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(54) Equipment for the selection of not ferromagnetic metallic materials from Municipal Industrial Solid Waste based on the principle of the eddy currents induced by variable electromagnetic fields

(57) The equipment for the detection, acceleration and separation of not ferromagnetic metallic materials contained in Municipal or industrial Solid wastes based on the principle of the eddy currents comprises in combination: - inductor blocks made of ferromagnetic sheets having rabbets shaped like comb (1) and copper windings inside the rabbets (2); a metal detector (4); a microprocessor (5); an electrical three phase power supply system at variable or constant frequency (6), a tape conveyor (7), a waste measuring hopper (9) provided with motorized stellar valve (15) and air shaker (17), a system of waste height control (19) ; a system of collection of the separated not ferromagnetic metals (21); a conveyor tape (22 Fig.3) for the removal of the wastes after the passage between the inductor blocks and a cooling system of inductor blocks (8),

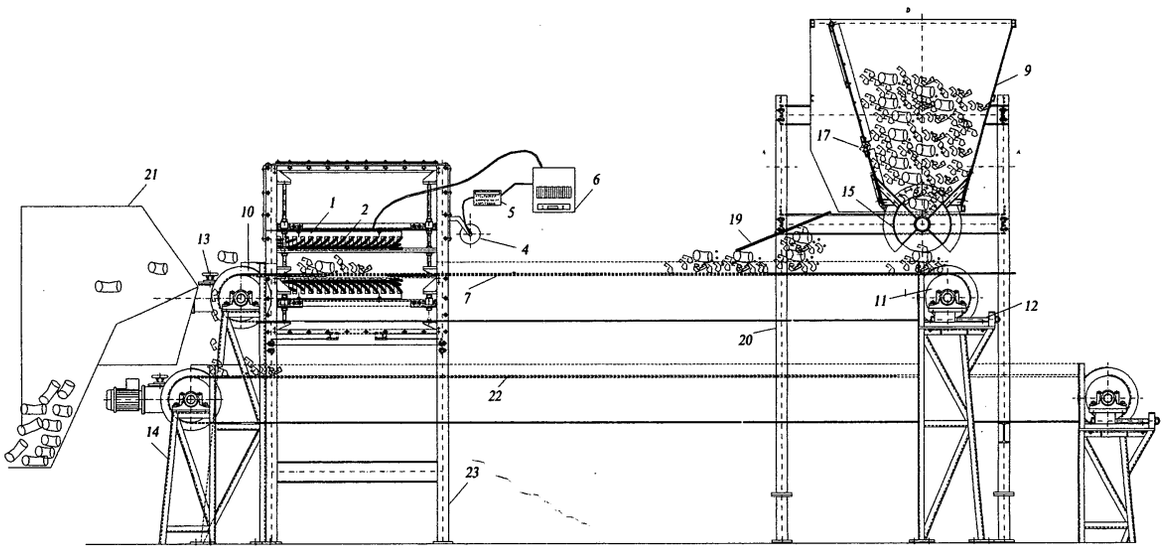


FIG 3

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Description

[0001] The invention regards an equipment that allows the detection, the acceleration along a well defined linear trajectory and the separation of not ferromagnetic metals, like the aluminium cans, from Municipal or Industrial solid wastes.
In particular municipal solid wastes contain important (from the economic point of view) quantity of not ferromagnetic metals, in particular Aluminium.

[0002] The not ferromagnetic metals can be detect using the eddy currents phenomenon generated by means of variable magnetic fields. The combination of variable magnetic fields and the eddy currents generates on the not ferromagnetic metals the Lorentz Forces having a direction depending on the magnetic field direction. These forces are normally too small for permitting the separation of the not ferromagnetic metals from the other wastes. Only the use of magnetic field of extremely high intensity could permit the separation of the not ferromagnetic metals from the wastes which they are immersed in. In this case, the systems which produce the magnetic field require a very big electric power and consequently the energy electric consumption is tremendously high. Therefore the overall costs for the separation (capital, amortization, fiscal year costs) overcome greatly the income deriving from the recover of the not ferromagnetic metals. Another big problem in the separation of not ferromagnetic metals contained in the Municipal solid wastes is their very small quantity (1÷5% of the total wastes) and their statistical distribution in the wastes. Therefore the systems which produce the magnetic field must not be switched on continuously in order to not waste uselessly electric energy.

