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Published:

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(54) **Title**: PROCESSING OF MIXED WASTE TO REMOVE NON-COMPOST COMPATIBLE MATERIALS

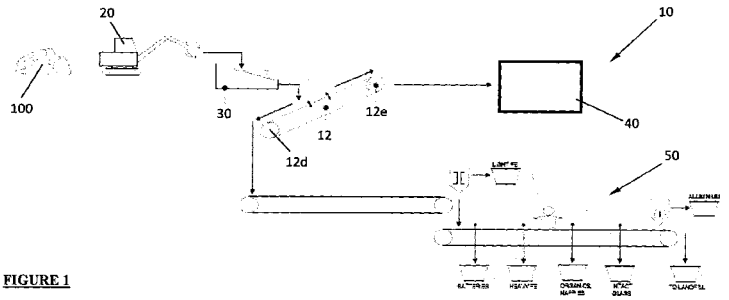


FIGURE 1

(57) **Abstract**: ABSTRACT Disclosed herein is a method and apparatus (10) for processing mixed waste (100). The mixed waste (100) is fed onto an inclined conveyor (12) having an upward incline in the direction of belt travel, such that the mixed waste (100) is separated into a first proportion that rolls backward due to the incline and a second proportion that continues in the direction of belt travel. The first proportion of the waste that rolls backward down the inclined conveyor (12) is subjected to further processing to recover recyclables therefrom. The second proportion of the waste that passes the inclined conveyor (12) in the direction of belt travel is subjected to further processing to produce compost.

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"Processing of mixed waste to remove non-compost compatible materials"

Technical Field

[0001] The present disclosure relates generally to processing of mixed waste to remove non-compost compatible materials. More specifically, the present disclosure proposes a method of processing mixed waste to remove materials such as car batteries, steel objects and glass containers. The presently disclosed method will be described hereinafter with reference to this application. However, it will be appreciated that the method is not limited to this application and may be gainfully employed for other purposes.

Background

[0002] Municipal solid waste (MSW) is general waste materials generated by households and business, and contains a vast array of discarded materials, including food wastes, discarded apparel, packaging and paper of various forms, glass and metal objects, plant matter, nappies, household pet wastes, etc. In some areas, MSW may also include recyclables, such as plastic, glass and metal containers, paper and cardboard.

[0003] One method of reducing MSW inputs to landfills, and recovering materials from the MSW stream, is to pre-process to remove valuable materials prior to composting the remaining organic rich fraction. After composting, a refining stage is performed to remove physical contaminants such as glass fragments and plastics.

[0004] Most Australian States, for example, have regulations concerning the chemical contaminants allowed in the final compost. One of the most difficult to control contaminants in Australia is lead, which is typically limited to below 420 mg/kg on a dry matter basis in the final compost product.

[0005] Lead is present in many materials within MSW, both mineral and biological in source, at a low level. Other sources include legacy inks and paints, which have now been regulated out of the market but still appear in MSW, and plastics and electronic components that are discarded. The most problematic source, although generally regulated against by Australian States, is disposal of lead acid batteries into the MSW

stream. Other countries, with different lead acid battery management systems, have different levels of battery contamination in MSW.

[0006] By the time a lead acid battery has been discarded, due to failure, approximately 50% of the lead plates have been dissolved in the acid. If the battery case ruptures, this dissolved lead paste spreads rapidly through the surrounding materials. Also, the remaining lead plates are very thin and fragile, and may also migrate to the surrounding materials. Theoretical calculations indicate that one typical 12 volt car battery can contaminate 100 tonnes of compost to above the regulated limit.

[0007] It is known to include mechanical screens in processing of MSW and compost, which may remove battery cases at downstream processing stages. However, in conventional MSW processing, the location of such screens is too far downstream to reliably avoid contamination of compost.

[0008] Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present disclosure as it existed before the priority date of each claim of this application.

Summary

[0009] Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

[0010] In a first aspect, the present disclosure provides a method of processing mixed waste, said method comprising:

feeding the mixed waste onto an inclined conveyor having an upward incline in the direction of belt travel, such that the mixed waste is separated into a first proportion that rolls backward due to the incline and a second proportion that continues in the direction of belt travel;

subjecting the first proportion to further processing to recover recyclables therefrom; and

subjecting the second proportion to further processing to produce compost.

