(12) STANDARD PATENT (11) Application No. AU 2017217619 B2
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Screening machine

(51) International Patent Classification(s)
B07B 1/46 (2006.01) ***B07B 1/50*** (2006.01)

(21) Application No: **2017217619** (22) Date of Filing: **2017.02.08**

(87) WIPO No: **WO17/137418**

(30) Priority Data

(31) Number	(32) Date	(33) Country
1670037	**2016.02.11**	**FR**

(43) Publication Date: **2017.08.17**
(44) Accepted Journal Date: **2022.08.11**

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(56) Related Art
WO 2015/001514 A1

(12) DEMANDE INTERNATIONALE PUBLIÉE EN VERTU DU TRAITÉ DE COOPÉRATION EN MATIÈRE DE BREVETS (PCT)

(19) **Organisation Mondiale de la Propriété Intellectuelle**
Bureau international

(43) **Date de la publication internationale**
17 août 2017 (17.08.2017)

WIPO | PCT

(10) **Numéro de publication internationale**
WO 2017/137418 A1

(51) **Classification internationale des brevets** :
B07B 1/46 (2006.01) ***B07B 1/50*** (2006.01)

(21) **Numéro de la demande internationale** :
PCT/EP2017/052709

(22) **Date de dépôt international** :
8 février 2017 (08.02.2017)

(25) **Langue de dépôt** : français

(26) **Langue de publication** : français

(30) **Données relatives à la priorité** :
1670037 11 février 2016 (11.02.2016) FR

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(81) **États désignés** *(sauf indication contraire, pour tout titre de protection nationale disponible)* : AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **États désignés** *(sauf indication contraire, pour tout titre de protection régionale disponible)* : ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), eurasien (AM, AZ, BY, KG, KZ, RU, TJ, TM), européen (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Publiée :

— *avec rapport de recherche internationale (Art. 21(3))*

WO 2017/137418 A1

(54) **Title** : SCREENING MACHINE

(54) **Titre** : MACHINE DE CRIBLAGE

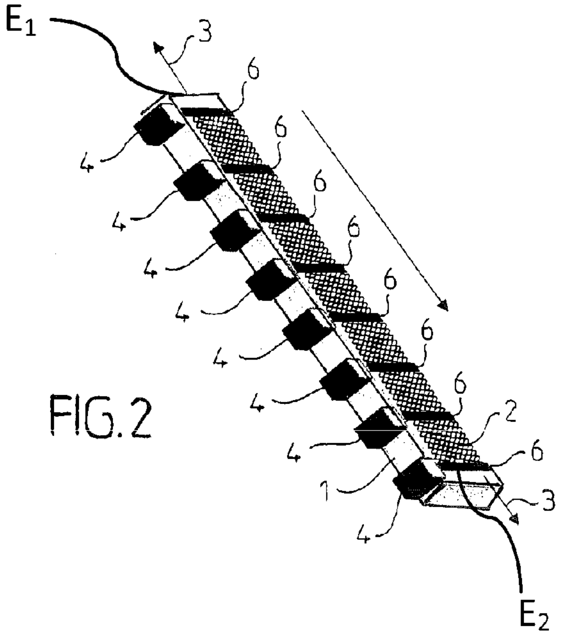

FIG.2

(57) **Abstract** : The present invention relates to vibrating screening machines that comprise a flat screening grid (2) situated in a plane inclined at a non-zero angle with respect to the horizontal, a device for feeding material to be screened positioned at the top end of the grid, a vibration generator designed to transmit vibrations to the grid, wherein the specific configuration of the metal wires (5) making up the grid allows easy cleaning, in particular when the materials to be screened include fibrous materials. The present invention also relates to screening grids for vibrating screening machines, to installations for treating waste that comprise such machines, and to methods for treating waste that employ said machines.

(57) **Abrégé** : La présente invention est relative à des machines de criblage vibrant comprenant une grille (2) de criblage plane située dans un plan incliné d'un angle a non nul par rapport à l'horizontale, un dispositif d'alimentation en matériau à cribler positionné à l'extrémité haute de la grille, un générateur de vibrations agencé pour transmettre des vibrations à la grille, dans lesquelles la configuration spécifique des fils métalliques (5) constituant la grille permet un nettoyage aisé, en particulier lorsque les matériaux à cribler comportent des matières fibreuses. La présente invention est également relative à des grilles de criblage pour machines de criblage vibrant, à des installations de traitement de déchets comprenant de telles machines, et à des procédés de traitement de déchets mettant en oeuvre les dites machines.

SCREENING MACHINE

The present invention relates to screening machines, in particular machines for screening waste containing fibrous materials, and to methods employing such screens. The present invention relates more particularly to machines for screening waste containing sticky and moist fibrous materials, such as organic materials, mixed with undesirable materials, notably metals, mineral materials, plastic materials, glass, and to methods for treating said waste employing such screens.

Methods for treating waste with a view to their energy and/or material valorization are in constant development.

Methods for treating waste with a view to its energy valorization and its material valorization include in particular methane production methods, which aim to produce biogas, and composting methods applied after methane production or directly to fresh domestic waste containing organic material. The raw material of these methods may be waste from selective collections, green waste, kitchen waste or agriculture-foodstuffs industry waste, or domestic waste from non-selective collections containing different categories of materials, such as perishable waste (food waste, green waste), paper, cardboard, glass, plastic, ferrous or non-ferrous metals, fabrics, sanitary textiles, and possibly toxic waste in diffused quantities (DTQD) from households (electrical batteries, etc.).

For example, methane production and/or composting domestic waste with a view to transforming it into biogas and/or into marketable compost employ three to four main steps:

- mechanical preparation of the waste that aims to separate the biodegradable organic materials from other fractions that are not valorizable as biogas or compost; this step may comprise various grinding and/or screening operations, as well as the passage of the waste into a pre-fermentation rotary tube, generally essentially horizontal, which constitutes a means for such preparation. In particular, the processing of unsorted domestic waste necessitates one or more screening and ballistic separation operations, which enable sorting of the materials according to their particle size range and according to their density, and separation of biodegradable organic materials from other fractions that are not valorizable as biogas or compost, whether this be light fractions (plastic films, hard plastic, etc.), or heavy fractions (glass, stones, metals, etc.);

- methane production that aims to produce renewable energy and is carried out in horizontal or vertical enclosures, mechanically agitated or not;
- composting the fresh fraction coming from the pre-treatment of domestic waste, or aerobic maturing of the digestate, which generally involves a prior operation of pressing the digestate coming from methane production, in order to achieve a dry material content level and a porosity enabling auto-composting of the digestate, or which necessitates the addition of a structuring agent and mixing thereof with the digestate to obtain a compostable substrate;
- final refining that aims at complementary extraction of the remaining contaminants following the previous two operations, and at preparing the compost with a particle size range enabling its agronomical valorization.

Of the methods of treating waste with a view to its energy valorization, there may also be cited the production of recovered solid fuels (CSR), from dry waste with a high calorific value (wood, chlorine-free plastics, paper, and cardboard and wood), which are sorted and ground and refined to obtain a particle size range fraction suitable for use. The raw material of these methods may be residual domestic waste (OMR waste), commonplace industrial waste (DIB waste), and bulky waste that is heterogeneous or too voluminous to be valorized in energy valorization (incineration and co-incineration) units.

All these methods employ one or more sorting and/or grinding and/or screening operations. In particular, at various stages of these waste treatment methods, it is desirable to employ fine screening using a fine screen mesh.

In methane production processes, fine screening using a fine mesh makes it possible, in the mechanical preparation phase preceding methane production proper, to optimize the collection of organic materials that could be valorized through methane production and through composting, and which are concentrated in the fine fraction, in particular after passing through a pre-fermentation rotary tube. This fine screening must typically make it possible to recover a waste fraction with dimensions of less than 5 millimeters, in which the organic materials that could be valorized through methane production and through composting are concentrated.

Fine screening therefore makes it possible to select the materials to be treated according to their particle size range and to separate degradable organic materials and mineral materials.

Similarly, fine screening, or even very fine screening, is useful for the calibration of refuse derived fuels (RDF) and recovered solid fuels (RSF) produced by grinding the light coarse fraction derived from domestic waste and/or dry waste with a high calorific value, in particular plastics materials, wood, wood composites, motor vehicle grinding refuse, textiles, where the aim is to eliminate fines. Eliminating fines is essential because the fines generally contain the low PCI components and/or generally more moist components and because this prevents the formation of soot during the use of the fuels.

