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(11) Publication number:

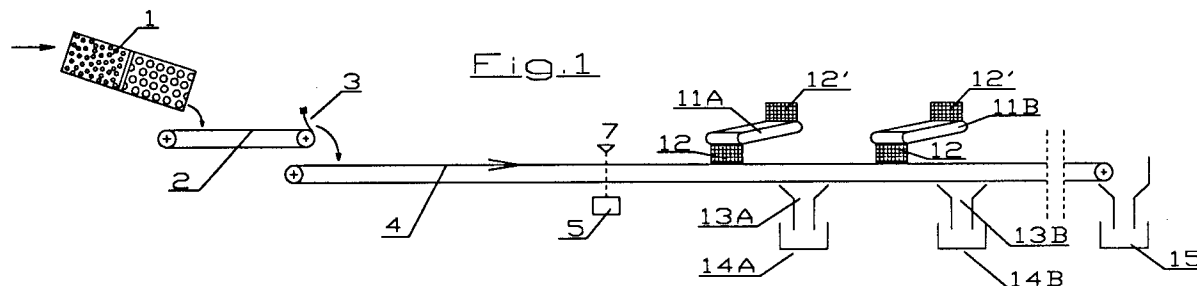
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EUROPEAN PATENT APPLICATION(21) Application number: **93113956.2**(51) Int. Cl.⁵: **B07C 5/34, B07C 5/36**(22) Date of filing: **01.09.93**(30) Priority: **17.09.92 IT MI922142**(43) Date of publication of application:
23.03.94 Bulletin 94/12(84) Designated Contracting States:
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I-20129 Milano (IT)**(54) **Procedure for selection and separate collection of solid waste.**

(57) The procedure to recover solid waste is finalized in particular at selectively recycling the waste. The waste, which has already been pre-treated by removing small pieces and lightweight and ferromagnetic materials, is taken onto a continuous conveyor so it is spread out. The waste on the belt is then visually checked to supply information about the

quality of the waste and its relative position on the belt. This information is then fed into a computerized tracking control system which uses it to selectively pilot robotized waste-removal stations, each one specialised to act on a specific type of waste (fig. 1). There will be an installation to put the procedure into effect.

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The procedure subject of this present invention concerns the recovery of solid waste, finalized in particular at selectively recycling the waste.

It is especially suited to selecting non-biodegradable waste, such as that from the demolition of buildings, construction sites, special waste from manufacturing, and pre-selected dry solid urban waste. The installation to put this procedure into effect also forms part of this present invention.

The type of such waste includes, for instance, the following materials: wood of various sizes (painted and not painted); plastic materials in general; foamed polystyrene and foamed polyurethane; inert materials such as bricks, stone, concrete; ferromagnetic metals; non-ferromagnetic metals such as aluminium, copper, lead; paper and plasterboard in panels; carpet, etc..

Particularly significant for selection are the inert materials (to go to form road subgrade, concrete, etc.); ferrous and non-ferrous materials; wood; thermoplastic materials; cardboard, etc..

In the sector there are plants to treat this waste, collecting materials in bulk from the various producers, or perhaps from temporary waste deposits, and selecting it to get recyclable material and end waste to be sent to a landfill.

Waste treatment procedures known to date put the material unloaded in bulk through a series of pre-selections, generally based on physical treatments of the waste such as screening to remove the powdery and smaller sized part; ventilation to remove the small and lightweight parts; electromagnetic separation to remove ferrous materials; floating on water to separate the lighter material; and more besides.

However, after applying a whole series of treatments as mentioned above, there remains a considerable part of materials for which as yet the only selection method is still done by hand; the waste to be selected is usually fed on a continuous conveyor belt while a certain number of workers (usually about ten) inspects the waste passing in front of each station and removes it manually, putting it into containers according to a criterion of homogeneity.

This procedure has considerable drawbacks: using a lot of labour, with the consequent problem of finding personnel and of the high cost of selection due to the high labour cost; the health hazards for the personnel who have to handle - even though they do wear gloves, face masks, etc. - the, probably infected, waste, with the risk of getting injured or ill; the discomfort of this kind of dangerous and menial work.

The purpose of this invention is to propose a technological procedure and a relative installation to overcome the above drawbacks, automatically selecting, removing, and homogeneously stocking

waste, that is without people handling the waste directly.