[0011] At least a portion of the inclined conveyor may be vibratory. The vibratory portion may be provided by providing the inclined conveyor with one or more striker axles that have longitudinally and circumferentially spaced apart radially extending formations thereon that engage an underside of a belt of the conveyor to agitate the belt. Material in the mixed waste that has similar height to base dimension characteristics has a relatively high centre of gravity in comparison to bagged or separated food waste and the vibratory action induced by the striker axles tends to disturb this relatively high centre of gravity and cause material with a relatively high centre of gravity to topple down the incline of the inclined conveyor. The formations of the striker axles induce localised and relatively short and sharp upward movements of the conveyor belt, which provide a localised increase in the gradient of the belt and momentum imparted by the localised belt movements serves to further unbalance material in the mixed waste with a relatively high centre of gravity. A cleaning mechanism may be provided for cleaning the conveyor belt. The cleaning mechanism may comprise an opposed counter rotating brush roller provided to an upper or drive roller of the inclined conveyor. Waste cleaned from the belt by the cleaning mechanism may be combined with the second proportion. The inclined conveyor may comprise a cross-angle. The inclined conveyor may comprise side guards to inhibit side spillage of the MSW.

[0012] The inclined conveyor may be inclined at an angle of between 15 to 30 degrees, 20 to 25 degrees or in some embodiments around 22 degrees. The inclined conveyor may have a cross-angle of between 0 and 30 degrees. The cross angle may facilitate shedding of material from a main belt of the conveyor to a side belt of the conveyor. The inclined conveyor may have a length up to 20 metres, and in some embodiments the conveyor length is between 5 to 15 metres.

[0013] The further processing of the first proportion may include selective removal of one or more of the items selected from the group consisting of: lead acid batteries,

ferrous materials, intact glass, aluminium, plastic containers, e-waste, and organics/nappies. Light ferrous materials may be removed from the first proportion by passing the first proportion through a magnetic field. Lead acid batteries may be manually removed from the first proportion. Heavy ferrous materials may be manually removed from the first proportion. Intact glass may be manually removed from the first proportion. Plastic containers may be manually removed from the first proportion. E-waste may be manually removed from the first proportion. Organics/nappies may be manually removed from the first proportion. Aluminium may be electro-mechanically removed from the first proportion, such as by eddy current. Material not removed during the further processing of the first proportion may be sent to landfill.

[0014] A plurality of the inclined conveyors may be provided in series.

[0015] A feed mechanism may uniformly meter the MSW onto the inclined conveyer. The feed mechanism may comprise a vibratory feeder. An excavator, front-end-loader or similar machine may load the MSW into the feed mechanism. .

[0016] In a second aspect, there is provided a processing plant for processing mixed waste, said processing plant comprising:

a feeding mechanism for feeding the mixed waste;

an inclined conveyor for receiving the mixed waste from the feeding mechanism, the conveyor having an upward incline in the direction of belt travel, such that the mixed waste is separated into a first proportion that rolls backward due to the incline and a second proportion that continues in the direction of belt travel;

a recycling system for further processing of the first proportion to recover recyclables therefrom; and

a compost producing system for further processing of the second proportion to produce compost.

[0017] At least a portion of the inclined conveyor may be vibratory. The vibratory portion may be provided by providing the inclined conveyor with one or more striker axles that have longitudinally and circumferentially spaced apart radially extending formations thereon that engage an underside of a belt of the conveyor to agitate the

belt. Material in the mixed waste that has similar height to base dimension characteristics has a relatively high centre of gravity in comparison to bagged or separated food waste and the vibratory action induced by the striker axles tends to disturb this relatively high centre of gravity and cause material with a relatively high centre of gravity to topple down the incline of the inclined conveyor. The formations of the striker axles induce localised and relatively short and sharp upward movements of the conveyor belt, which provide a localised increase in the gradient of the belt and momentum imparted by the localised belt movements serves to further unbalance material in the mixed waste with a relatively high centre of gravity. A cleaning mechanism may be provided for cleaning the conveyor belt. The cleaning mechanism may comprise an opposed counter rotating brush roller provided to an upper or drive roller of the inclined conveyor. Waste cleaned from the belt by the cleaning mechanism may be combined with the second proportion. The inclined conveyor may comprise a cross-angle. The inclined conveyor may comprise side guards to inhibit side spillage of the MSW.