However, in either of these methods, it is difficult to use fine mesh screens without encountering clogging problems, in particular when it is wished to collect valorizable organic fractions, which may contain moist, sticky or fibrous materials, or when the meshes of the screens are very fine. Whatever the configuration, this clogging represents a penalty in terms of quantity (organic materials) or quality (RDF, RSF) of the recovered valorizable fractions.

For methane production treatments, the existing devices use meshes of relatively large size preventing the loss of organic material but not offering the selectivity necessary for the purification thereof, or also offer self-unclogging screens or screens integrating periodic cleaning systems.

The patent EP 1 957 210 thus discloses a “flip flop” screening machine, also known as a trampoline effect screen, or voltage wave screening machine. This is equipment in which the screening surface, which is inclined (at approximately 20° relative to the horizontal), is constituted of a flexible synthetic material cloth including closed meshes. This cloth is successively tensioned and released by motorized crossbeams to which it is fixed. These high-frequency movements generate acceleration of several tens of “g” of the objects present on the screening cloth and detach them so as to bring about declogging. It is however necessary to wash these cloths periodically with pressurized water, which leads to problems of downtime and of management of the cleaning water, as well as risks of weakening or even perforating the cloth.

The service life of synthetic material flexible cloths (notably polyurethane) used in these screens is limited: they are subject in particular to tearing caused by the presence of abrasive materials in the screened waste.

The application EP 2 364 782 discloses the use of a trampoline effect screen for screening moist organic materials, with cloths having a mesh size of 10 millimeters. This application also mentions the risks of chemical attack of the cloths when relatively moist organic waste is screened.

Generally speaking, the meshes of these screens may be constituted of slots, square, rectangular or round openings. Their dimensions generally vary for moist domestic waste between 8 and 12 millimeters. With these devices, it seems difficult to screen waste comprising moist organic materials with a mesh size less than 10 mm without clogging the cloths. In all cases, the mesh aperture is increased and reduced as the cloth moves, which can give rise to quality problems.

Alternatively, the application WO 2015 001514 discloses the use of screens constituted of a metal grid inclined at approximately 40° relative to the horizontal which is struck on its lower face by hammers disposed on a plurality of transverse bars at a frequency of several tens of hertz. The vibrations of the grid generated in this way, combined with a system for automatic brushing of the upper surface of the grid, makes it possible to prevent clogging. The meshes of the grids may be less than 5 millimeters, or again less than 2 millimeters.

However, in use, it is found with the type of screen described in the application WO 2015 001514 that cleaning the lower surface of the grid may be ineffective under certain conditions and that these grids therefore become clogged, in particular when they are used to screen waste containing fibrous, in particular moist and sticky, organic materials.

There is therefore a need for waste screening systems using a fine screen mesh and making it possible to avoid the clogging problems. In particular, there

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is a need for systems of this kind also having an improved service life, through limiting the downtime and maintenance problems.

The present invention consists in a vibrating screening machine comprising:

- a flat screening grid (2) comprising a series of metal wires (5) extending in substantially a same longitudinal direction, all the metal wires (5) being situated in the plane of the grid, the distance between a metal wire (5) and its adjoining wires varying between a maximum and a minimum, the minimum distance being non-zero, the grid (2) comprising at least one transverse bar (6), disposed perpendicularly to the direction of the longitudinal wires (5), said grid (2) being situated in a plane inclined at a non-zero angle α relative to the horizontal, and including a high end (E1) and a low end (E2),
- a device for feeding material to be screened positioned at the high end (E1) of the grid, the direction of the longitudinal wires (5) of said grid being close to the direction of flow of the materials to be screened over the grid,
- a brushing means adapted to execute a to-and-fro movement over the grid comprising at least one cylindrical brush with its axis substantially parallel to the at least one transverse bar wherein the diameter of the metal wires of the grid is between 0.5 and 2 millimeters inclusive, and the at least one cylindrical brush includes bristles with a diameter between 0.4 and 1.0 millimeter inclusive.

The present invention also relates to screening grids for vibrating screening machines, to waste treatment installations comprising such machines, and to waste treatment methods employing said machines.

The present invention also relates to an automatic brushing system deployed on the upper face of the grid and that clean its upper and lower faces.

Thanks to their specific configuration and to the specific diameter of the metal wires that constitute them, the grids of screening machines according to the invention have a flexibility allowing the brushes to pass through the grid to clean its lower face, thereby preventing the accumulation of material on that lower face and preventing clogging.

The specific configuration of the metal wires constituting the grid of machines according to the invention therefore enables easy cleaning, in particular when the materials to be screened include fibrous materials, in particular moist or sticky fibrous materials.

Moreover, these wire diameters are sufficiently large to maintain a robustness of the grid appropriate to its use, and sufficiently small to enable an optimum open surface area/total surface area ratio.

The diameter of the wires of the grids of screening machines according to the invention is advantageously between 1 and 1.7 millimeters inclusive, preferably between 1.1 and 1.6 millimeters inclusive, or again between 1.2 and 1.6 millimeters inclusive, or between 1.3 and 1.6 millimeters inclusive, or again between 1.4 and 1.5 millimeters inclusive.

In the sense of the present invention, there is meant by screening an operation of separating a particulate material into two particle size range fractions by passing it through a grid or screen comprising openings or meshes of particular size.

In the sense of the present invention, there is meant by longitudinal wire a wire that extends in the lengthwise direction in a rectilinear manner. The longitudinal wires of the grid according to the invention are not perfectly rectilinear, and may feature patterns (arcs, crenellations, triangular patterns etc.) divided on either side of this rectilinear direction.

In the sense of the present invention, there is meant by longitudinal wires of substantially the same direction wires whose directions have relative to one another a maximum angle between 0 and 5 degrees inclusive.

In the sense of the present invention, there is meant in particular by non-zero minimum distance between a wire and its neighbors the fact that the wires constituting the grids according to the invention are not fastened to one another, for example not welded to one another or interwoven with one another, even if, taking account of deformations, adjacent wires of the grids may have a few points of non-permanent contact between them.

In screening machines according to the invention, the material to be screened flows over the grid from the end (E1) to the end (E2) of the grid in a substantially rectilinear manner.

In screening machines according to the invention, the grids are typically mounted on a rigid chassis (1). The ends (E1) and (E2) of the grid are typically fastened to tensioning systems (3) enabling them to be maintained substantially flat.

The transverse bars (6) of the grids are typically rubber strips. The grids according to the invention may equally include a rubber strip on their exterior edges, facilitating fixing to the chassis (1) by clamping.

According to one embodiment, the grids of vibrating screening machines according to the invention are situated in a plane inclined at an angle α relative to the horizontal between 30° and 60° inclusive, preferably between 40 and 45° inclusive. This angle is typically 42°.

According to one embodiment, the vibration generator comprises at least one electromagnetic hammer (4) positioned to strike at least one transverse bar (6).

According to one embodiment, vibrating screening machines according to the invention include a brushing means (9, 10) adapted to execute a to-and-fro movement over the grid (2).

Said brushing means typically comprises at least one cylindrical brush (10) with its axis substantially parallel to the at least one transverse bar (6).

In the sense of the present invention, there is meant by substantially parallel two straight lines that have between them an angle between 0 and 5 degrees inclusive.

According to one embodiment, the diameter of said cylindrical brushes (10) is between 500 and 700 millimeters inclusive.

Said cylindrical brushes (10) typically have bristles with a diameter between 0.4 and 1.0 millimeter inclusive.

Said cylindrical brushes (10) are typically mounted on a mobile chassis (8, 9).

In vibrating screening machines according to the invention, the grids (2) are advantageously constituted of metal wires (5) having a substantially sinusoidal profile in the plane of said grid (2).

In the sense of the present invention, there is meant by substantially sinusoidal profile a profile that approximates a sinusoid, that is to say composed of arcs similar to those of a sinusoid, with the same amplitude and the same period, regularly distributed on either side of the straight line that coincides with the direction of the longitudinal wires. The sinusoidal character of the profile is not called into question by any localized deformations of the wire that may happen to exist.

According to one embodiment, in vibrating screening machines according to the invention, the mesh L of the grid (2) is between 5 and 12 millimeters inclusive, preferably between 6 and 10 millimeters inclusive, preferably between 7 and 9 millimeters inclusive.