[0003] The invention seeks to overcome the previous mentioned difficulties providing an equipment which first detects the not ferromagnetic metals and after produces a very big forces on the metals, for a short instant of time, accelerating them in the same direction of the movement of the other wastes. The separation occurs when the wastes fall for gravity while the accelerated metals flight in a collection container.

[0004] In accordance with the invention , this performance is accomplished :

- detecting the presence of the not ferromagnetic metals in the wastes by means of the use of a very low electric energy consumption metal detector always switched on,
- using a microprocessor which receives the signal from the metal detector and switches on ,with a calculated time delay and for a short time, the electric system which produces a very strong variable magnetic field travelling,
- accelerating the not ferromagnetic metals by means of a system , nearly always switched off , which produces a very strong variable magnetic field travelling in the direction of the waste movement.

[0005] The electric system producing the Lorentz forces on the not ferromagnetic metals acts as a three phase electric linear engine at induction. The induced are the metals and the inductor are blocks of ferromagnetic metal sheets, shaped like a comb, and Copper windings lodged in each rabbet of the sheets , connected each other in such way that each block constitutes an inductor having ' p' poles and' n' phases.

[0006] An equipment of detection and separation of not ferromagnetic metals formed in accordance with the invention has a number of advantages. The electric system producing the magnetic field is able to impress a very big force on the metal , moreover being nearly always switched off the electric energy consumption is very little and normally cooling system for the removal of effect Joule heating are not necessary. Therefore the income deriving from the recover of the separated metal overcome greatly the costs of the separation due to the low investment costs (induction electric engine technology is low cost and reliable) and low production costs.

[0007] The invention will now be described by way of an example and with reference to the accompanying drawings in which: :

- Figure 1 shows the configuration of the inductor blocks ;
- Figure 2 shows the principle on which the generation of the separation force is based;
- Figure 3 shows the front view of equipment assembly;
- Figure 4 shows the plan of the equipment assembly.

[0008] The equipment is made up of:

a) 2 blocks of ferromagnetic material each of the which is made of ferromagnetic metal sheets shaped like a comb (1) and Copper windings that are lodged in each rabbet of the sheets (2) and are connected each other in such way that the assembly constitutes an inductor having ' p' poles and' n' phases (n is normally equal to 3). The assembly of the metal sheets (1) and the windings (2) of one block, powered by alternate tension, having constant or variable frequency, generates a sinusoidal magnetic field whose direction is normal to the plan of the windings and it travels along the direction of the metal sheet length.
If a not ferromagnetic metal (3) is introduced in correspondence of a inductor block eddy currents are generated in it. These currents, with the joint action of the variable magnetic field, originates a force on the metal having the direction parallel to the length of the sheets (Fig.2).The intensity of such force depends on the variation of the magnetic field intensity.
In Figure 2 the principle of generation of the force

on the metal is illustrated.
The force on the metal is originated also from a single inductor block. The presence of two opposite inductors with reversed polarity allows to regulate and to increase the force developed on the metal.

b) a detector of metals like a ' metal detector' (4) that detects the presence of the metal which has to be separated, sending an electric signal to a microprocessor (5) that powers the inductor blocks with a temporal delay correspondent to the time employed from the metal to cover on the conveyor tape (7) the distance between the detector and the beginning of the inductor blocks.

