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## (54) Separator for industrial waste

(57) The present invention relates to a ballistic waste separator. The separator includes an inclining shaker table with at least four screen elements (1). The material mix which is to be separated is released onto the screen elements (1). These execute a rotational movement with an amplitude and at a speed which result in hard material bouncing on the elements (1) and being discharged at the lower end (6) while soft and flexible material which does not bounce against the shaker table migrates upwards and is discharged at the upper end (5). The screen elements (1) are driven by a drive motor (10) via crankshaft arrangements as a synchronous unit in such a manner that every second element assumes the highest and lowest position simultaneously. Each crankshaft arrangement includes two crankshafts (12) interconnected via an intermediate shaft (13) and a transmission (14). Each crankshaft (12) does not support more than two or three screen elements (1).

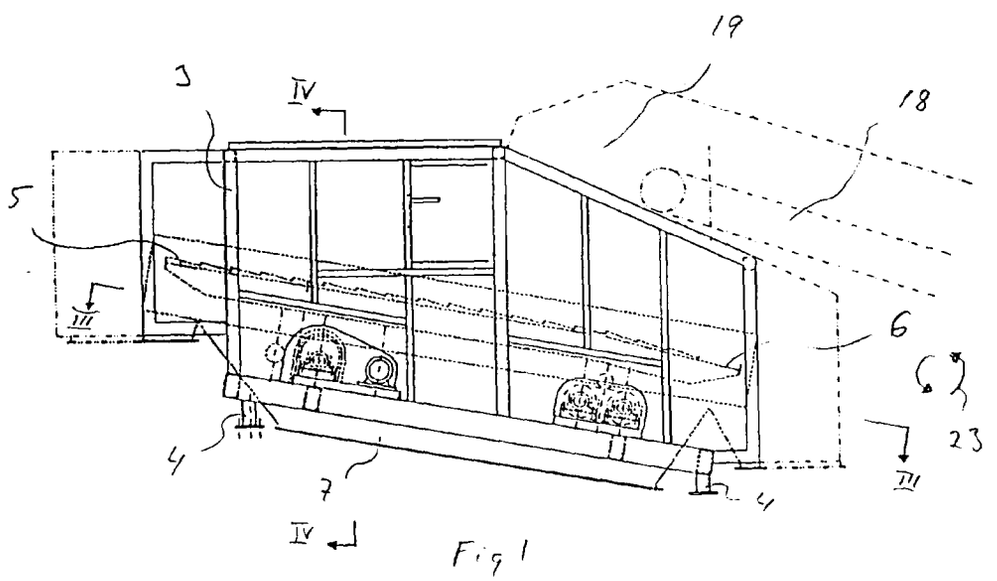


Fig 1

EP 0 870 550 A2

## Description

The present invention relates to a waste separator according to the preamble to appended Claim 1. It is previously known in the art to employ so-called ballistic separators to divide up material mix into two or more fractions depending upon the properties and/or size of the various matter components.

The principle of ballistic separators is that the material mix which is to be separated is released down onto a sloping shaker table. The shaker table is then caused to execute a rotation movement with an amplitude and at a speed which result in hard matter bouncing on the shaker table and being discharged at the lower end, while soft and flexible matter which does not bounce against the shaker table migrates upwards and is discharged from its upper end. It is also possible to separate additional fractions by providing the shaker table with a large number of apertures through which fragments of small size are allowed to fall. By providing apertures of different dimensions, where the smallest dimension is at the inlet, a separation of the fraction which falls out through the apertures may also be achieved.

In, for example, Swedish patent No. 402409, there is shown such a separator which is primarily intended for fragmented domestic waste. While this apparatus functions satisfactorily for its contemplated field of use, it has proved that this technology does not function to the full when the intention is to separate heavier waste, such as construction debris and rubble. The problem in such instance is, for instance, that the prime mover driving the separator cannot handle the heavy material. If driving according to the above-mentioned Swedish patent were to be employed, the requisite physical size of bearings, anchorages, suspension and cranks for handling the load would be so great that the available space would not be sufficient.