The purpose is achieved with the procedure to collect solid waste, finalized in particular at selectively recycling the waste. This procedure is characterised by the fact that the waste, already pre-treated with the removal of small pieces and lightweight and ferromagnetic materials, is taken onto a continuous conveyor so it is spread out. The waste on the belt is then visually checked to supply information about the quality of the waste and its relative position on the belt. This information is then fed into a computerized tracking control system which uses it to selectively pilot robotized waste-removal stations, each one specialised to act on a specific type of waste.

The procedure and the installation will be more clearly comprehended with the illustration of a practical example amplified with some variants or alternatives.

The attached drawings show:

in figure 1 a diagrammatic side view of an installation in conformity with the invention;

in figure 2 a diagrammatic axonometric view of a control panel;

in figure 3 a diagrammatic cross-section with some parts omitted in conformity with track III-III of fig.4;

in figure 4 a diagrammatic top view of a position where one particular type of recyclable material is unloaded;

in figures 5 and 6 two top views of the installation in two different positions of a given material to be recycled;

in figure 7 a diagrammatic axonometric view of a different control panel;

in figure 8 a diagrammatic side view of a variant of the installation in conformity with the invention;

in figure 9 a flow chart for the operations sequence of the installation.

With reference to fig.1, which shows a diagrammatic picture of the installation, number 1 indicates a known rotating drum screen to separate the small part of the waste, up to a size in the order of about 200-250 mm in diameter. The above waste will previously have undergone other known mechanical selecting operations such as ventilation to remove the lighter parts; removal of pieces that are too long; removal of ferromagnetic objects by means of magnets.

The waste pre-treated in this way is then continuously dumped onto a slow conveyor belt 2 at the end of which is a flexible deforming wall 3. The unit 2 and 3 has the purpose of staggering the flow of the single elements composing the waste in order to spread them out better on another conveyor belt below 4, faster than belt 2.

Staggering may be supervised by an operator who can use a suitable tool - for example a pole with a hook on the end - to spread out the objects falling onto conveyor belt 4 so they will be suitably spaced apart, lengthwise, on belt 4.

At the same time, this operator positioned close to the start of belt 4 will also be able to carry out an initial check on the waste loaded there, with the purpose, for instance, of separating any hybrid elements - that is composed of non-homogeneous materials - that may easily be separated from each other.

The speeds of belts 2 and 4 may be adjusted as preferred by means of motor speed variators fitted onto the gears driving them; in this manner, the rate of flow of the material to be selected can be varied and even stopped in the event of an accident or blockage.

At the start of conveyor belt 4 there will therefore be a sequence of all kinds of objects, but suitably spaced one from another, and sized between a minimum average diameter of 200-250 mm and a maximum in the order of about 1 m, depending on the selection criteria previously made.

These objects can easily be seen and identified by an operator positioned a few metres further on, close to the belt, who will therefore see the objects passing in front of him or her. This operator will have a control panel 5 with a keypad 6 having, for instance, six push-buttons A, B, C, ..., better described in fig.2.

This control panel is connected to a computerized control system (PLC in technical terms) equipped with a belt 4 position detector (encoder) able to memorise the position of any longitudinal area of belt 4 and to keep that position in memory while the belt is moving (tracking system).

Number 7 indicates a target, or reference line, positioned close to the panel 5 operator.

Number 11A indicates a short power-driven belt, or track, better shown in fig.3, positioned crossways above conveyor belt 4 at an angle that may be varied within an arc X - X of a limited range around an axis perpendicular to the one of the conveyor belt 4.

Fig.3 gives a cross-section of belt 4 to show track 11A; integral with it there are two large equidistant brushes 12, 12' that are dragged to brush across the area above belt 4 when the track is driven, just barely touching its surface. For brushes 12, 12' to be more effective they are slightly tilted in a direction parallel to that of the conveyor belt 4, as indicated in fig.4 which shows a plan view detail of the transverse positioning of the track.

Operation of track 11A is to be cyclic, in the sense that it normally makes half a turn of the track ring, stopping with the position of brushes 12, 12'

inverted; being able, therefore, to repeat several successive cycles in sequence.

The speed of track 11A is to be greater than that of belt 4, as the longitudinal component of the speed of the track must preferably be equal to the speed of belt 4.