[0018] The inclined conveyor may be inclined at an angle of between 15 to 30 degrees, 20 to 25 degrees or in some embodiments around 22 degrees. The inclined conveyor may have a cross-angle of between 0 and 30 degrees. The cross angle may facilitate shedding of material from a main belt of the conveyor to a side belt of the conveyor. The inclined conveyor may have a length up to 20 metres, and in some embodiments the conveyor length is between 5 to 15 metres.

[0019] A plurality of the inclined conveyors may be provided in series.

[0020] A feed mechanism may be provided upstream of the inclined conveyor to uniformly meter the MSW onto the inclined conveyer. The feed mechanism may comprise a vibratory feeder.

Brief Description of Drawings

[0021] An embodiment of the presently disclosed method for processing mixed waste will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of a processing plant for processing MSW in accordance with an embodiment of the presently disclosed MSW processing method; and

Figure 2 is a perspective view of a vibratory feeder and an inclined conveyor of the processing plant of Figure 1;

Figure 3 is a perspective view of the inclined conveyor of Figure 2, shown with the conveyor belt removed;

Figure 4 is an enlarged view of the circled portion of Figure 3;

Figure 5 is a side elevational view of the vibratory feeder and inclined conveyor of Figure 2; and

Figure 6 is an enlarged view of the circled portion of Figure 5.

Description of Embodiments

[0022] Referring to Figures 1 to 6, there is shown a processing plant 10 for processing mixed MSW 100. The plant 10 includes an inclined (or "bounce") conveyor 12 having an upward incline of around degrees in the direction of belt travel. The conveyor 12 has a main belt 12a with a length of around 7 metres and a width of around 1.8 metres. The conveyor 12 also comprises a side belt 12b of the same length as the main belt 12a, but having a lesser width of around 400mm.

[0023] The conveyor 12 comprises an adjustable sub-frame 12c allowing for the conveyor incline to be set at a desired gradient of between 20 and 24 degrees in the direction of belt travel. The sub-frame 12a also allows a cross angle of the main belt 12a to be set at a desired angle of between 0 and 22 degrees.

[0024] The conveyor 12 includes several striker axles 14 that have longitudinally and circumferentially spaced apart radially extending formations 16 thereon that engage an underside of the conveyor belt to agitate the belt. The striker axles 14 are spaced apart by around 600mm and are individually driven. The rotational direction of the striker axles 14 is opposite to the direction of belt travel. The speed of the conveyor belt is adjustable, as is the rotational speed of the striker axles 14.

[0025] Material in the mixed waste that has similar height to base dimension characteristics has a relatively high centre of gravity in comparison to bagged or

separated food waste and the vibratory action induced by the striker axles 14 tends to disturb this relatively high centre of gravity and cause material with a relatively high centre of gravity to topple down the incline of the inclined conveyor 12. The formations 16 of the striker axles 14 induce localised and relatively short and sharp upward movements of the conveyor belt, which provide a localised increase in the gradient of the belt and momentum imparted by the localised belt movements serves to further unbalance material in the mixed waste with a relatively high centre of gravity and increase the tendency for this material to topple down the incline.

[0026] On the main belt 12a, toppling of relatively high centre of gravity materials down the incline may be inhibited by the presence of relatively "flat" materials on belt. Accordingly, especially when the main belt 12a is set to have a cross-angle, the action of the striker axles 14 facilitates toppling of relatively high centre of gravity materials onto the side belt 12b, where such materials may have a clearer path down the incline.

[0027] The conveyor 12 also comprises side guards 18 to inhibit side spillage of the MSW. A cleaning mechanism, in the form of an opposed, under-slung, counter rotating, self-adjusting cleaning brush roller 19, is provided to an upper drive roller of the inclined conveyor for cleaning the conveyor belt. Waste cleaned from the belt by the cleaning mechanism 19 may be combined with the second proportion.

[0028] Referring to Figure 1, an excavator, front-end-loader or similar machine 20 loads unscreened MSW into a feed mechanism, in the form of a vibratory feeder 30, which uniformly meters the MSW onto the conveyer 12.