One object of the present invention is, therefore, to obviate the problem inherent in the drive means. One solution of this problem is stated in the characterizing part of Claim 1. One of the characterizing features of the present invention is that each crankshaft only supports a part of the screener elements which form the shaker table. In the prior art technology as disclosed above, each crankshaft carries all screen elements.

Expedient embodiments of the present invention are disclosed in the appended subclaims.

The present invention will now be described in greater detail hereinbelow with reference to the accompanying drawings, in which:

Fig. 1 is a side elevation of a separator according to the present invention;

Fig. 2 is a top plan view of the separator of Fig. 1;

Fig. 3 is a schematic sketch of the driving arrangement shown from above and taken along the line III-III in Fig. 1;

Fig. 4 is a sectional view taken along the line IV-IV in Fig. 1;

Fig. 5 is a detailed view showing the anchorage of screen elements on the crankshafts; and

Figs. 6 and 7 are detailed views showing a screen element from the side and from above, respectively.

In the embodiment shown in the figures, the apparatus has four parallel screen elements 1 which together form a shaker table. The screen elements 1 are supported via brackets 16 by number of crankshafts 12. The crankshafts are journalled via journal housings in a framework. The framework comprises a super structure 3 which rests on a bottom frame 2. In a number of embodiments, the superstructure is clad with suitable wall material for protection against dust and noise. The bottom frame 2 rests on supports 4. The bottom frame 2 is disposed inclining in relation to the horizontal plane, for which reason the screen elements 1 forming the shaker table will be disposed inclined. By modifying the vertical position of the one support 4, it is a simple matter to alter the angle of inclination of the shaker table.

The shaker table has three different outlets for different material fractions. An outlet at the upper end 5 of the shaker table, an outlet at the lower end 6 of the shaker table and an outlet 7 disposed beneath the shaker table. The screen elements 1 display a large number of apertures 8 in order to allow the passage of material of relatively small size to the outlet 7 disposed beneath the shaker table. In certain embodiments, the apertures 8 are smaller at the inlet, in which event this fraction is divided up further. Such relatively small-sized material may, in construction debris and rubble, consist of various pollutant such as crushed material, organic material etc. Each individual screen element 1 is parallel with the direction of feed of the material on the shaker table.

In the illustrated embodiment, the screen elements 1 are discontinuous, such that the lower portion of each screen element 1 is of greater inclination in relation to the horizontal plane than the upper portion of the screen elements 1. The break point is disposed at approximately 1/4 of the total length from the lower end. The break point is normally disposed in the region where the waste falls down onto the shaker table. As a result, this region is kept cleaner. In certain embodiments, the screen elements 1 are clad with a suitable damping material, for example rubber, at least in the region where the waste falls down onto the shaker table. In other embodiments, the break point is disposed in other

positions, or the break point is wholly omitted, i.e. the screen elements display the same inclination throughout their entire extent.

The screen elements 1 are further provided with a bead 9 of serrated construction at 20 seen from the side, with a vertical side 21 and an inclining upper side 22. The inclining upper side 22 is disposed such that it inclines down towards the lower end 6 of the shaker table. The beads 9 are normally disposed centrally in the screen elements 1 and extend throughout the entire length of the screen elements, apart from the final distance at the lower end of the shaker table. The major purpose of the serrated configuration is to move the material upwards.

Thanks to the beads 9 on the screen elements 1, the material on the shaker table will also have movement impulses which are transverse in relation to the normal direction of movement. This assists in agitating the material and reducing the risk that the material "floats above" other material. For example, there is a risk that hard material lands on and remains lying above, for example, a corrugated fibre board panel. The mutual movement between adjacent screen elements gives the major agitation movements.