Indicating the velocity of the belt with V_n , that of the track with V_c , and the angle (adjustable according to the arc X-X) between track 11A and belt 4 with α , we have the following relationship:

$$V_n = V_c \cdot \cos \alpha$$

taking a value close to 45 nonagesimal degrees as an indication for α .

An application variant, instead of varying the angle α , may be to vary the velocity V_c in relation to the velocity V_n , obtaining this variation automatically by means of a correlation made by the PLC computerized control.

The result of this relative motion between brushes 12, 12' and belt 4 involves a transverse translation of the brushes with consequent removal of the material from belt 4 towards one side of it.

On the side brushes 12, 12' travel to, after brushing belt 4, there is a hopper 13A to collect the objects the brushes 12, 12' have moved, travelling crosswise, and pushed off the edge of belt 4.

At the base of hopper 13A there is a container 14A to collect the objects falling into the hopper.

There should be several tracks (for example six) 11A, 11B, 11C, ... with their respective hoppers 13A, 13B, 13C, ... and containers 14A, 14B, 14C, ... installed successively in sequence on belt 4.

The number of these sets A, B, C, ... is equal to the number of selections desired (and therefore of types of waste desired) plus one.

At the end of belt 4 the end hopper 15 collects whatever is left on the belt, not being removed by the brushes of tracks 11A, 11B, 11C, etc..

Operation is as follows:

The operator at the checking station (5, 7) observes, in good lighting conditions, the objects moving along with belt 4, spaced out in sequence on it.

When an object is crossing the target line 7, the operator presses the push-button of the six A, B, C, ... corresponding to the type of waste of that object.

This causes the PLC tracking program to memorize that area and the relative type of waste A, B, C, ... recognised by the operator.

When that area crosses track 11 corresponding to that kind of waste, the program orders that track to start, for one or two cycles depending on the length of the object consequently memorized by the program.

The PLC has, in fact, been supplied with all the necessary information (through the encoder), the location and extent of the area of the belt and the type of waste corresponding to that area.

The PLC tracking system will then be able to start up the respective track 11A, or 11B, ..., and that one only, at the instant when that area crosses the operative sector of the track corresponding to that waste, which will then be collected in the relative container.

Fig.9 gives an example of the flow chart of the management software for the waste selection line outlined above.

Starting from top to bottom, 100 indicates the program's "START" function; 110 the "KEYBOARD READING" function; 102 the "KEY PRESSED" option that may result in a "no" (N) or a "yes" (Y).

130 represents the "FINISH PRESSING KEY" option that also results in a N/Y alternative.

140 is the encoder reading function; 150 "UP-DATING SELECTED TRACK QUEUE" (A, B, C, ...); 160 the "KNOCKOUT MANAGEMENT ROUTINE"; and lastly 170 the "END" function.

It is overall routine programming which is normally applied in the field of industrial automation.

In this way even long pieces of waste material (for instance copper wire windings) can be selected and removed selectively as brushing belt 4 by effect of a track 11 can be achieved for unlimited lengths of the belt, corresponding to an unlimited sequence of track operation cycles.

Moreover, in the event of homogeneous waste passing before the operator (for example, a series of pieces of wood) it need not be spaced out or staggered as the entire area taken up by this homogeneous type of waste can be selected.

Examining an operation example in a diagrammatic plan view of an object which for simplicity belongs to waste category "A", fig.5 shows an initial sequence in which the object 8 is approaching the target line 7 and is recognised by the operator positioned at panel 5.

The area object 8 is deposited on is represented by dotted lines on belt 4, and indicated with number 9.

In the event of long waste, and especially lengths greater than that of a brush 12, when area 9 crosses the target line 7 the operator presses push-button A for the length of time area 9 takes to cross the target line: thereby giving the computer tracking control system an indication of area 9 (in position and length), and the type of waste (A).

Fig.6 shows a moment later when the memorized area 9 has passed the target line 7 and is about to pass under the brushing action of belt 11A, corresponding to that type of waste.

Waste not selected in any of the areas A, B, C, ... will be left to pass by all the tracks 11A, 11B,

11C, ..., and will reach the end hopper 15; this type of waste will preferably be that of inert material.