[0029] The upward incline and vibration of the conveyor 12 facilitates "flat' materials with a relatively low centre of gravity progressing to the top discharge end 12d of the conveyer, while heavy or round objects with higher centre of gravity already effected by the belt incline are pushed past their point of balance by the localised elevation of the main belt 12a and momentum imparted by the striker axles 14 under the main belt. The momentum, incline and further impacts by striker axles 14 continue the toppling backwards of the relatively high centre of mass objects for discharge at the bottom end 12d of the conveyer, whilst the rest of the MSW progresses to the top discharge end 12e of the conveyor. Thus, the MSW is separated into a first proportion that rolls

backwards and a second proportion that continues in the direction of belt travel. The first proportion generally comprises lead-acid batteries and other non-compost compatible materials, whilst the second proportion contains a high proportion of compost compatible materials. The second proportion is directed to a compost producing system 40 for further processing to produce compost. The second proportion may be fed directly to the compost producing system 40 or fed to the compost producing system 40 after further pre-processing to increase its organic content.

[0030] In the illustrated embodiment, the non-compost compatible first proportion is directed to a recycling system 50 and is further processed to remove lead acid batteries, ferrous materials, intact glass, aluminium, and organics/nappies. Light ferrous materials are removed from the first proportion by passing the first proportion through a magnetic field. Lead acid batteries, heavy ferrous materials, intact glass and organics/nappies and bagged materials are manually removed from the first proportion. Aluminium cans are electro-mechanically removed from the first proportion by eddy current. Material not removed during the further processing of the first proportion is sent to landfill.

[0031] The above described processing plant 10 and method have been found to reliably maintain the second proportion of MSW that passes the conveyor 12 substantially free from lead acid batteries, such that this second proportion is rendered compliant with the relevant State regulations for compost. The resulting lead concentrations in the second proportion have also been found to be lower than those resulting from pre-treatment systems that have been used in the past. Other benefits provided by the above described processing plant 10 and method include:

- Steel objects present in the first proportion at a high rate, which facilitates extraction for sale by electro-mechanical means (eg. magnets). As the conveyer 12 is placed early in the process, this steel is cleaner than if obtained from other downstream processes, and may therefore attract a higher price from recyclers.
- Glass bottles and containers, and other glass items, tend to roll backwards down the incline of the conveyor 12. Broken glass in compost is undesirable, and early removal via the inclined conveyor 12 therefore facilitates improvement in the quality of compost processed from the second proportion. The

majority of glass separated out of the MSW stream via the conveyor 12 generally remains intact, and can relatively easily be extracted from the first proportion for recycling or sale.

- Steel and glass contaminants have an abrasive action on composting and refining systems. Early removal of steel and glass contaminants via the inclined conveyor 12 therefore facilitates a reduction downtime and maintenance of composting and refining systems.
- PET and other round plastic containers tend to roll backwards down the incline of the conveyor 12. These containers can be recovered from the first proportion for recycling or sale.
- Aluminum round containers, such as aluminium cans, tend to roll backwards down the incline of the conveyor 12. The aluminium containers tend to remain clean, and can be recovered from the first proportion by an electro-mechanical process (eg. eddy current) for recycling or sale.
- E-waste, such as small NiCd and alkaline batteries, and electronic components from televisions to telephones, appears to be more concentrated in the first proportion of the MSW that rolls backwards down the incline of the conveyor 12. Reduction in e-waste in the second proportion facilitates a reduction in heavy metal contamination in compost produced from the second proportion that passes the conveyor 12.
- Removal of the above materials, which are undesirable from a composting perspective, leads to some additional processing capacity in the subsequent composting system.
- Lead acid batteries that roll backwards down the incline of the conveyer 12 are generally not ruptured by the process. Keeping the batteries intact has occupational health and safety advantages in subsequent handling of the batteries.

[0032] It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the above-described embodiments, without departing from the broad general scope of the present disclosure. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive. Examples of possible modifications include, but are not limited to:

- A plurality of the conveyors 12 may be provided in series to increase efficiency by providing increased material time over an effective zone, increased spreading and layering of the material to second and subsequent conveyors;
- E-waste may be manually removed from the first proportion for further processing;
- Plastic containers may be manually removed from the first proportion for further processing, recycling or sale; and/or
- Using the illustrated processing plant 10 and associated method to treat commercial and industrial wastes (C&I) before composting, especially if the C&I is contaminated with batteries.

CLAIMS:

1. A method of processing mixed waste, said method comprising:

feeding the mixed waste onto an inclined conveyor having an upward incline in the direction of belt travel, such that the mixed waste is separated into a first proportion that rolls backward due to the incline and a second proportion that continues in the direction of belt travel;

subjecting the first proportion to further processing to recover recyclables therefrom; and

subjecting the second proportion to further processing to produce compost.