The mesh L of the grid is defined as the maximum average distance between consecutive longitudinal wires of the grid in a direction orthogonal to the direction of said longitudinal wires. For example, for a grid comprising wires of sinusoidal profile, the mesh L represents approximately twice the amplitude of the sinusoid.

In vibrating screening machines according to the invention, the mesh L of the grid (2) is advantageously between 7 and 9 millimeters and in that the diameter of the wires of the grid (2) is between 1 and 1.7 millimeters inclusive.

According to another embodiment, in vibrating screening machines according to the invention, the mesh L of the grid (2) is between 1 and 4 millimeters inclusive, preferably between 1.5 and 3.5 millimeters inclusive, preferably between 2 and 3 millimeters inclusive.

The present invention also relates to flat screening grids (2) for vibrating screening machines as described above, comprising a series of metal wires (5) extending in substantially the same longitudinal direction, the metal wires (5) being all situated in the plane of the grid, the distance between a metal wire (5) and its adjacent wires varying between a maximum and a minimum, the minimum distance being non-zero, characterized in that:

- the diameter of the metal wires (5) is between 1 and 1.7 millimeters inclusive,
- the mesh L of the grid (2) is between 7 and 9 millimeters inclusive,

- the grid comprises at least one transverse bar (6) disposed perpendicularly to the direction of the longitudinal wires (5).

Grids according to the invention typically comprise stainless steel wires. The transverse strips (6) of the grids according to the invention are typically made of rubber.

According to one embodiment, the grids (2) according to claim 13, characterized in that the metal wires (5) have a substantially sinusoidal profile in the plane of the grid.

The present invention also relates to waste treatment installations comprising at least one vibrating screening machine as described above.

The present invention also relates to methods comprising at least one step of vibrating screening of materials from/derived from waste on a machine as described above, said step comprising the vibration of the grid (2) by a vibration generator positioned to transmit said vibrations to the grid (2) via the at least one transverse bar (6).

According to one embodiment, in methods according to the invention, some or all of the materials from the at least one vibrating screening step are subjected to a treatment enabling their energy and/or material valorization.

By materials from the at least one vibrating screening step there is meant both materials that have passed through the grid (2) and screening rejects that have remained on top of the grid (2).

In one particular embodiment, in the methods according to the invention, the waste contains organic materials mixed with undesirable materials, in particular metals, mineral materials, plastic materials, glass, and said methods comprise:

- at least one vibrating screening step carried out on a machine as claimed in any one of claims 1 to 9, said machine comprising a grid (2) the mesh L of which is between 6 and 10 millimeters inclusive, preferably between 7 and 9 millimeters inclusive, and
- optionally, one or more grinding and/or screening steps enabling reduction of the particle size range of the waste

intended to feed the vibrating screening step to a dimension less than 30 millimeters, preferably less than 20 millimeters.

In this embodiment, the waste containing organic materials may be unsorted waste, for example unsorted domestic waste. Alternatively, this waste may result from sorting domestic waste or waste from other sources, and include a large fraction of organic material associated with undesirable materials. These undesirable materials are for example packaging soiled by organic material.

This waste generally has a high moisture content, typically between 50 and 80% inclusive, and contains a large amount of sticky and/or fibrous material (kitchen waste, restaurant waste, unsold supermarket items, etc.).

In particular, in this embodiment of the methods according to the invention, the waste having passed through the at least one vibrating screening step is subjected to a methane production treatment in a digester.

In particular, in this embodiment of the methods according to the invention, the at least one vibrating screening step is preceded by a pre-fermentation treatment in a rotary tube with feeding at one end and extraction at the other end.

The present invention relates in particular to methods of treating waste, in particular domestic waste, containing organic materials mixed with undesirable materials, in particular metals, mineral materials, plastic materials, glass, in which:

- the waste is subjected to a first sorting by screening,
- the fraction of the waste passing through the screen is subjected to a pre-fermentation treatment in a rotary tube with feeding at one end and extraction at the other end,
- the waste from the pre-fermentation treatment is subjected to one or more grinding and/or screening steps enabling reduction of its particle size range to a dimension less than 30 millimeters, preferably less than 20 millimeters,
- said waste fraction with a dimension less than 30 millimeters, preferably less than 20 millimeters is subjected to at least one vibrating screening

step carried out on a machine as described above, said machine comprising a grid (2) the mesh L of which is between 6 and 10 millimeters inclusive, preferably between 7 and 9 millimeters inclusive,

– at least some of the material that has passed through the vibrating screening step is subjected to an energy and/or material valorization treatment, preferably a methane production treatment in a digester.

The present invention also relates to installations for execution of the methods described above, and comprising:

- at least one vibrating screening machine as described above, said machine comprising a grid (2) the mesh L of which is between 6 and 10 millimeters inclusive, preferably between 7 and 9 millimeters inclusive,
- one or more grinding and/or screening devices enabling reduction of the particle size range of the waste intended to feed the vibrating screening machine to a dimension less than 30 millimeters, preferably less than 20 millimeters.

In particular, installations according to the invention may comprise at least one pre-fermentation rotary tube.

According to a variant, the methods according to the invention are waste treatment methods in which the waste is dry waste with a high lower calorific value, and comprising:

- one or more fine grinding steps enabling reduction of the particle size range of the waste to a dimension less than 30 millimeters, preferably less than 20 millimeters, followed by
- at least one vibrating screening step carried out on a machine as described above, said machine comprising a grid (2) the mesh L of which is between 1 and 4 millimeters inclusive, preferably between 1.5 and 3.5 millimeters inclusive, preferably between 2 and 3 millimeters inclusive.

In this embodiment, the dry waste with a high lower calorific value is in particular plastic materials, wood, wood composites, motor vehicle grinding rejects, synthetic textiles.

By dry waste is meant waste having a moisture content less than 25%, or again less than 20%, or again less than 10%, typically between 25 and 5% inclusive. By high lower calorific value (LCI) is meant a lower calorific value typically between 12 and 18 MJ/kg inclusive.

In this embodiment, the methods according to the invention may advantageously comprise, upstream of the fine grinding step, one or more coarse grinding steps enabling reduction of the particle size range of the waste to a dimension less than 300 millimeters, preferably less than 200 millimeters.

Finally, the present invention also relates to the use of the materials constituting the rejects from the vibrating screening by the methods as described above as recovered solid fuels.

By recovered solid fuels is typically meant so-called “CSR” fuels or “RDF” (refuse derived) fuels.

Other features and advantages of the invention will become apparent in the following description of one embodiment given with reference to the appended drawings but which has no limiting character.

In these drawings:

Figure 1 is a diagram representing the operation of the method according to the invention,

Figure 2 is a diagrammatic perspective view of a screen used in the method according to the invention,

Figure 3 is a diagrammatic top view of the grid of the screen from figure 2,

Figure 4 is a diagrammatic view to a larger scale of a detail from figure 3,

Figure 5 is a diagrammatic perspective view of a screen used in the method according to the invention, equipped with a roller brushing device,

Figure 6 is a view in lateral elevation of the screen from figure 5,

Figure 7 is a view similar to figure 6 with a retractable support deployed,

Figure 8 and figure 9 are views similar to figure 7, the retractable support moving to effect cleaning,

Figure 10 is a view similar to figure 6, at the end of cleaning,

Figure 11 and figure 12 are views similar to figure 5 showing the position of the carriage above a grid and another, adjacent grid, and

Figure 13 is a view similar to figure 11 and figure 12 with the carriage in a waiting position.

Figure 1 enables the invention to be situated in its context. There can be seen top left the line entry where the waste to be treated is introduced. After a first or primary screening, the fine fraction with a particle size range less than 450 mm passes through a pre-fermentation rotary tube and then through a trommel screen in which the finest fraction, with a particle size range less than 80 mm, is recovered and passes through a second trammel in which the finest fraction, with particle size range from 20 mm, is recovered to be passed through a screen, that is to say a screen according to the invention, which enables separation of a very fine first fraction, with a particle size range less than 5 mm, from a second fraction with a particle size range between 5 and 20 mm inclusive.

Thereafter the first fraction passes through a mechanically agitated horizontal digester with at least partial recirculation via a mixer hopper.

It is during this digestion phase that biogas is extracted. The digestate is composted to be valorized agronomically.

