,7b,7c) are arranged between two perpendicular side walls (25), which are connected to one another by horizontal, stable connecting cross-
5 pieces (26a,26b,26c) to a rigid whole, and that the whole is oscillatingly suspended over springs (12) on a framework (24).

17. A separation cascade according to claim 16, characterised in that an unbalance motor (9) is secured to each of the outer
10 surfaces of the two side walls (25), whose direction of rotation is opposed to one another.

18. A separation cascade according to any of claims 11-17, characterised by an air inlet jet (10) blowing essentially over
15 the whole trough width, approximately horizontally to the respective higher edge (17a), and a suction exhaust jet (11) extending essentially over the whole trough width, approximately horizontally from the respective lower edge (17b) for support during removal of the light fraction.

20 19. A device for separating waste such as mixed building waste or the like of a maximum grain size into small fraction (16a) and coarse fraction (16b), according to step b) of the process according to claim 1, characterised in that a vibration
25 separation tube (5) is provided slightly inclined opposite the horizontal line, having an approximately cylindrical cross-section and an inlet opening (51) and an outlet opening (52) from which the coarse fraction (16b) can be extracted,
30 that the vibration separation tube (5) is displaced in oscillation by a vibration motor opposite the horizontal line about a pointed angle (32) directed upwards in the transverse direction, and
in the region just in front of outlet opening (52) opposite the lowest point of the floor (53) of vibration separation tube (5),
35 a removal opening (54) is provided for small fraction (16a) displaced from that side, which is located opposite floor (53) in the upward direction of oscillation.



20. A device according to claim 19, characterised in that in addition to the (first) vibration separation tube (5), a second vibration separation tube (6) is provided of approximately the same construction, to which the separated small fraction (16a) from the first vibration separation tube (5) is supplied, and this is split into fine grain (6f) and coarse grain (6g), and in the region of outlet opening (62) of the second vibration separation tube (6) additional air (10) is introduced, and exhaust air (11) is used for transporting the suspended particles (6b) contained in the coarse grain (6g) away.

21. A device according to claim 20, characterised in that a flexible screen is provided on the floor (63) in the end area (62) of the second vibration separation tube (6) for additional support in separating the fine grain (6f).

22. A device according to claim 19, characterised in that one or more cyclone separators are provided as gravity separator (8) for reprocessing exhaust air (11).

23. A device according to claim 19, characterised in that essentially all equipment is accommodated in one or more transportable containers (21,22).

24. A device according to claims 22 & 23, characterised in that the device is divided between two containers (21,22), where in one of the containers (22) accommodates the gravity separator (8) also if necessary the additional equipment belonging to same such as the blower (23) for producing additional air, and the remaining equipment (4,5,6,7,9,10,11) is accommodated in the other container, however without equipment (3) for crushing as according to step a).

This Sheet Has Been Replaced