2. A method according to claim 1, wherein at least a portion of the inclined conveyor is vibratory.

3. A method according to any one of the preceding claims, comprising inclining the conveyor at an angle of between 15 to 30 degrees.

4. A method according to any one of the preceding claims, including providing the conveyor with a cross-angle of between 0 and 30 degrees to shed material toward a side of the conveyor.

5. A method according to claim 4, wherein material shed toward the side of the conveyor is shed onto a side belt.

6. A method according to any one of the preceding claims, wherein the further processing of the first proportion comprises selective removal of one or more of the items selected from the group consisting of: lead acid batteries, ferrous materials, intact glass, aluminium, plastic containers, e-waste, and organics/nappies.

7. A method according to claim 6, comprising passing the first proportion through a magnetic field.

8. A processing plant for processing mixed waste, said processing plant comprising:

a feeding mechanism for feeding the mixed waste;

an inclined conveyor for receiving the mixed waste from the feeding mechanism, the conveyor having an upward incline in the direction of belt travel, such that the mixed waste is separated into a first proportion that rolls backward due to the incline and a second proportion that continues in the direction of belt travel;

a recycling system for further processing of the first proportion to recover recyclables therefrom; and

a compost producing system for further processing of the second proportion to produce compost.

9. A processing plant according to claim 8, wherein at least a portion of the inclined conveyor is vibratory.

10. A processing plant according to claim 9, wherein the vibratory portion is provided by providing the inclined conveyor with one or more striker axles that have longitudinally and circumferentially spaced apart radially extending formations thereon that engage an underside of a conveyor belt of the conveyor to agitate the belt.

11. A processing plant according to claim 10, comprising a cleaning mechanism for cleaning the conveyor belt.

12. A processing plant according to claim 11, wherein the cleaning mechanism comprises rotating brush roller that is counter rotating with respect to the conveyor belt.

13. A processing plant according to claim 12, wherein waste cleaned from the belt by the cleaning mechanism is combined with the second proportion.

14. A processing plant according to any one of claims 8 to 13, wherein the inclined conveyor comprises a cross-angle of between 0 and 30 degrees to shed material toward a side of the conveyor.

15. A processing plant according to claim 14, wherein material shed toward the side of the conveyor is shed onto a side belt.

16. A processing plant according to any one of claims 8 to 15, wherein the inclined conveyor comprises side guards to inhibit side spillage of the MSW.

17. A processing plant according to any one of claims 8 to 16, wherein the inclined conveyor is inclined at an angle of between 15 to 30 degrees.

18. A processing plant according to any one of claims 8 to 17, wherein the inclined conveyor has a length of no more than 20 metres.

19. A processing plant according to any one of claims 8 to 18, including a vibratory feeder upstream of the inclined conveyor to meter the MSW onto the inclined conveyer.

20. A processing plant according to any one of claims 8 to 19, comprising a plurality of the inclined conveyors in series.