In place of the tracks 11A, 11B, ... there may be installed known devices to remove objects from a continuous line, such as deflector tiles, powered articulated arms, etc..

In a variant (fig.7, 8) allowing the operator to organise the recognition work differently, by the side of and parallel to the initial part of conveyor belt 4', a continuous band is fitted comprising elements that can be lit up: 10' and 10'' indicate two strips of these elements - for example, two rows of light bulbs - placed by the side of and parallel to belt 4' for a length of some metres starting from a fixed reference point Z.

For simplicity in the following description, these strips that can be illuminated will be called "guide-lights".

At the end of these guide-lights and from the opposite side of belt 4' with to them there is a control station 5' with an operator.

This control station is better represented in the diagram of fig.7.

It comprises a lever 18 in a central position which may be moved forwards or backwards by the operator and which has a push-button 19 on top of it; in addition, it includes a keypad 17 that has six push-buttons indicated as A', B', C', D', E', F' respectively.

The control station 5', along with guide-lights 10' and 10'' are part of a computerized control network of the process governed by a data elaboration centre (PLC in technical jargon) which is not illustrated and which works according to known computer technologies.

Also comprising part of the computer control system is a belt kinematic position detector (encoder in technical jargon) able to memorize any position, or longitudinal area of the belt and to assign it with a given code number.

Referring to fig.8, which diagrammatically represents this solution, the operator at control station 5' observes, in good lighting conditions, the objects moving forward together on belt 4', laid out in sequence and spaced apart on it.

Each guide-light 10', 10'' is formed by a succession of light bulbs. The lever 18 is used to light up at least one light bulb of the series 10', 10'' depending on the movement of the lever in one direction or the other, thus giving light signals for varying positions. In particular, when the operator recognises the waste 8', he or she moves the lever 18 (without pressing key 19) so that the light bulb of series 10'' comes on corresponding to the start of the deposit area of the recognised waste 8', e.g. at line F. By this he or she communicates to the encoder, through a known interface, the distance the start of the deposit area (i.e. F) is from a fixed

point of reference, e.g. from station 5', 7' (line Z). At this stage he or she presses push-button 19 causing the second guide-light 10' to come on. With the push-button pressed down, the operator moves lever 19 and lights up a sequence of light bulbs of that guide-light taking up a length (K) of the deposit area that the operator selects on the basis of the observed length (size) of waste 8'. At the end of this selection procedure the operator lets go of lever 18 and presses push-button A', B', etc. to indicate the type of waste recognised.

The first reference distance ZF (obtained by means of guide-light 10") added to the fixed distance between the reference point Z and the removal robot 11'A, 11'B, etc. specific for that type of waste 8' supplies the information to start the robot working. The distance worked out by means of the second guide-light 10' gives an approximation of the longitudinal size of the piece (basically the distance K) and therefore have the specific robot intervene for a number of work cycles to ensure the piece is entirely removed even if considerably long.

This variant has the advantage for the operator to be able to better organise his or her work, anticipating the arrival of objects at the target line 7.

In a third variant, the continuous conveyor belt may be substituted with another type of chain conveyor, for example a bucket or tray conveyor the bottom of which can be tipped up with conventional unhooking systems positioned at the unloading hoppers and slaved to the PLC.

The procedure selection, in the above examples, with direct observation by the operator, may as a variant be done with indirect observation by means of a closed circuit television circuit.

In this case, selection of each object, or area of the belt 4, 4' may occur by means of computer systems operating with known technologies, with the operator for instance being able to directly interact on the television screen by means of a pointer, or mouse, to make the selection and give this information to the process control system.

The procedure, expounded in the examples above to select seven types of waste, may be applied to many types of waste without any special restraints.

It should be noted that the material not selected (also because of error by the operator) which is unloaded at the end of belt 4, 4' into hopper 15, 15' may be recycled with conveyors taking it back onto belt 2, 2'.