c) a microprocessor (5) that receives a signal of tension (±10 Volt) or current (0-4 Ampere) from the detector (4) and sends a signal, with a predetermined delay, in order to switch on the electrical three phase alternate power supply system at constant or variable frequency (6) that powers the blocks inductors. The microprocessor sends a signal in order to switch off the power supply system after an interval of time correspondent at the time spent by the metal between the inductors.
The microprocessor controls the temperature of the inductors and sends a start signal at the cooling system (8) in the extremely rare case in which the temperature exceeds the allowable value for the inductors constituent materials

d) a three phase alternate power supply system at variable or constant frequency (6)

e) a tape conveyor (7) that conveys the wastes from the hopper (9) to the detector and to the blocks inductors. The tape conveyor is made up of a tape of not metallic material, of a capstan(10), of a freewheel roller (11) of a stretch-tape (12), of a speed reducer engine (19) and of a metallic structures of support (14)

f) a metallic structures of support (23) of the inductor blocks and the detector

g) a waste measuring hopper (9) provided with a stellar valve (15) operated from a speed reducer engine (16), an air shaker (17), a system of waste height control (19) and a frame of support (20)

h) a system of collection of the separated not ferromagnetic metals (21), a tape conveyor (22) for the removal of the wastes from the equipment after the passage between the inductor blocks

[0009] Synthetically the equipment operates in the following manner:

the municipal or industrial solid wastes containing not ferromagnetic metals are sent through the measuring hopper (9) and the stellar valve (15) on the tape conveyor (7) and are controlled in height by means of an' adjustable plate(19) and pass under the detector of metals (4). If a not ferromagnetic metal is present in the wastes, the detector sends a signal of tension or current to a microprocessor (5) which switches on the electrical three phase alternate power supply system (6) with a well determined temporal delay respect the instant of the detection, depending on the tape conveyor speed and correspondent to the time employed from the metal to cover the distance between the detector and the beginning of the inductor blocks (1).

The inductor blocks are powered for an interval of time correspondent to the time spent by the metal to pass through the inductors. The metal which has to be separated enters in the variable magnetic field, generated from the inductor blocks, which has a travel direction parallel to the direction of the tape movement.
Eddy currents are generated in the metal which develop forces (force of Lorentz) on the metal in combination with the magnetic field.
This force overcomes the friction forces and accelerates the metal respect with the surrounding waste giving it a trajectory that is initially rectilinear and parallel to the tangent to the tape conveyor roller. The acceleration permits at the not ferromagnetic metals of being separated from the wastes and being sent in a suitable container(21). While the solid wastes follow the profile of the tape conveyor roller and for gravity fall on a beneath tape (22) that removes them from the equipment.
The microprocessor (5) controls the temperature of the blocks inductors and in case of overcoming of a allowable value switches on the refrigeration system (8).

Claims

1. An equipment for the detection, acceleration and separation of not ferromagnetic metallic materials contained in Municipal or industrial Solid wastes based on the principle of the eddy currents comprising in combination: - inductor blocks made of ferromagnetic sheets having rabbets shaped like comb (1) and copper windings inside the rabbets (2); a metal detector (4); a microprocessor (5); an electrical three phase power supply system at variable or constant frequency (6); a tape conveyor (7), a waste measuring hopper (9) provided with motorized stellar valve (15) and air shaker (17); a system of waste height control (19) ; a system of collection of the separated not ferromagnetic metals (21); a conveyor tape (22) for the removal of the wastes after the passage between the inductor blocks and a cooling system of inductor blocks (8), **character-**

ized from the fact that the inductor blocks powered by three phase alternate tension to constant or variable frequency generate a variable magnetic field travelling in the direction of the ferromagnetic sheets and such that on a not ferromagnetic metal, introduced between the inductor blocks develop forces having the direction parallel to the tape conveyor movement

2. An equipment as claimed in claim 1 **characterized from** the fact that there is only one inductor block located above or below the conveyor tape

3. An equipment as claimed in claim 1 or 2, **characterized from** the fact that the electric power to the inductor blocks is switched on after the detection of the metal by means of a metal detector or an equivalent device and that such electric power is operated by an electronic (5) or electromechanical equipment that controls the delay and the duration of the electric power of the blocks inductors and their temperature.

4. An equipment as claimed in claims 1 or 2 and 3, **characterized from** the fact that the metal separated from the waste is accelerated in the direction of the conveyor tape movement and collected in a container while the wastes fall at the end of main conveyor tape on a other beneath conveyor tape.