The second fraction passes first through a ballistic separator enabling heavy waste to be set aside before passing through a digester in a similar manner to the first fraction. The digestate undergoes a maturing phase through dripping or dehydration to stabilize it or to convert it into fuel or to be valorized agronomically.

In figure 2 can be seen the screening device used in the method according to the invention.

The screening device comprises a chassis 1 supporting an inclined grid 2. The grid 2 is situated in a plane inclined at an angle α to the horizontal.

The grid 2 is advantageously mounted on a static grid support with an inclination adjustable from 30 to 60 degrees. In this embodiment the inclination is of 42° relative to the horizontal.

This steep inclination enables the product to be treated to run down the slope without being forced to pass through a mesh. Clogging is therefore much less frequent.

The grid 2 has an elongate shape, a lower end (E2) and an upper end (E1) being fastened to tensioning systems 3 enabling a permanent tension to be imparted to the grid 2 to maintain it substantially flat.

Electromagnetic hammers 4 enabling vibrations to be transmitted to the grid are mounted on the sides of the grid fastened to the chassis 1. These electromagnetic hammers may be constituted for example by electromagnets driving in rotation cylinders provided with projecting lugs or pins, disposed just below the grid, and extending transversely to the chassis 1, at the level of the transverse bars 6. The impact of the pins on the bar or bars 6 enables the transmission of vibrations to the grid.

The grid 2 (figure 4) takes the form of a series of longitudinal wires 5 having a substantially sinusoidal profile organized into a rectangular shape.

The wires 5 are situated in the same plane, the distance between one wire 5 and its adjoining wires varying between a maximum and a minimum. But, even when the distance between a wire and its neighboring wire is minimal, there is no weld between the two wires. This particular disposition was retained after numerous trials. It minimizes clogging and facilitates cleaning of the grid. The maximum distance between the wires constitutes the size of the mesh L.

Transverse stiffener bars 6 are provided at regular intervals to maintain a constant spacing between the wires 5.

The electromagnetic hammers 4 are disposed facing the stiffener bars. The frequencies used are generally between 10 and 60 Hz inclusive. In the case of use of a plurality of screening stages, it is possible to use a different frequency for each stage.

To guarantee the functioning of the method, a cleaning step is provided.

In figure 6 can be seen a metal frame 7 placed above the grid 2. A carriage 8 is suspended under the frame 7 by means of rails in such a manner as to be able to slide transversely relative to the grid 2. The carriage 8 is constituted of metal structural sections assembled to one another to delimit in particular an upper surface 8a, to which are fixed rollers cooperating with the rails on the frame 7, and an inclined lower surface 8b, parallel to the surface of the grid 2, under which is mounted a retractable support 9 supporting cylindrical cleaning brushes 10. Means not shown are provided for driving the cylindrical brushes in rotation about their axis.

The retractable support 9 includes two parallel faces 9a and 9b connected by links 9c. The first face 9a is mounted so it can slide under the carriage 8 and the second face 9b supports the cylindrical cleaning brushes 10.

Two (1.7 m × 3.60 m) grids 2 are provided, disposed side by side and fed by a V-shaped chute that is not shown. The chute enables the two grids 2 to be fed simultaneously or only one of them.

In this way it becomes possible to reduce temporarily the flowrate of waste arriving at the screening station whilst orienting the totality of the flow to one of the two grids to enable cleaning of the other grid just in time but without the presence of waste.

The carriage 8 may therefore be located above one or the other of the grids or offset to the side, in a waiting position.

In operation, the carriage 8 is disposed in the waiting position as in figure 13.

When a cleaning operation is deemed necessary, the carriage 8 is moved above one of the grids 2 that is to be cleaned (figures 11 and 12). The retractable support 9 is then located in a folded away position as shown in figure 6.

Once the carriage 8 reaches it position above the grid 2 to be cleaned, the retractable support 9 is deployed (figure 7) to place the cylindrical brushes 10 in contact with the grid 2.

The retractable support 9 then effects a downward movement in translation relative to the carriage 8, parallel to the grid 2, to clean it (figures 8 and 9).

Once the grid 2 has been cleaned the retractable support 9 is folded away (figure 10) before the carriage 8 returns to the waiting position (figure 13).

Alternatively, a single grid is disposed on each screening machine, and has its own feed hopper and its own cleaning system comprising a carriage, one or more cylindrical brushes, and a system for moving the carriage over the grid. During cleaning cycles, the feeding of the grid with material from the hopper is stopped, the carriage is moved in translation above the grid and the cylindrical brush or brushes moved into contact with the grid to clean it. During screening, the carriage 8 and the brushes are located in the lower part of the grid, in a position raised above the end (E2).

Screening trials:

In a method of treating unsorted domestic waste as shown in figure 1, a screening machine as described above and shown in figures 5 to 8, with integral brushing system, was used, with different grids (2), to screen the fraction of material of size between 0 and 20 millimeters inclusive, having a moisture content of approximately 50%, coming from the pre-fermentation rotary tube and two trommel screens located downstream of that tube.

The grids that were used are as shown in figure 2, and are flat grids with longitudinal wires of sinusoidal profile that are not joined. The usable screening area was 3.45 m^2 in all the trials; the duration of the trials was 12 hours, including 1.2 minutes of cleaning (stopping of feeding) every 10 minutes.

In the various trials, the mesh L and the diameter d of the wires were varied, and the quality and the quantity of the material passing through the screen, intended for methane production and composting, analyzed **(cf. table 1).**

The capture mass rate of the 0-5 mm fraction (of less than millimeter size) in the material passing through the screen was obtained by screening that fraction in a sample of mass m of the feed material and by weighing the mass m' obtained and carrying out the same operation for a mass m of material passing through, to obtain a mass m''; (m''/m')*100 is the capture rate (%).

It is found, in trials 1 and 2, that the flowrate of material passing through the screen is low, which indicates a problem of clogging of the screen, caused by the excessive stiffness of the wires and to the insufficiently large open area of the grid. This is confirmed by the low capture rate of the 0-5 mm fraction.

The results are clearly improved in trials 7 and 8 where the diameter of the wires is reduced with a mesh of substantially the same dimension. The outlet flowrate is increased approximately 50% and the capture rate of the 0-5 mm fraction in the material passing through the target likewise. In quality terms, the plastic content of the material passing through remains zero, which is perfect. The glass content increases, but remains within acceptable limits for use in methane production and composting.

In trials 3 and 4, the increase in the mesh size leads to flowrates and a capture rate of the 0-5 mm fraction that are very satisfactory, but with degraded quality in terms of glass content.

The optimum compromise of quality and quantity is obtained for trials 5 and 6.

	Grid: Mesh L, wire diameter d	0-20 mm feed flowrate	% material passing through flowrate / feed flowrate	% mass of plastic in material passing through	% mass of glass in material passing through	Capture rate of 0-5 mm fraction
1	L: 6 mm d: 2.5 mm	3 t/h	31%	0.1%	0.75%	43%
2	L: 6 mm d: 2.5 mm	4.8 t/h	23%	0.00%	0.70%	37%
3	L: 9 mm d: 1.6 mm	? 4.8 t/h	57%	0.15%	2.10%	89%
4	L: 9 mm d: 1.6 mm	4.8 t/h	53%	0.13%	1.98%	87%
5	L: 8 mm d: 1.6 mm	3.0 t/h	57%	0.06%	1.20%	94%
6	L: 8 mm d: 1.6 mm	4.8 t/h	48%	0.06%	1.50%	82%
7	L: 7 mm d: 1.6 mm	3.1 t/h	47%	0.05%	1.65%	69%
8	L: 7 mm d: 1.6 mm	4.3 t/h	41%	0.03%	1.49%	66%

Table 1

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The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS

1. A vibrating screening machine comprising:

- a flat screening grid comprising a series of metal wires extending in substantially a same longitudinal direction, all the metal wires being situated in the plane of the grid, the distance between a metal wire and its adjoining wires varying between a maximum and a minimum, the minimum distance being non-zero, the grid comprising at least one transverse bar, disposed perpendicularly to the direction of the longitudinal wires, said grid being situated in a plane inclined at a non-zero angle α relative to the horizontal, and including a high end (E1) and a low end (E2),

- a device for feeding material to be screened positioned at the high end (E1) of the grid, the direction of the longitudinal wires of said grid being close to a direction of flow of the materials to be screened over the grid,

- a brushing means adapted to execute a to-and-fro movement over the grid comprising at least one cylindrical brush with its axis substantially parallel to the at least one transverse bar wherein the diameter of the metal wires of the grid is between 0.5 and 2 millimeters inclusive, and the at least one cylindrical brush includes bristles with a diameter between 0.4 and 1.0 millimeter inclusive.