Claims

1. Procedure to recover solid waste, finalized in particular at selectively recycling it, charac-

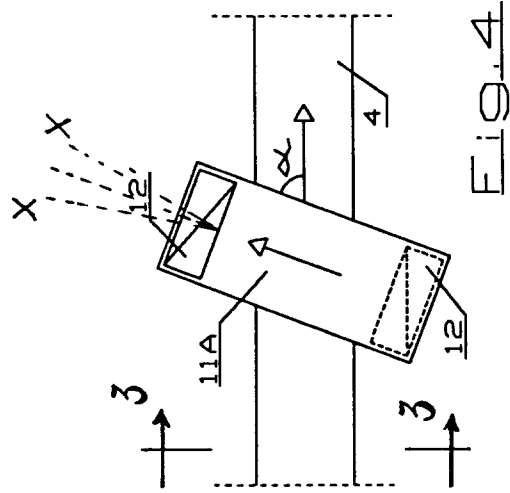
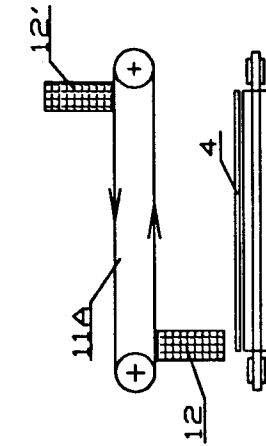
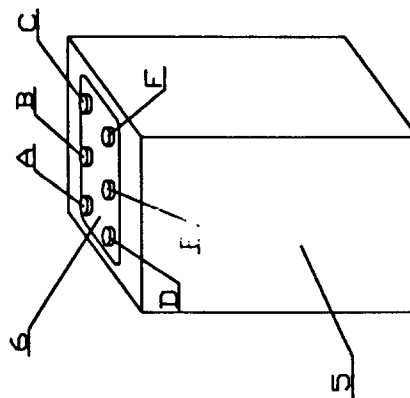
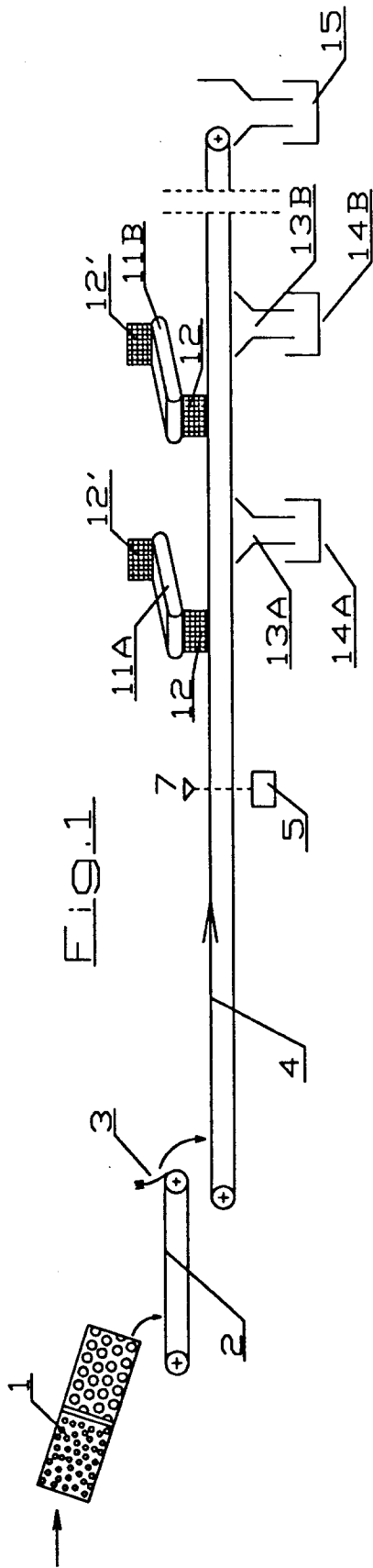
terised by the fact that the waste, already pre-treated by removing small pieces and lightweight and ferromagnetic materials, is dumped onto a continuous conveyor so that it is staggered. The waste on the belt is then visually checked to supply information concerning the type of waste and its respective position on the belt to be fed into a computerized tracking and control system which on the basis of this information selectively pilots robotized stations to remove the waste, each one specialised to intervene on a specific type of waste.