As was mentioned above, the screen elements 1 are supported by crankshafts 12. The crankshafts are included in a crankshaft arrangement where each crankshaft 12 supports only two screen elements 1. The loading on each crankshaft 12 will thus be less than would have been the case if, according to the prior art technology, each crankshaft 12 had supported all screen elements 1. In the illustrated embodiment, each crankshaft arrangement includes two crankshafts 12,a,b;c,d an intermediate shaft 13, a transmission 14 and journals 15. The crankshafts 12 in a crankshaft arrangement are driven by a single motor 10. The motor 10 drives, via a gear 11, a first crankshaft 12a, this first crankshaft 12a being connected to an intermediate shaft 13 which, via a transmission 14, drives a second crankshaft 12b. This second crankshaft 12b supports the two remaining screen elements 1 which are not supported by the first crankshaft 12a. The end of the second crankshaft 12b facing away from the transmission 14 is disposed in a journal 15 carried on the framework. Both of the crankshafts 12a,b in the crankshaft arrangement are disposed mutually offset in the longitudinal direction. In the illustrated embodiment, the transmission 14 consists of a chain drive, but in other embodiments cog gears or cog belts are employed. In the illustrated embodiment, one and the same motor thus drives both of the crankshafts 12 which support the screen elements 1. The screen elements 1 move pairwise in such a manner that every other element moves synchronously, i.e. they assume uppermost position and lowermost position, and so on, simultaneously.

In an alternative embodiment (not shown), each crankshaft 12 is driven by an individual motor 10, the intermediate shaft 13 and the transmission 14 normally being omitted. In a number of embodiments with one drive shaft for each crankshaft, the individual crankshafts 12 each support three screen elements 1, since on synchronous driving of two screen elements, there is a risk that they arrive in a dead stop position from which driving cannot be started.

It is possible to dispose crankshafts 12 and intermediate shafts 13 in several different manners than that shown in this embodiment. However, the important feature is that the parts of the shafts rotate with constant displacement and that the crankshafts are interconnected and driven as a synchronous unit. In the embodiments where an individual motor drives each crankshaft, synchronization takes place by accurate control of the motors, often with the aid of electronics.

In the illustrated embodiment, the drive means is disposed at the upper end 5 of the shaker table. At the lower end 6 of the shaker table, there is disposed an additional crankshaft arrangement which supports the screen elements 1. The crankshafts 12c,d at the lower end are not driven in the embodiment shown on the drawings. Also here, each crankshaft 12c,d supports only two screen elements 1 each. The crankshafts 12c,d are interconnected via an intermediate shaft 13 and a transmission 14. Interconnection of the idling crankshafts 12c,d is put into effect in order to avoid the occurrence of uncontrolled dead stop points. The screen elements 1 transfer a movement to the idling crankshafts 12c,d at the lower end 6 of the shaker table. Thus, all crankshafts 12 are driven directly or indirectly by one and the same motor 10 in the illustrated embodiment. In embodiments with one drive motor for each crankshaft in a crankshaft arrangement, only one crankshaft arrangement is, as mentioned above, generally driven, in which event the screen elements transfer the movement to the other crankshaft arrangements.

The screen elements 1 are supported on each respective crankshaft 12 by a bracket 16 which, via a journal 17, is rotatably disposed in relation to the crankshaft 12. Adjacent screen elements 1 are variably supported at different levels on the crankshafts.

The outlet 7 beneath the shaker table is of such funnel-like configuration that it catches all material falling through the apertures 8 along the entire extent of the screen elements 1. In those embodiments where the screen elements 1 are provided with apertures of different sizes, the outlet 7 is divided in response to the siting of the apertures 8.

In operation, each individual screen element 1 executes a rotation movement in the direction of the arrow 23 according to Fig. 1, the crankshaft rotating counterclockwise as shown in Fig. 1. The speed of rotation of the screen elements 1 is set such that the speed in a vertical direction exceeds the acceleration on free fall of the hard and soft materials included in the mix being separated.

The upper portion 5 of the shaker table normally inclines at an angle of 8-15° to the horizontal plane,

while the lower portion 6 inclines a further 5° in relation to the horizontal plane. The movement in the vertical direction of the screen element 1 is approx. 80-180 mm.

In certain embodiments, the waste separator is designed such that it may readily be moved if necessary. This is put into effect int. al. in that its size is adapted to the possibilities of transporting it using a lorry.