2. The vibrating screening machine as claimed in claim 1, wherein the angle α is between 30° and 60° inclusive, preferably between 40 and 45° inclusive.

3. The vibrating screening machine as claimed in either one of claims 1 or 2, wherein the vibration generator comprises at least one electromagnetic hammer positioned to strike at least one transverse bar.

4. The vibrating screening machine as claimed in claim 1 wherein the diameter of the at least one cylindrical brush is between 500 and

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700 millimeters inclusive.

5. The screening machine as claimed in any one of claims 1 to 4, wherein the cylindrical brush is mounted on a mobile chassis.

6. The vibrating screening machine as claimed in any one of claims 1 to 5, wherein the metal wires have a substantially sinusoidal profile in the plane of the grid.

7. The vibrating screening machine as claimed in any one of claims 1 to 6, whereinthe mesh L of the grid is between 5 and 12 millimeters inclusive, preferably between 6 and 10 millimeters inclusive, preferably between 7 and 9 millimeters inclusive.

8. The vibrating screening machine as claimed in claim 7 wherein the mesh L of the grid is between 7 and 9 millimeters and in that the diameter of the wires of the grid is between 1 and 1.7 millimeters inclusive.

9. The vibrating screening machine as claimed in any one of claims 1 to 6, whereinthe mesh L of the grid is between 1 and 4 millimeters inclusive, preferably between 1.5 and 3.5 millimeters inclusive, preferably between 2 and 3 millimeters inclusive.

10. A flat screening grid for a vibrating screening machine as claimed in any one of claims 1 to 8 comprising a series of metal wires extending in substantially the same longitudinal direction, the metal wires being all situated in the plane of the grid, the distance between a metal wire and its adjacent wires varying between a maximum and a minimum, the minimum distance being non-zero, wherein:

- the diameter of the metal wires is between 1 and 1.7 millimeters inclusive,

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- the mesh L of the grid is between 7 and 9 millimeters inclusive,
- the grid comprises at least one transverse bar, disposed perpendicularly to the direction of the longitudinal wires.

11. The grid as claimed in claim 10, wherein the metal wires have a substantially sinusoidal profile in the plane of the grid.

12. A waste processing installation comprising at least one vibrating screening machine according to any one of claims 1 to 9.

13. A waste processing method comprising at least one step of vibrating screening of materials from/derived from waste on a machine as claimed in any one of claims 1 to 9, said step comprising the vibration of the grid by a vibration generator positioned to transmit said vibrations to the grid via the at least one transverse bar.

14. The method as claimed in claim 13 wherein some or all of the materials from the at least one vibrating screening step are subjected to a treatment enabling their energy and/or material valorization.

15. The method as claimed in either one of claims 13 or 14 wherein the waste contains organic materials mixed with undesirable materials, in particular metals, mineral materials, plastic materials, glass, and comprising:
    - at least one vibrating screening step carried out on a machine as claimed in any one of claims 1 to 6, said machine comprising a grid the mesh L of which is between 6 and 10 millimeters inclusive, preferably between 7 and 9 millimeters inclusive, and
    - optionally, one or more grinding and/or screening steps enabling reduction of the particle size range of the waste intended to feed the vibrating screening step to a dimension

less than 30 millimeters, preferably less than 20 millimeters.

16. The method as claimed in any one of claims 13 to 15 wherein the waste having passed through the at least one vibrating screening step is subjected to a methane production treatment in a digester.

17. The method as claimed in any one of claims 13 to 16 wherein the at least one vibrating screening step is preceded by a pre-fermentation treatment in a rotary tube with feeding at one end and extraction at the other end.

18. A method of treating waste, in particular domestic waste, containing organic materials mixed with undesirable materials, in particular metals, mineral materials, plastic materials, glass, in which:

- the waste is subjected to a first sorting by screening,
- the fraction of the waste passing through the screen is subjected to a pre-fermentation treatment in a rotary tube with feeding at one end and extraction at the other end,
- the waste from the pre-fermentation treatment is subjected to one or more grinding and/or screening steps enabling reduction of its particle size range to a dimension less than 30 millimeters, preferably less than 20 millimeters,
- said waste fraction with a dimension less than 30 millimeters, preferably less than 20 millimeters is subjected to at least one vibrating screening step carried out on a machine as claimed in any one of claims 1 to 8, said machine comprising a grid the mesh L of which is between 6 and 10 millimeters inclusive, preferably between 7 and 9 millimeters inclusive,
- at least some of the material that has passed through the vibrating screening step is subjected to an energy and/or material valorization treatment, preferably a methane production treatment in a digester.

19. An installation for the execution of a method as claimed in any one of

claims 13 to 18 comprising:

- at least one vibrating screening machine as claimed in any one of claims 1 to 9, said machine comprising a grid the mesh L of which is between 6 and 10 millimeters inclusive, preferably between 7 and 9 millimeters inclusive,
- one or more grinding and/or screening devices enabling reduction of the particle size range of the waste intended to feed the vibrating screening machine to a dimension less than 30 millimeters, preferably less than 20 millimeters.

20. The installation as claimed in claim 19 comprising at least one pre-fermentation rotary tube.

21. The method as claimed in either one of claims 13 or 14 wherein the waste is dry waste with a high lower calorific value, and comprising:

- one or more fine grinding steps enabling reduction of the particle size range of the waste to a dimension less than 30 millimeters, preferably less than 20 millimeters, followed by
- at least one vibrating screening step carried out on a machine as claimed in any one of claims 1 to 10, said machine comprising a grid the mesh L of which is between 1 and 4 millimeters inclusive, preferably between 1.5 and 3.5 millimeters inclusive, preferably between 2 and 3 millimeters inclusive.

22. The method as claimed in claim 21 comprising, upstream of the fine grinding step, one or more coarse grinding steps enabling reduction of the particle size range of the waste to a dimension less than 300 millimeters, preferably less than 200 millimeters.

23. Use of materials constituting rejects from the vibrating screening methods as claimed in either one of claims 21 or 22 as recovered solid

fuels.

