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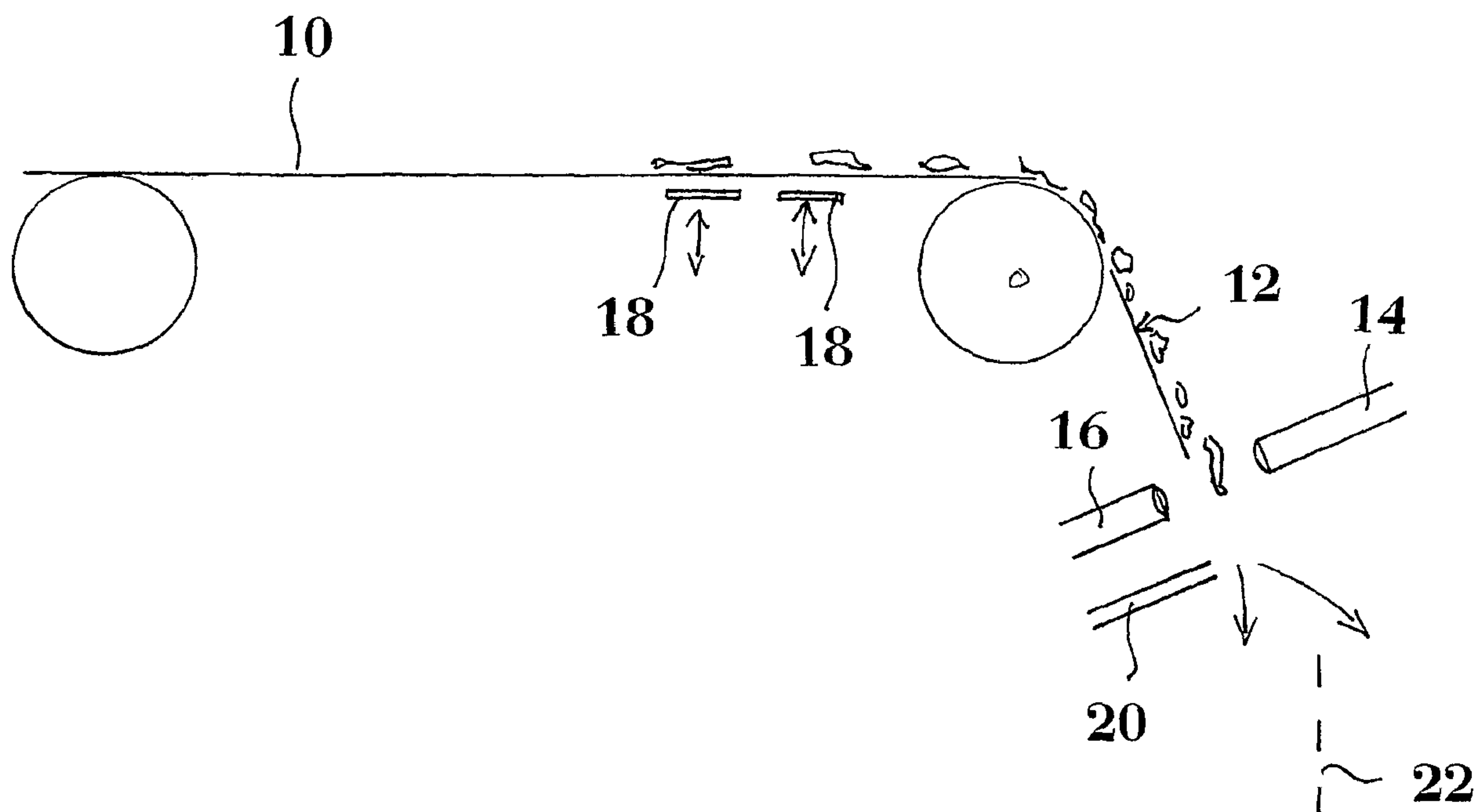
(72) Inventeurs/Inventors:
HARBECK, HARTMUT, DE;
PETZOLD, GUNTHER, DE;
REISCHMANN, GERD, DE

(73) Propriétaire/Owner:
COMMODAS GMBH, DE

(74) Agent: RIDOUT & MAYBEE LLP

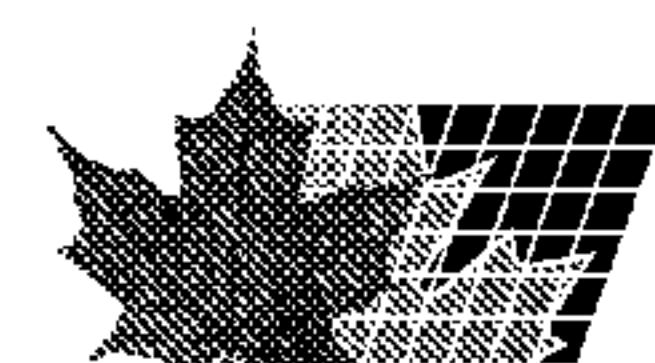
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(54) Title: APPARATUS AND METHOD FOR SORTING OUT METAL FRACTIONS FROM A BULK MATERIAL STREAM



(57) Abrégé/Abstract:

The invention relates to a device and a method for blowing out metal fractions from a stream of bulk material that is conveyed by bulk material conveying means (10). The device comprises blow-out nozzles (20) which are located on a drop section and which are arranged along a widthwise extension of the stream of bulk material, for blowing against individual particles of bulk material in order to modify the trajectory in such a way as to produce a second sub-stream that branches off. The blow-out nozzles (20) can be controlled according to the sensor coil scanning results relating to the bulk material particles. A plurality of sensor coils (18) is provided underneath an essentially horizontal section of the stream of bulk material in the form of an LC oscillating circuit. Said sensor coils are provided for detecting the eddy currents that are induced. Optoelectronic means (14) are also provided for determining the blow-out position and for determining the location of each of the particles of bulk material.