When the separator is put into operation, for example construction debris and rubble is fed to an inlet 19 of the separator with the aid of a conveyor 18. The inlet 19 and the conveyor 18 are only intimated by broken lines in Fig. 1. In order to control the position of the fall of the waste on to the shaker table, a guide plate (not shown) is, in a number of embodiments, disposed at the inlet. This guide plate is often adjustably disposed in order, when necessary, to modify the position of the fall region depending upon the type of waste being separated.

Hard material, such as brick, wood, metal, etc. included in the waste will bounce on the inclining shaker table. As a result of the inclination of the shaker table, the hard material will bounce in a direction towards the lower end 6. By adjusting the inclination of the shaker table, the direction of bounce can be adjusted as required. When the hard material, after the first bounce, has assumed a new position on the shaker table, it will "lift" from the shaker table when the screen element or elements 1 on which it rests moves downwards, since, in accordance with the foregoing, the speed of movement of the screen elements 1 in the vertical direction exceeds the acceleration on free fall of the material. When the screen elements 1 once again meet the falling, hard material, the material will receive a new bounce impulse or jolt in a direction towards the lower end 6, and thereby be moved in this direction in order, in due course, to be discharged out of the separator.

Soft and flexible material such as paper, cardboard, plastic film etc. which falls down on to the shaker table will, in principle, not bounce. When the screen element or elements 1 on which the soft material rests move downwards, these elements 1 are at such speed that the soft material does not have time to accompany in free fall. Thus, the soft material "lifts" from the elements 1. During the time when this soft material falls, the screen element 1 moves so far in its rotation movement that the soft material will have moved to a position further to the left on the screen elements 1 as seen in Fig. 1. The screen element 1 will have time to pass the lower turning point before the soft material once again impinges on the screen element 1. This is subsequently repeated until such time as the soft and flexible material has been discharged out at the upper end 5.

The third fraction, which consists of crushed material, organic matter, etc. and which is of such size that it falls through the apertures 8 provided in each respective screen element 1, is discharged via the outlet 7 disposed beneath the shaker table. As a result of the rotational movement of the screen elements 1, this fraction will be displaced until it falls down through an aperture 8 if it does not fall direct into an aperture 8 when leaving the conveyor 18. The size of the apertures is currently between 10 and 100 mm but may be made larger. The size of the apertures is selected in response to the type of material which is to be screened off via the outlet 7. As was mentioned above, the apertures 8 are of different sizes at different parts of the screen elements in a number of embodiments, a further screening taking place based on aperture size.

While four screen elements are shown on the drawings, a person skilled in the art will readily perceive that, in other embodiments, use may be made of more screen elements 1.

The waste separator has principally been produced to be employed as a construction rubble and debris separator, but it is self-evident that it may be employed for many different material separation operations. For example for demolition material, industrial waste and commercial waste.

## Claims

1. A ballistic separator which includes an inclining shaker table with at least four screen elements (1) and two or more crankshaft arrangements which support the screen elements (1), and where the screen elements (1) are disposed parallel with the direction of feed of material on the separator, **characterized** in that all crankshafts (12) are driven as a synchronous unit; that each individual crankshaft (12) does not support more than two or three screen elements (1); and that each crankshaft arrangement includes at least two crankshafts (12) which are disposed offset in relation to one another.

2. The ballistic separator as claimed in Claim 1, **characterized** in that a drive motor (10) drives all crankshafts either directly or indirectly.

3. The ballistic separator as claimed in Claim 1 or 2, **characterized** in that each crankshaft arrangement includes at least two crankshafts (12) operationally interconnected via an intermediate shaft (13) and a transmission; and that the transmission (14) is a chain drive, cog belt or cog gear.

4. The ballistic separator as claimed in Claim 1, **characterized** in that each crankshaft (12) in at least one crankshaft arrangement is driven by an individual drive motor (10).

5. The ballistic separator as claimed in any of the preceding Claims, **characterized** in that the motor or motors (10) only drive one crankshaft arrangement directly; and that the drive motion to the other crankshaft arrangement or arrangements is transmitted via the screen elements.