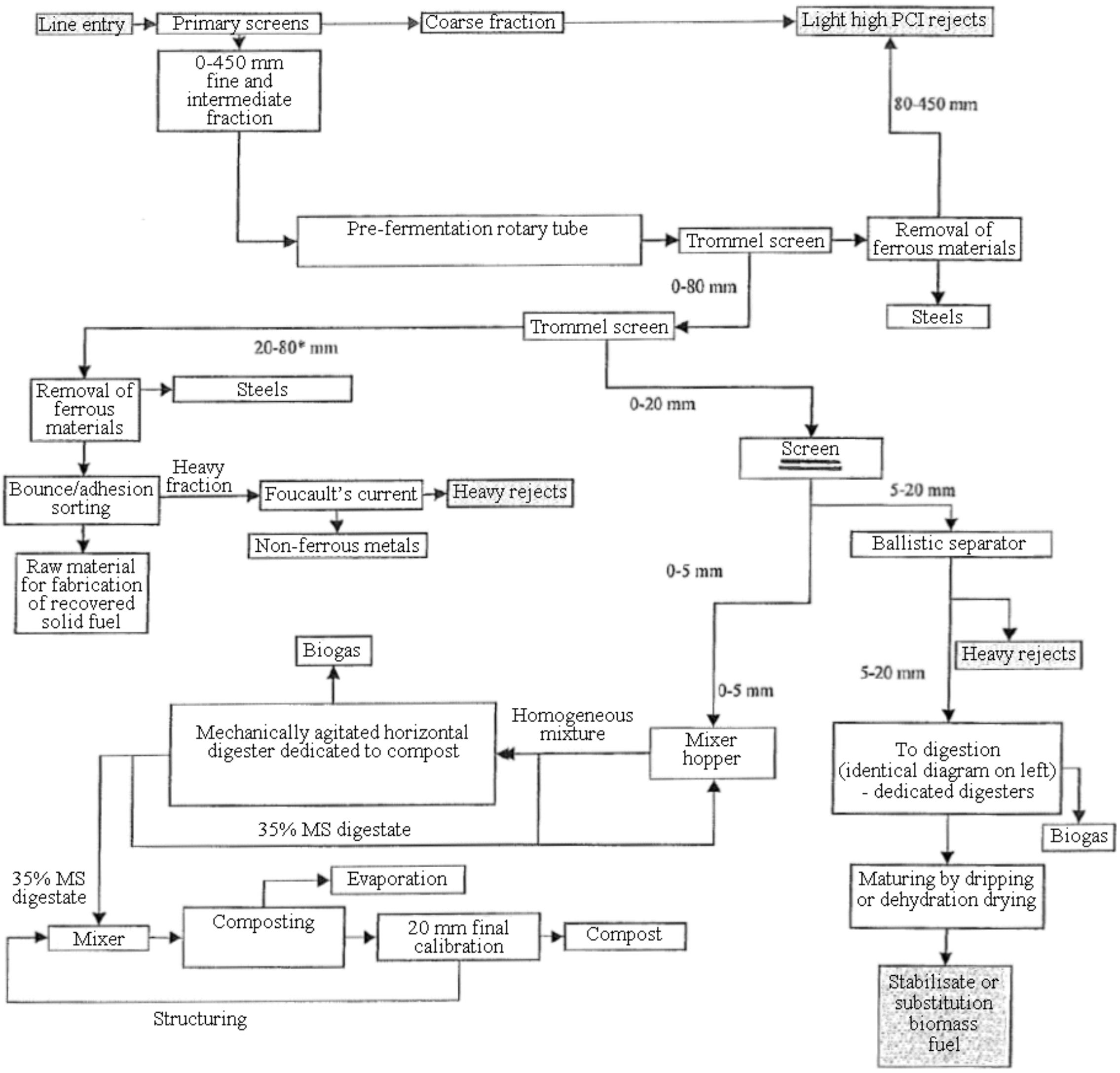
Line entry
Primary screens
Coarse fraction
Light high PCI rejects
0-450 mm fine and intermediate fraction
80-450 mm
Pre-fermentation rotary tube
Trommel screen
Removal of ferrous materials
Steels
0-80 mm
Trommel screen
20-80* mm
Removal of ferrous materials
Steels
0-20 mm
Screen
5-20 mm
Bounce/adhesion sorting
Heavy fraction
Foucault's current
Heavy rejects
Non-ferrous metals
Raw material for fabrication of recovered solid fuel
Ballistic separator
0-5 mm
Heavy rejects
5-20 mm
Biogas
0-5 mm
Homogeneous mixture
Mechanically agitated horizontal digester dedicated to compost
Mixer hopper
To digestion (identical diagram on left) - dedicated digesters
35% MS digestate
Biogas
35% MS digestate
Evaporation
Maturing by dripping or dehydration drying
Mixer
Composting
20 mm final calibration
Compost
Structuring
Stabilisate or substitution biomass fuel