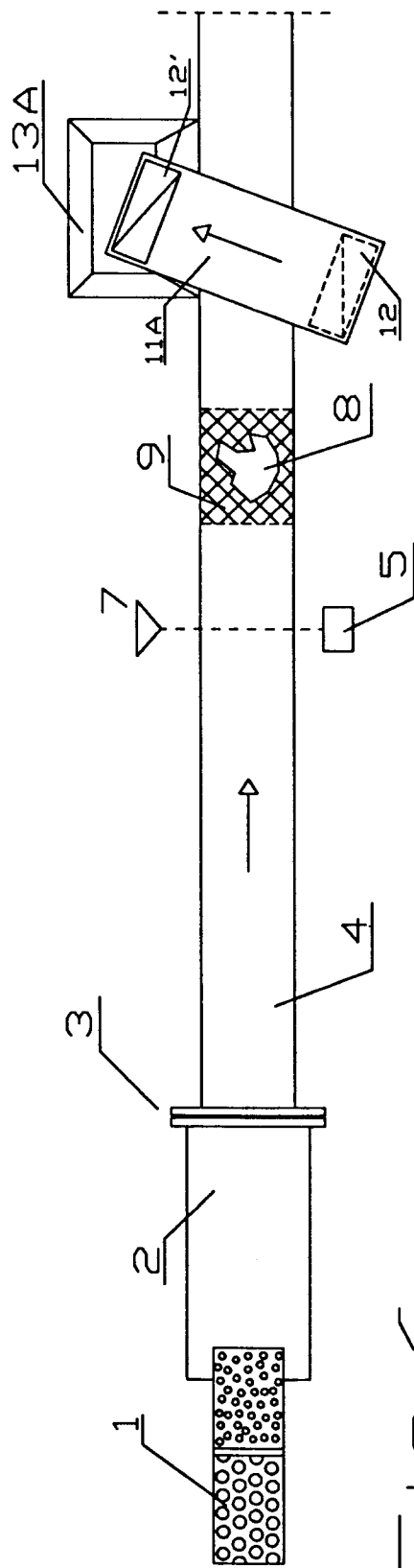
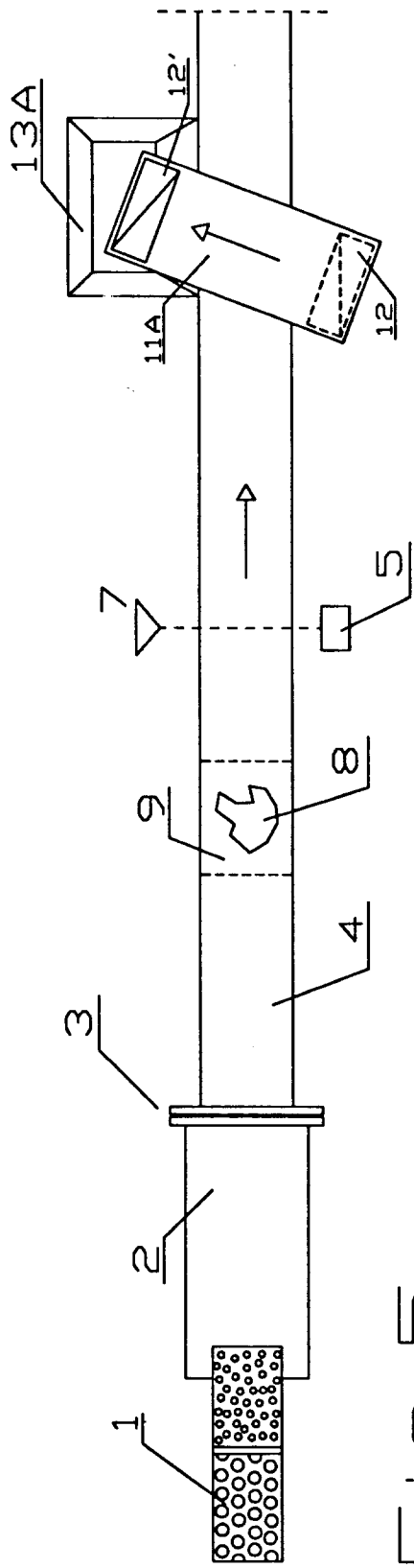
2. Procedure according to claim 1 characterised by the fact that the waste that is not selected is unloaded by the conveyor after the last robotized removal station and preferably put through the procedure again.

3. Installation to put the procedure of claim 1 into effect, characterised by the fact that it includes devices known in themselves to pre-treat the waste to remove small pieces and lightweight and ferromagnetic materials, means of staggering the pre-treated waste out on a continuous conveyor, a visual checking station for this staggered waste to identify the position and type of each single piece of waste. This station being equipped with a means of control to translate the result of the visual check into information for a computerized tracking and control system, a series of robotized stations to remove the waste from the conveyor, each station being specialised to act on a specific kind of waste on the basis of the pilot supplied by the computerized system.