6. The ballistic separator as claimed in any of the preceding Claims, **characterized** in that each individual screen element (1) executes a rotational movement where the screen element (1) is given an acceleration in the vertical direction which exceeds the acceleration in free fall.

7. The ballistic separator as claimed in any of the preceding Claims, **characterized** in that adjacent screen elements (1) are journal led variably at different levels on the crankshafts (12); that the screen elements (1) are supported by brackets (16) rotatably journalled on the crankshafts (12) via journals (17); and that each screen element (1) displays a bead (9) extending along at least the greater portion in the longitudinal direction of the screen element (1).

8. The ballistic separator as claimed in Claim 7, **characterized** in that the beads (9) are serrated seen from the side.

9. The ballistic separator as claimed in any of the preceding Claims, **characterized** in that the screen elements (1) are clad with a damping material, at least in the region which receives the waste.

10. The ballistic separator as claimed in any of the preceding Claims, **characterized** in that the screening elements (1) are of greater inclination in relation to the horizontal plane at the lower end (6) than at the upper end (5); and that the waste is received in the region of the break point between different inclinations of the screen elements (1).

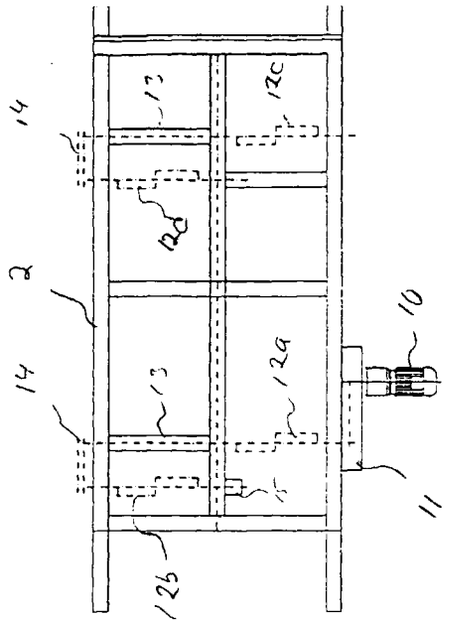


Fig 3

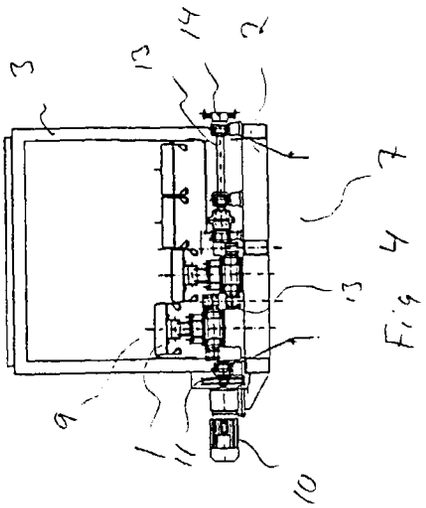


Fig 4

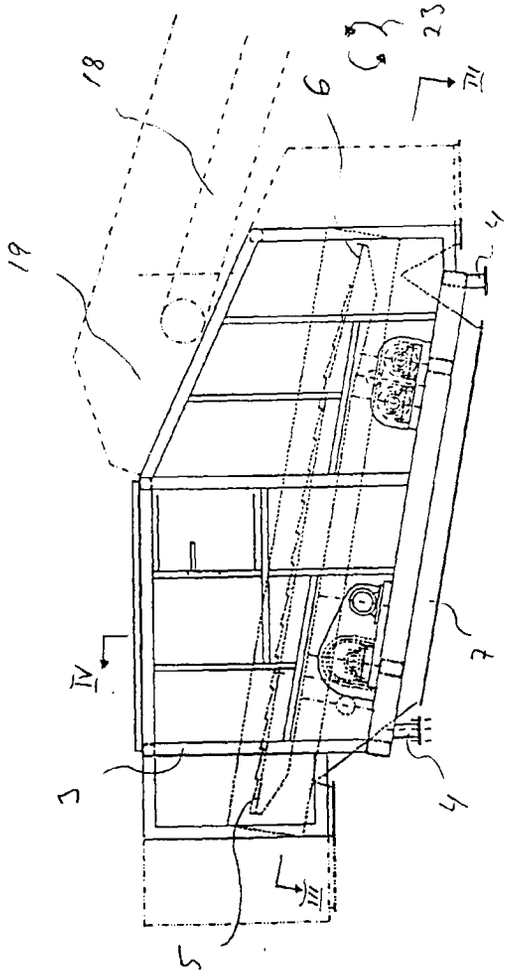


Fig 1

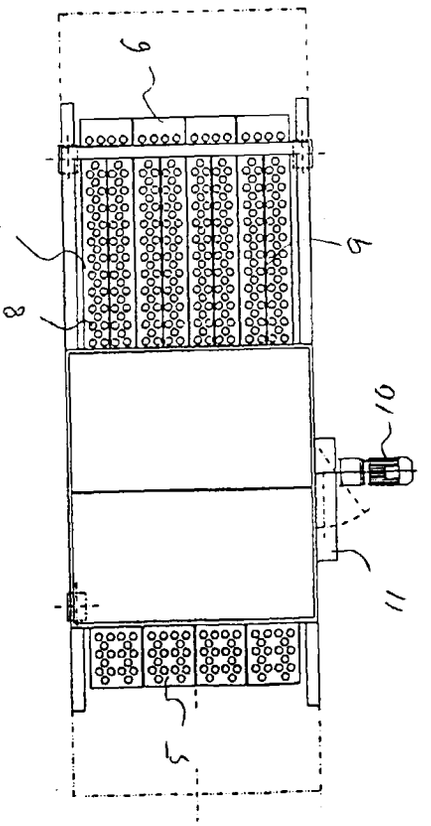


Fig 2

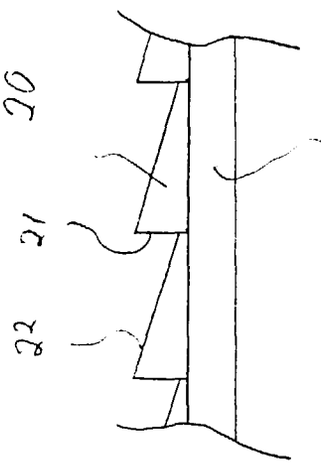


Fig 6

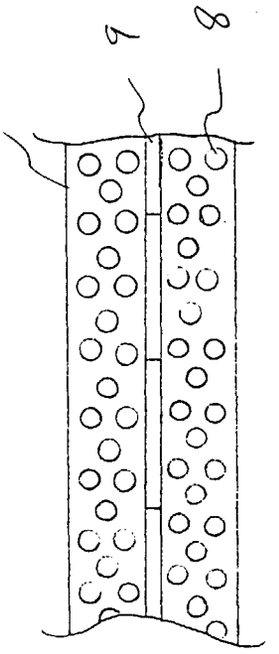


Fig 7

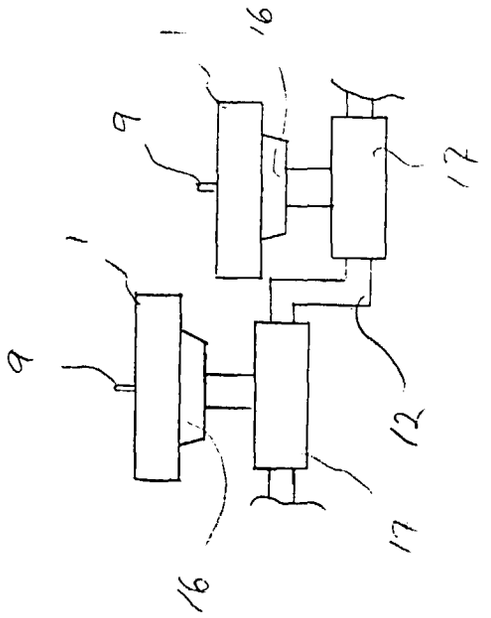


Fig 5