FIG. 1

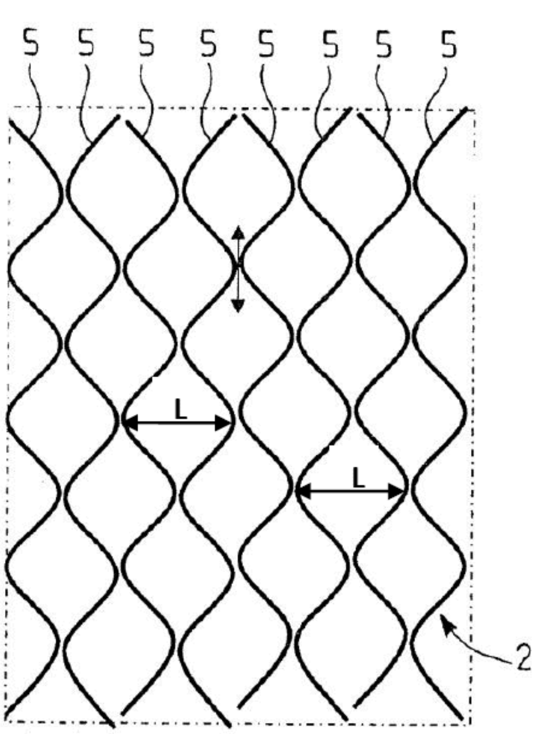

FIG.4

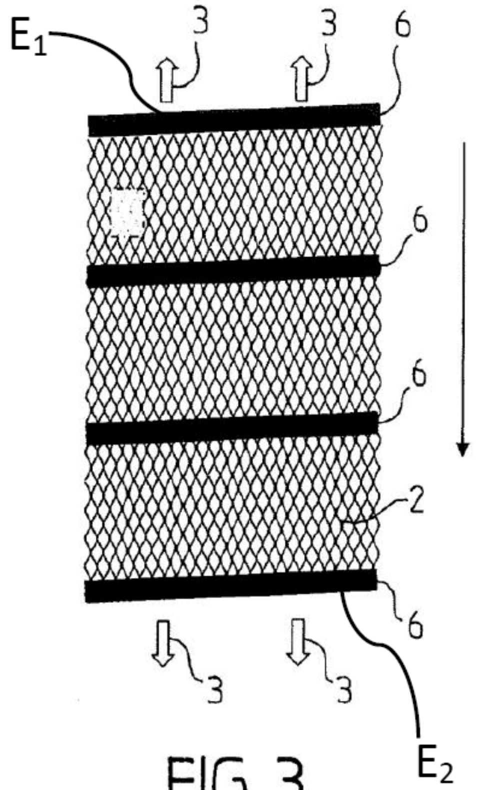

FIG. 3

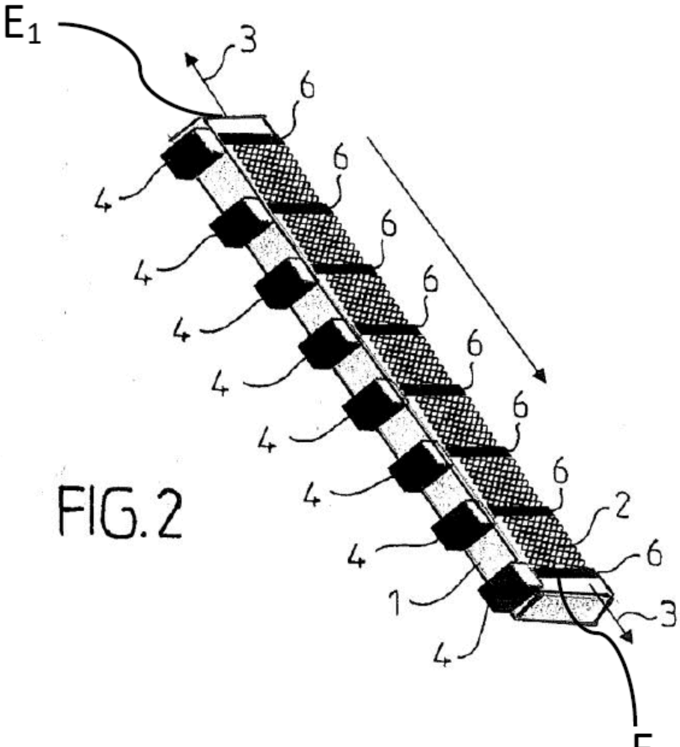

FIG.2

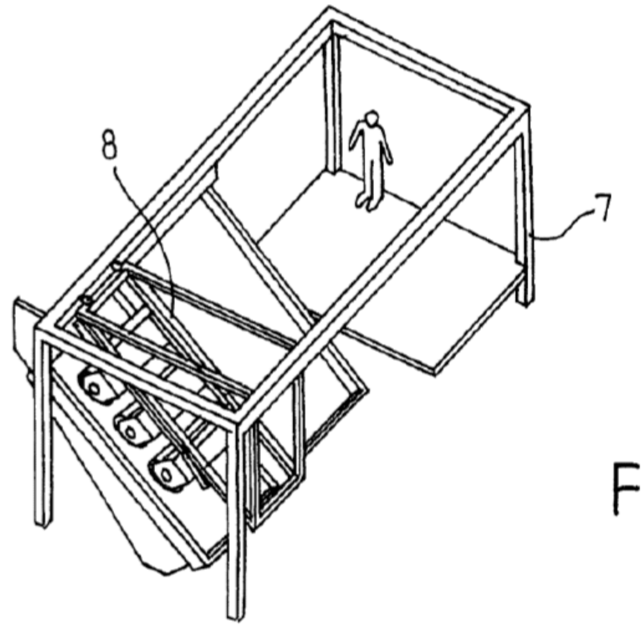

FIG.5

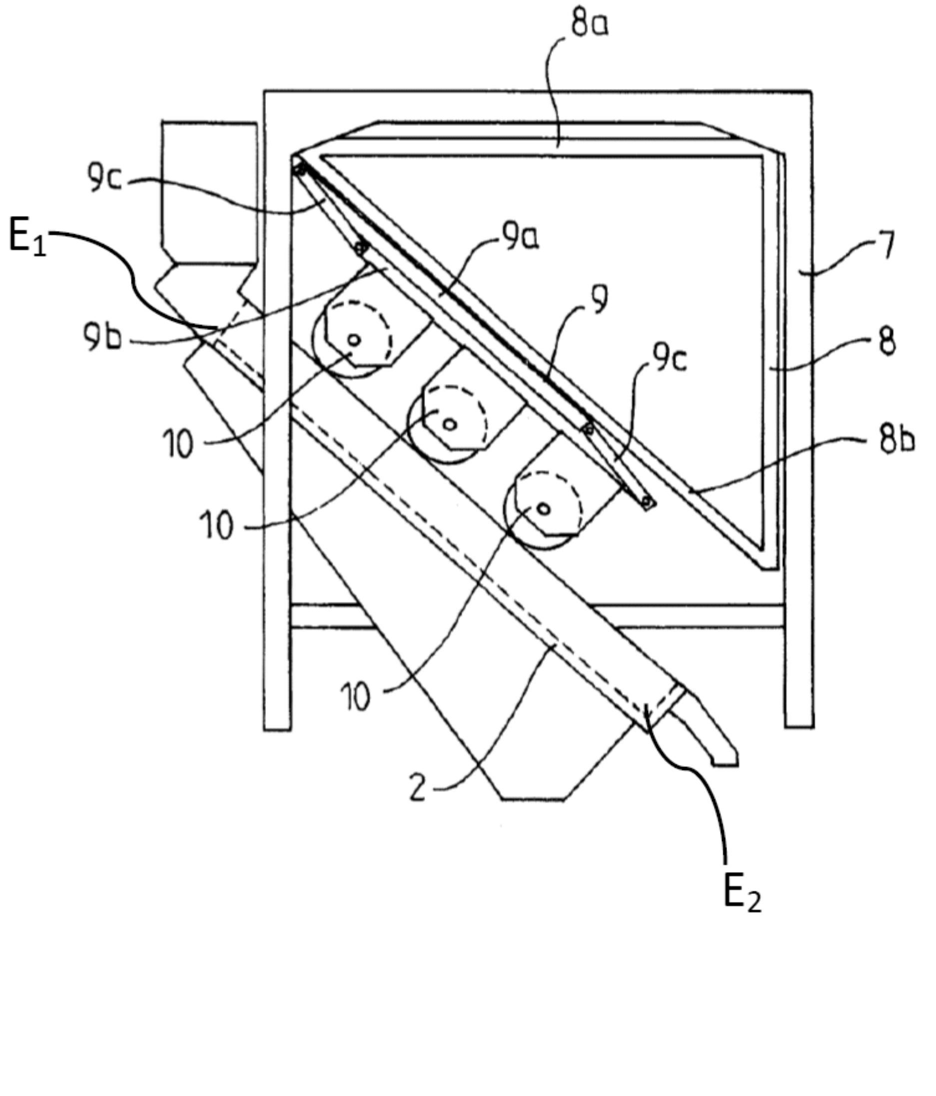

FIG.6

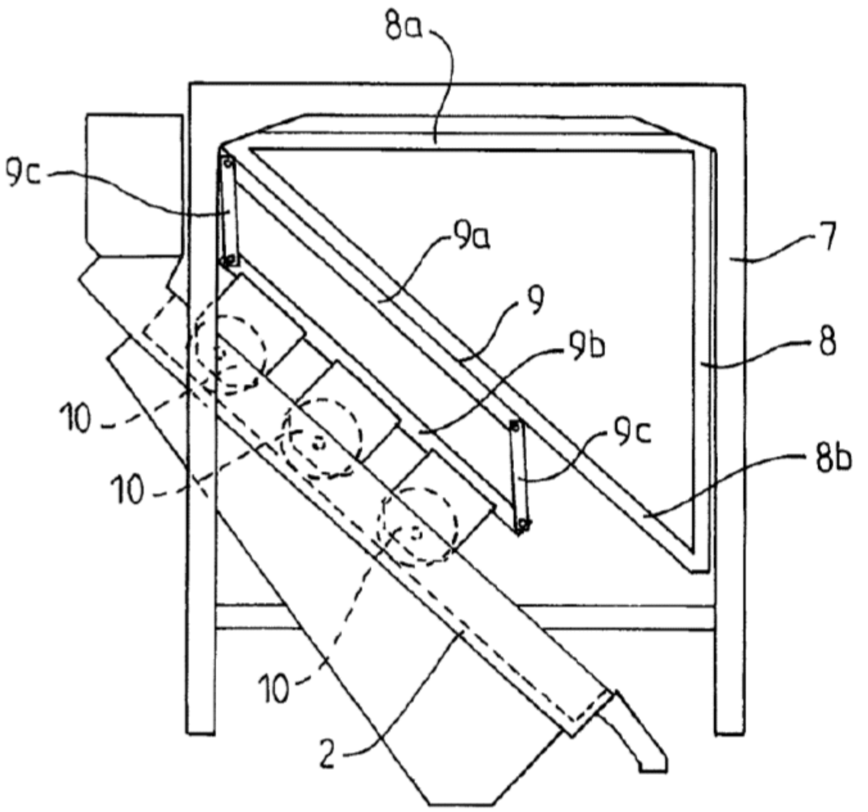