5. An equipment as claimed in claims 1 or 2 and 3 and 4, **characterized from** the fact that the inductor blocks are powered by means a variable frequency tension

6. An equipment as claimed in claims 1 or 2 and 3, 4 and 5 **characterized from** the fact that the wastes are distributed on a conveyor tape (7) by means of a hopper (9) provided with a motorized stellar valve (15,16), an air shaker (7 in Fig 3) and a waste height control (19)

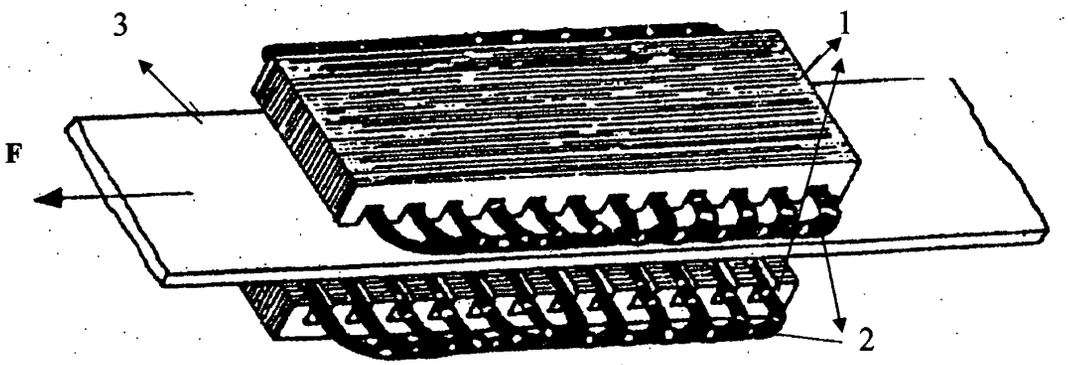