4. An installation according to claim 3, characterised by the fact that the robotized stations include mobile means that translating with at least one component of transversal motion with respect to the motion of the conveyor remove the waste from the latter.

5. An installation according to claims 3 and 4, characterised by the fact that at the end of the active stretch of the conveyor there are means to recycle the waste that has not been removed for a further recovery procedure.





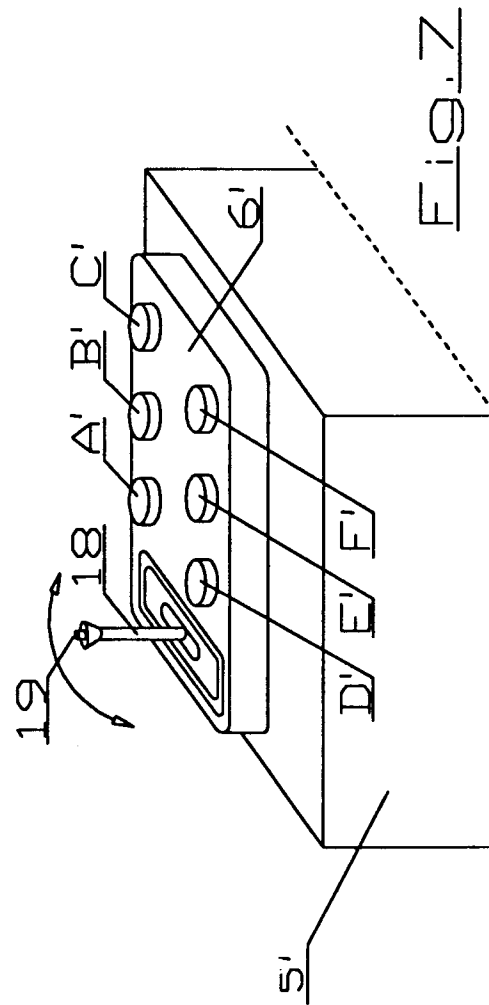
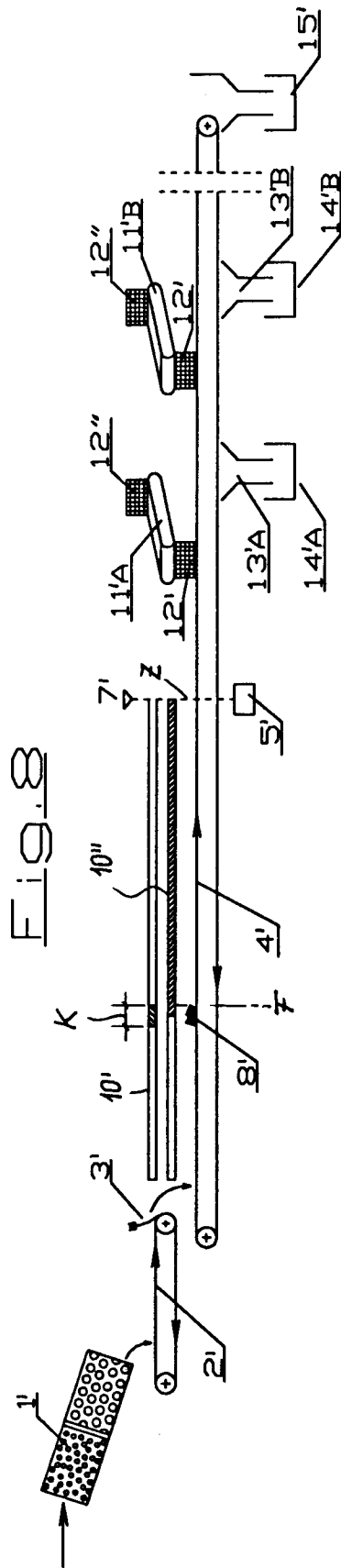
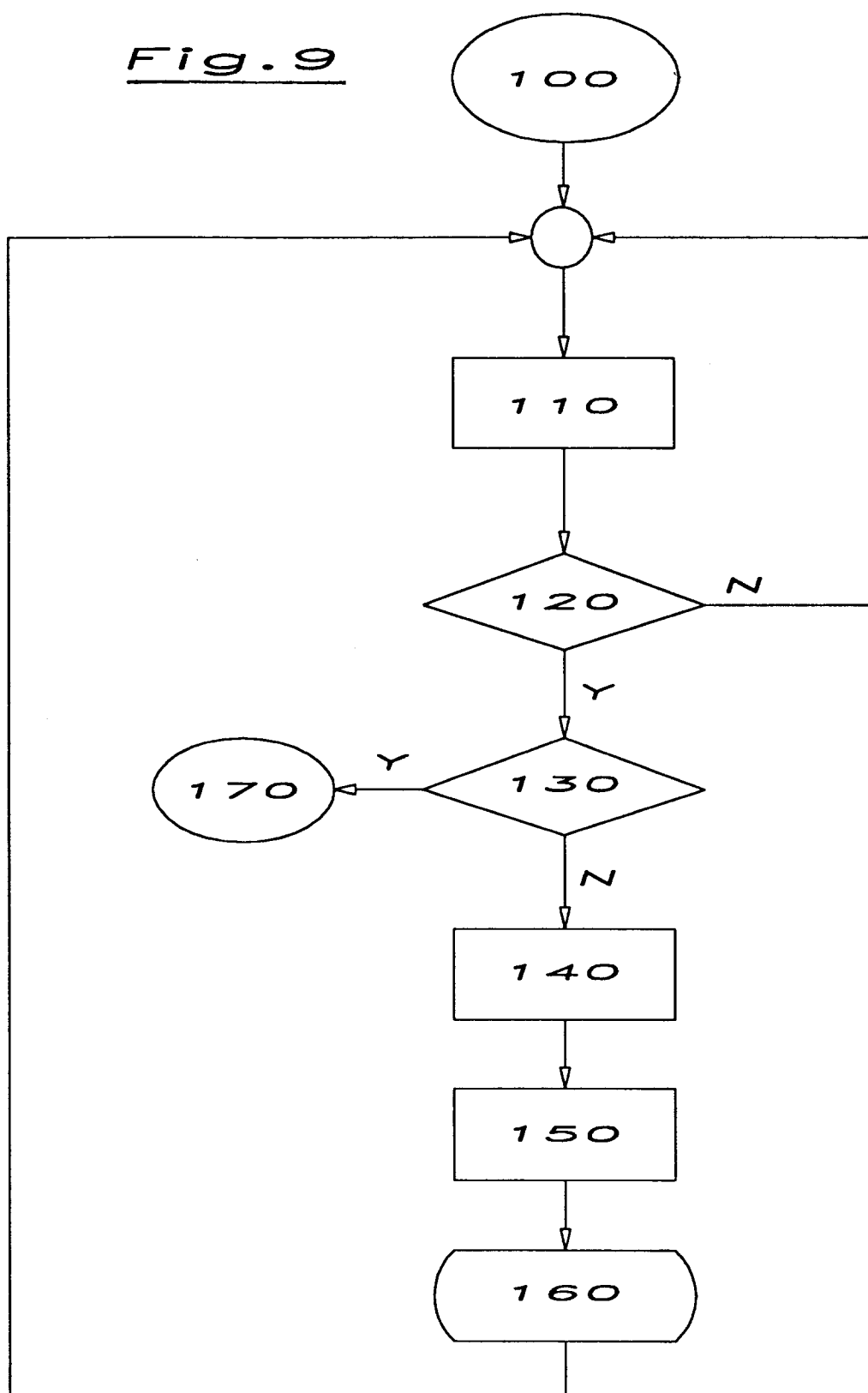


Fig. 9



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EUROPEAN SEARCH REPORT

Application Number
EP 93 11 3956

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
Y	DE-A-37 25 218 (MASCHINENFABRIK BEZNER) * the whole document * ---	1,3,5	B07C5/34 B07C5/36
Y	EP-A-0 439 674 (EDELHOFF POLYTECHNIK) * the whole document *	1,3,5	
A	---	2,5	
A	US-A-3 888 351 (MIT) * the whole document * -----	1-3,5	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			B07C B03B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 29 December 1993	Examiner Forlen, G
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