FIG.7

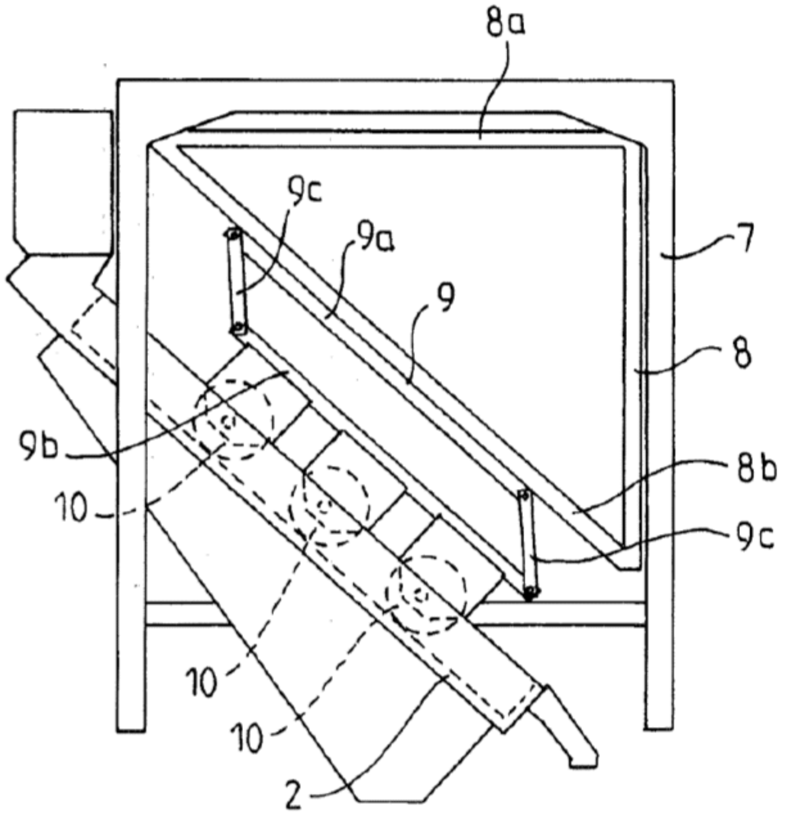

FIG.8

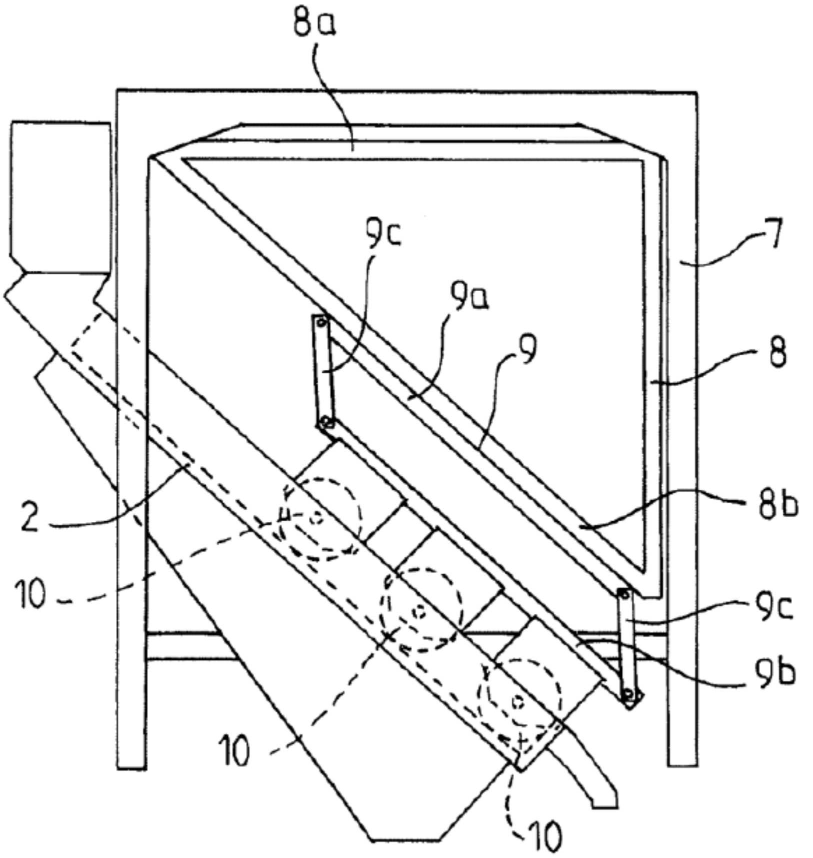

FIG.9

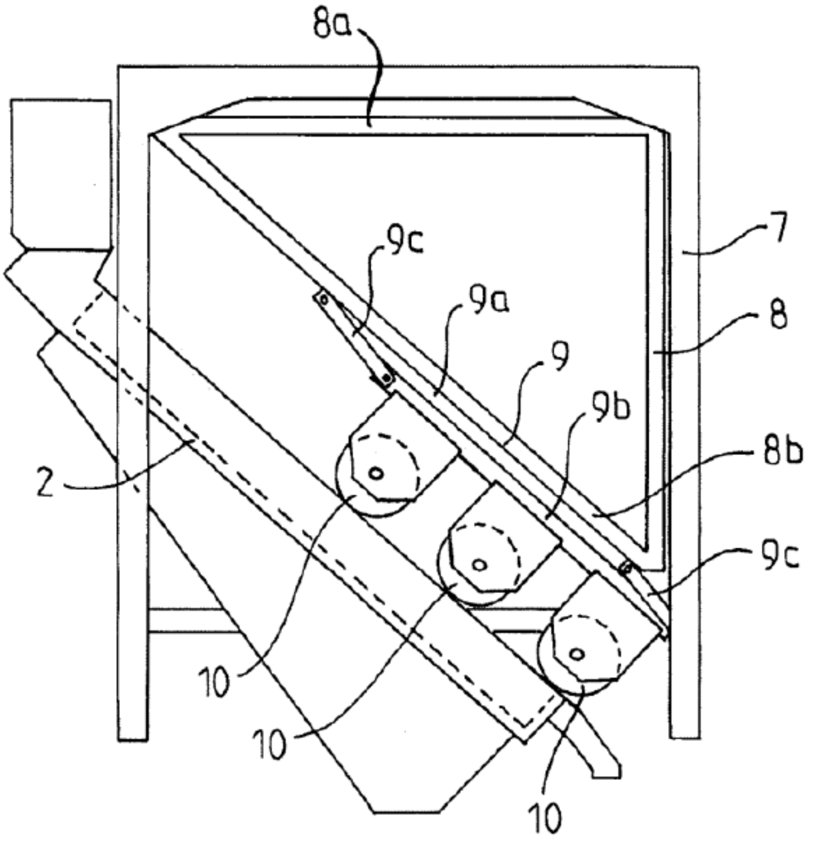

FIG.10

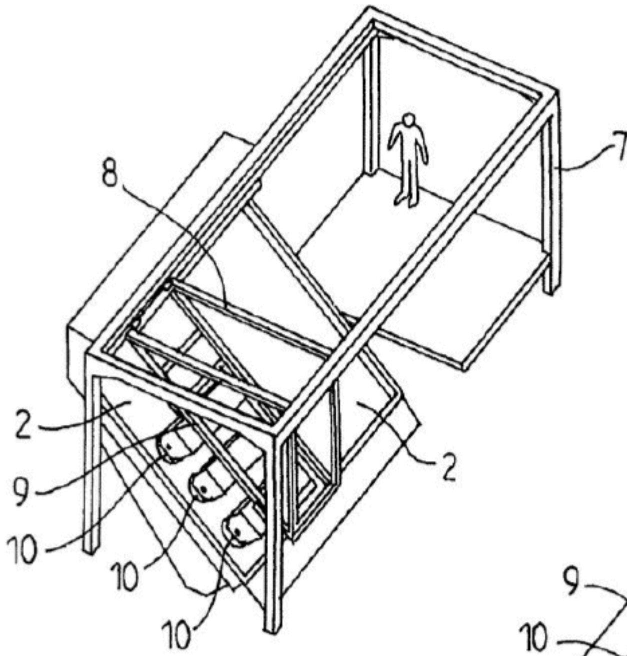

FIG.11

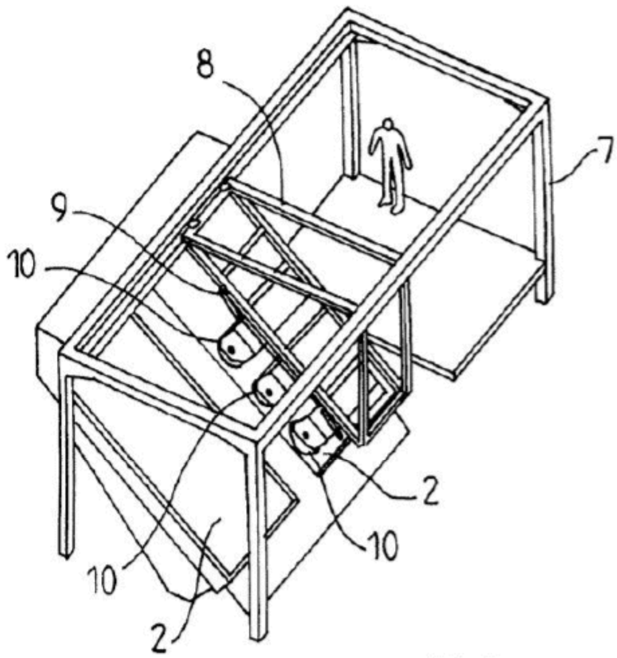

FIG.12

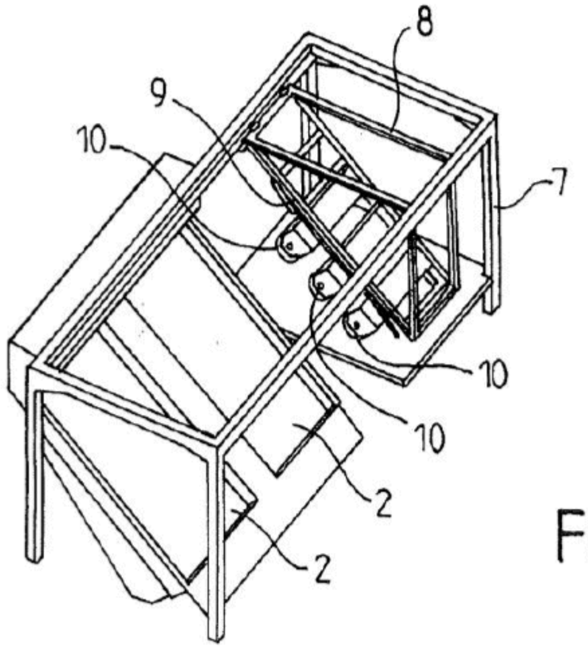

FIG.13