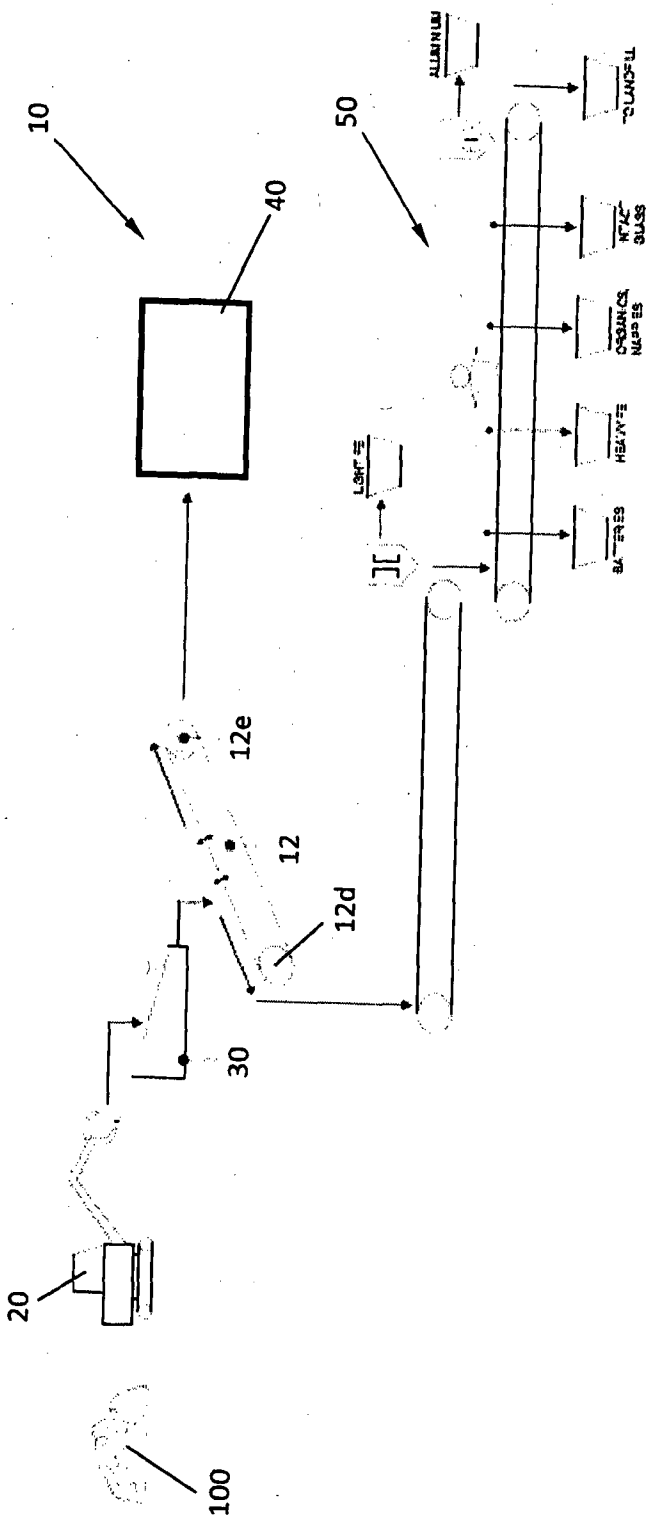

10
40
50
12e
12
12d
30
20
100
ALUMINIUM
TO LANDFILL
LIGHT FE
HEAVY FE

FIGURE 1

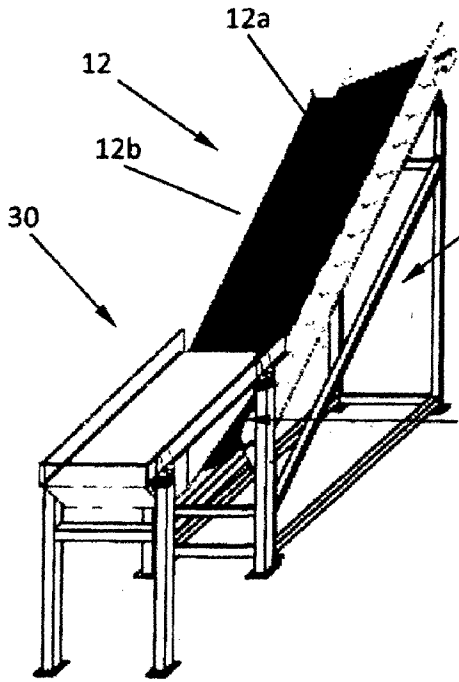


FIGURE 2

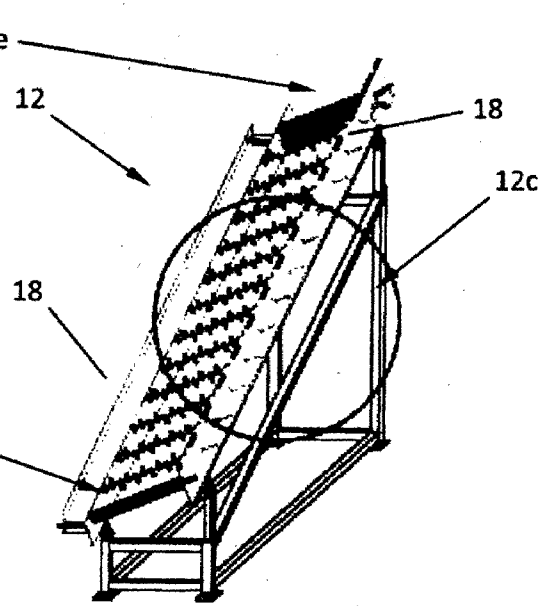


FIGURE 3

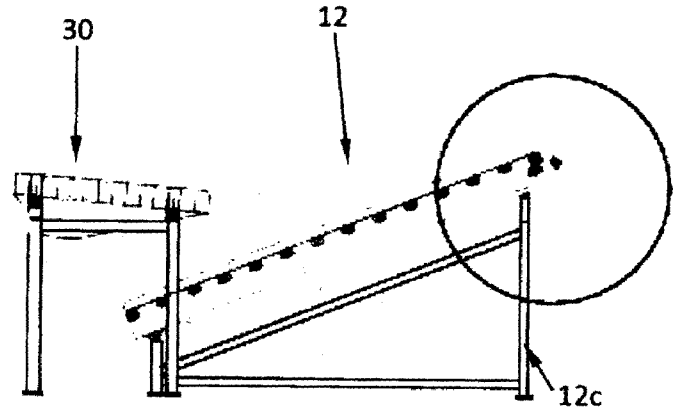


FIGURE 5

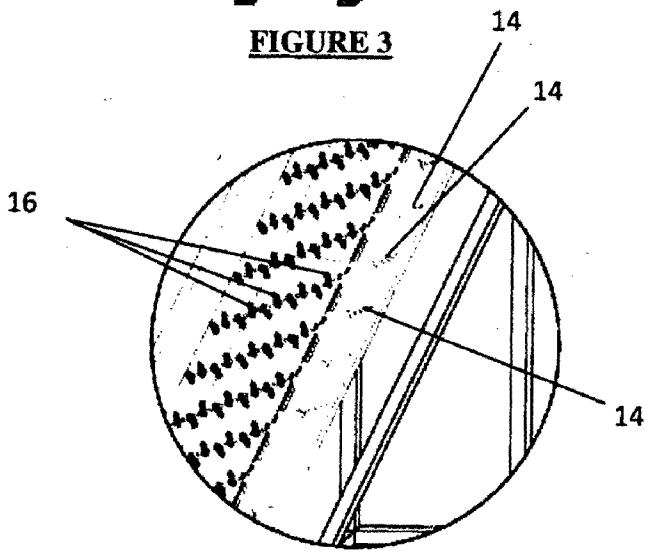


FIGURE 4

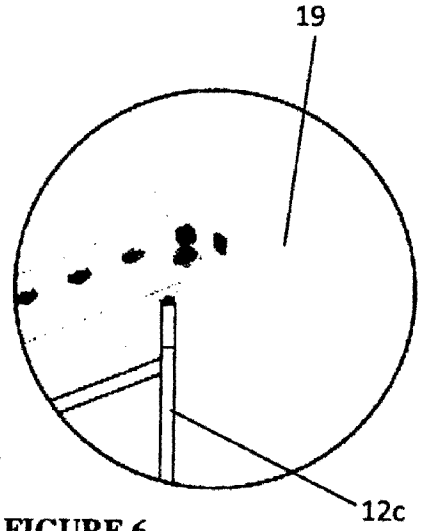


FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2013/000314

A. CLASSIFICATION OF SUBJECT MATTER

B02C 21/00 (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)

Google Scholar: Rubbish (or waste) procesing using inclined conveyor (or belt) and similar words.

EPODOC, WPI: IPC Mark and keywords-waste or trash or rubbish; process or treat or recover or recycle or separate or fraction; conveyor or belt; incline or vibrate or oscillate or angle or gradient or tilt or slant and similar words.

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:

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"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

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Date of the actual completion of the international search	Date of mailing of the international search report
27 May 2013	27 May 2013
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au Facsimile No.: +61 2 6283 7999	Jyoti Shamdasani AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832836

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2013/000314**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5101977 A (ROMAN) 07 April 1992 Entire document particularly fig. 2-6, column 1-8 Entire document particularly fig. 2-6, column 1-8	1, 3-8, 14-18, 20 2, 9-13, 19
Y	WO 1996/041515 A1 (SEKO S. P. A.) 27 December 1996 Entire document particularly pages 1-5 and fig. 1-2	2, 9-13, 19

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2013/000314**

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.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 5101977 A	07 Apr 1992	None	
WO 1996/041515 A1	27 Dec 1996	None	

End of Annex

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