3
1
F
2

FIG 1

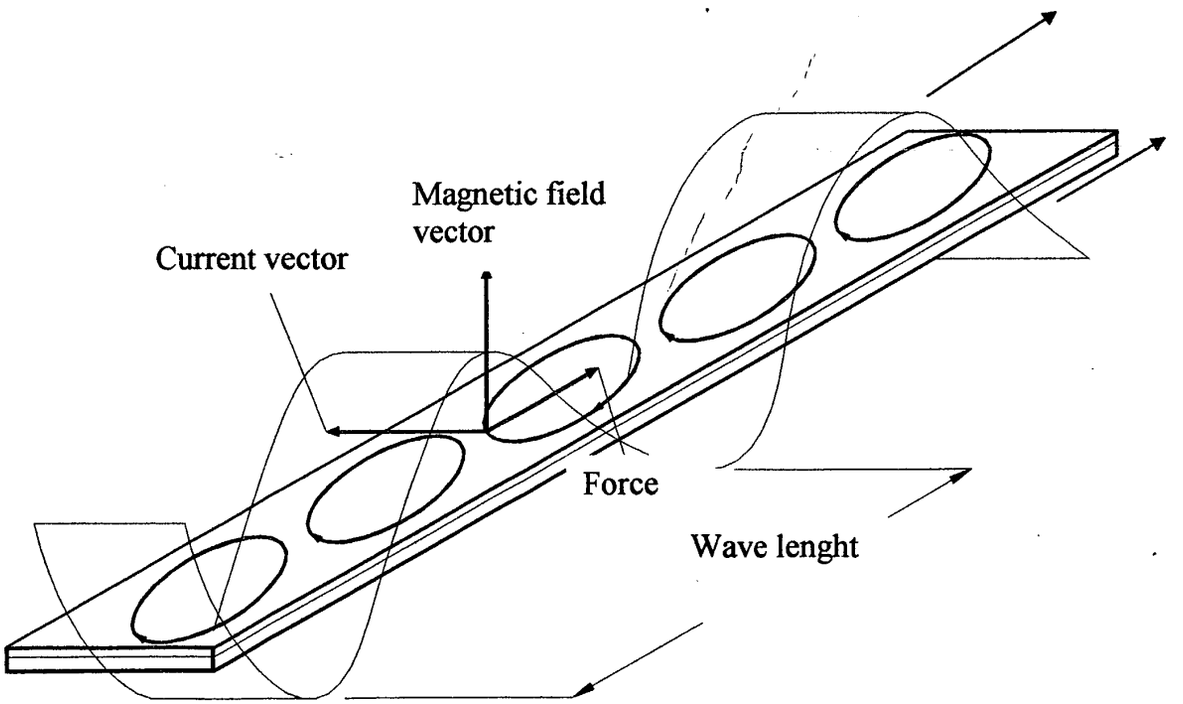

Magnetic field
vector
Current vector
Force
Wave lenght

FIG 2

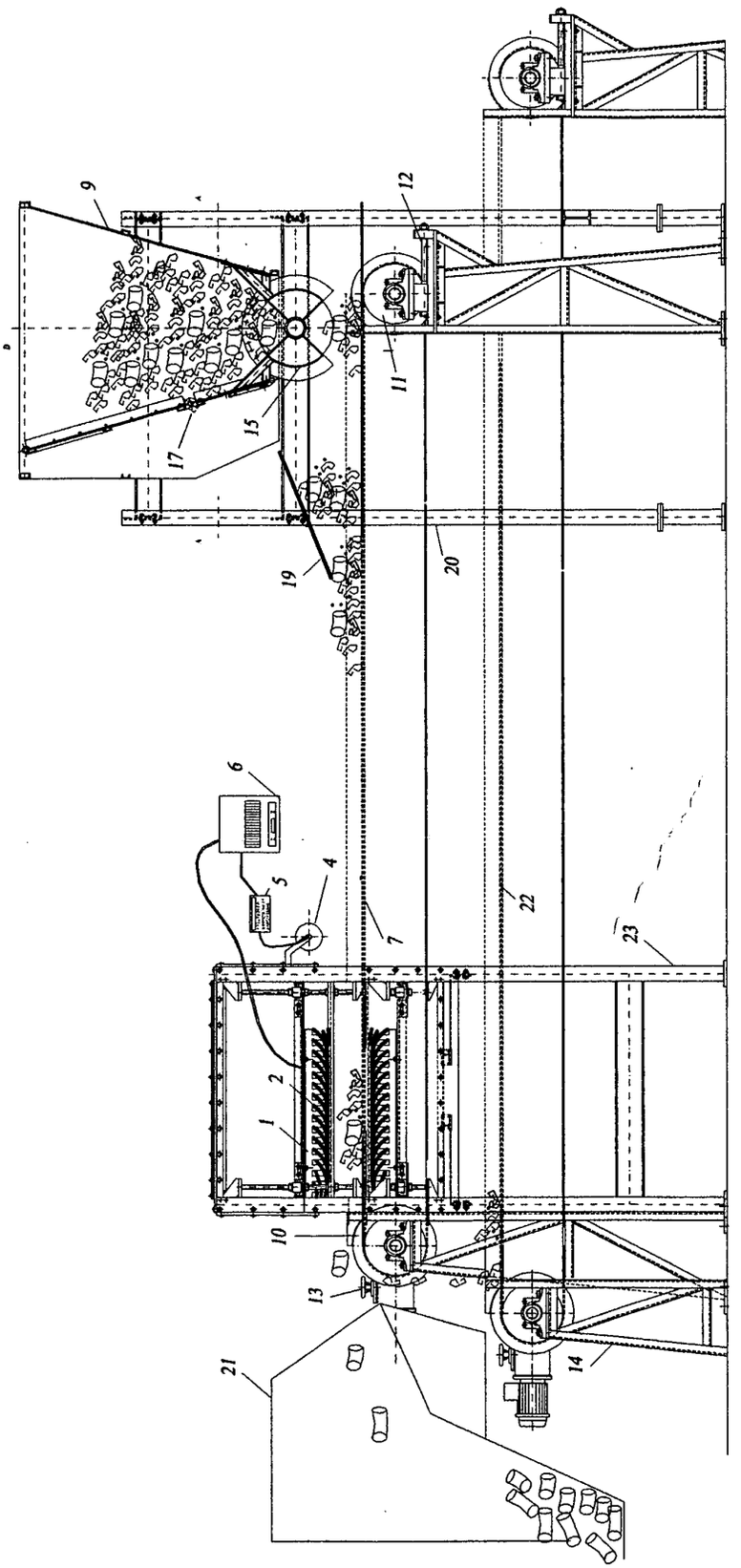


FIG 3

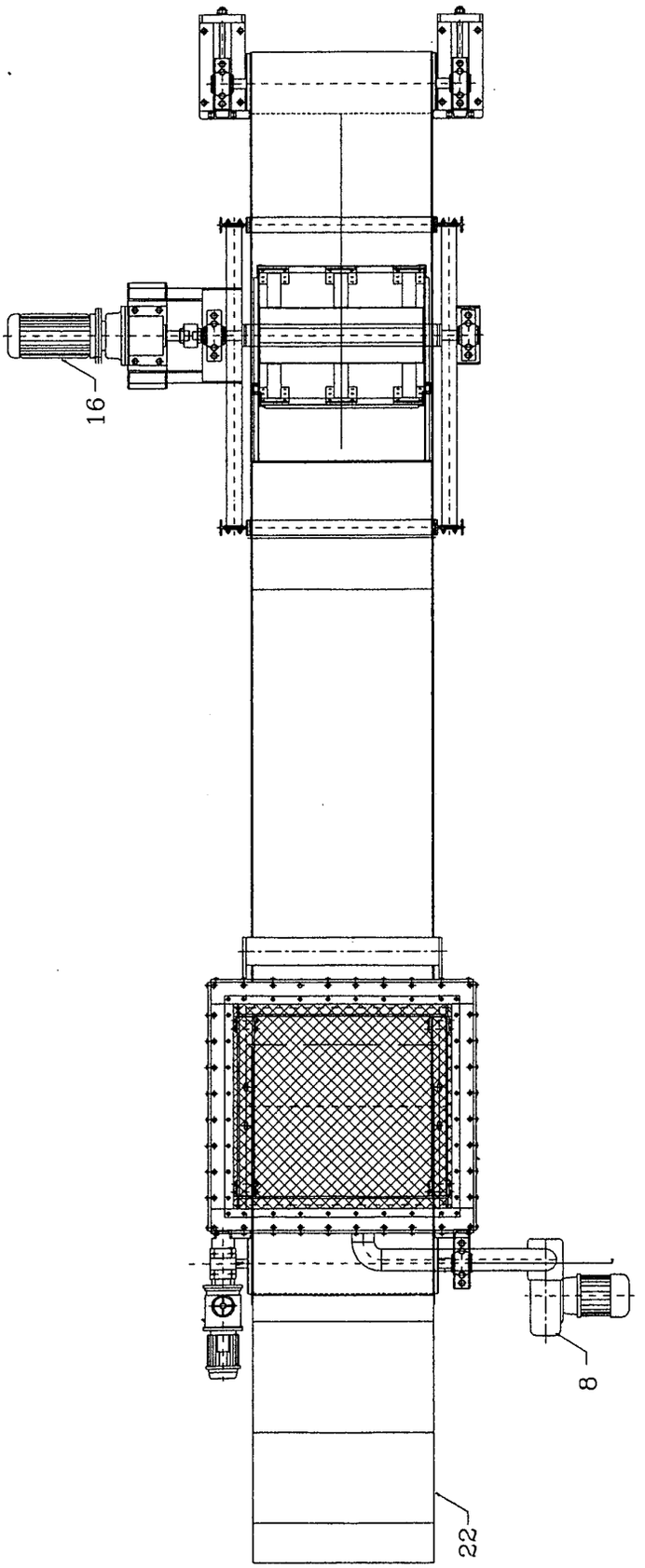


FIG 4