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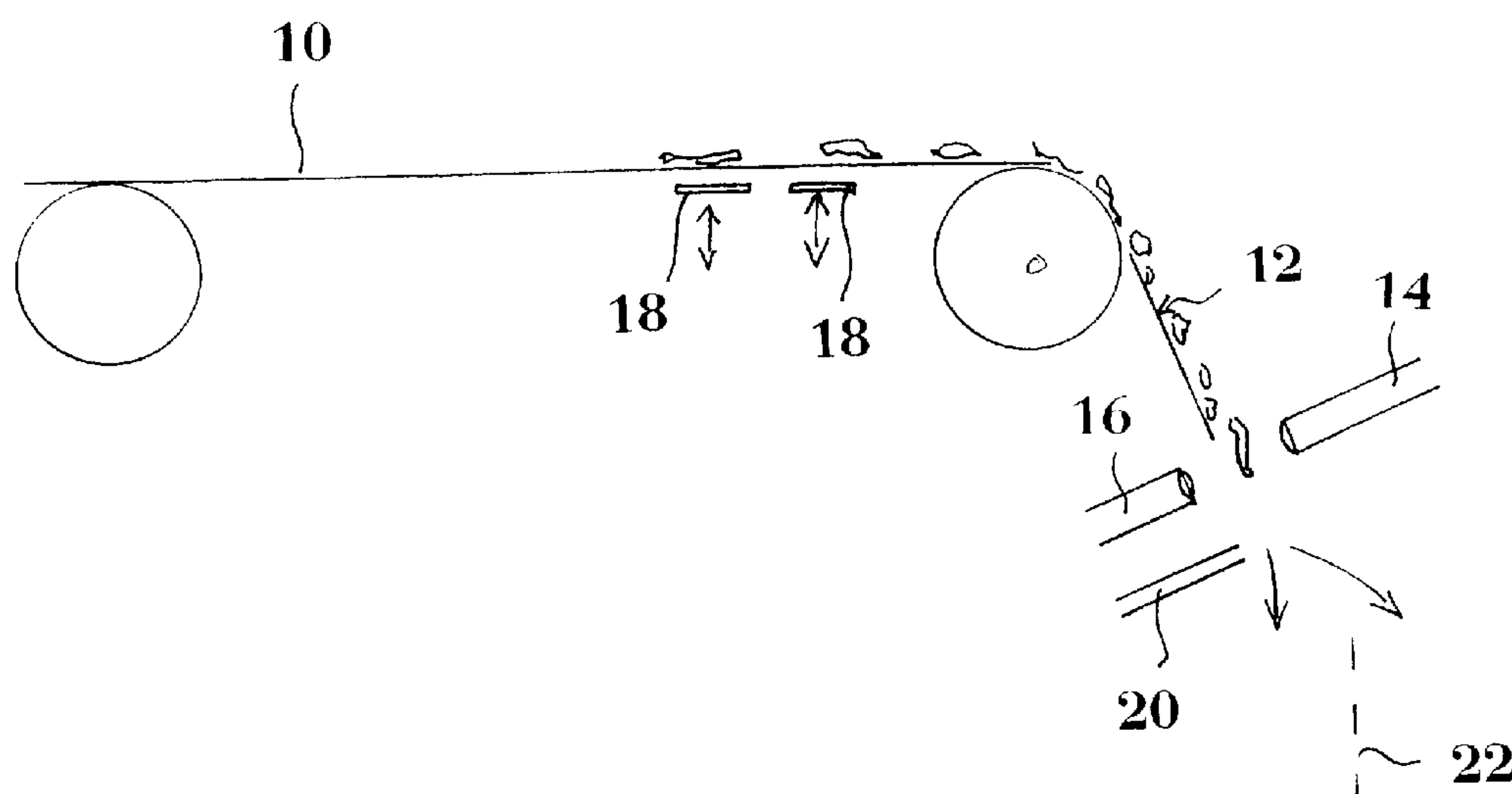
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US): **COMMODAS GMBH** [DE/DE]; Rosengarten 10,
22880 Wedel (DE).

(72) Erfinder; und

(75) Erfinder/Anmelder (nur für US): **HARBECK, Hartmut**
[DE/DE]; Op'n Klint 23, 22880 Wedel (DE). **PET-**
ZOLD, Günther [DE/DE]; Dorfstr. 16, 25462 Rellingen
(DE). **REISCHMANN, Gerd** [DE/DE]; Bertha-von-Sut-
tner-Ring 19, 25463 Tornesch (DE).(74) Anwalt: **BIEHL, Christian**; Boehmert & Boehmert, Nie-
mannsweg 133, 24105 Kiel (DE).(81) Bestimmungsstaaten (national): AE, AU, CA, CN, CZ,
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(54) Title: DEVICE AND METHOD FOR SORTING OUT METAL FRACTIONS FROM A STREAM OF BULK MATERIAL

(54) Bezeichnung: VORRICHTUNG UND VERFAHREN ZUM AUSSORTIEREN VON METALLISCHEN FRAKTIONEN AUS
EINEM SCHÜTTGUTSTROM

(57) Abstract: The invention relates to a device and a method for blowing out metal fractions from a stream of bulk material that is conveyed by bulk material conveying means (10). The device comprises blow-out nozzles (20) which are located on a drop section and which are arranged along a widthwise extension of the stream of bulk material, for blowing against individual particles of bulk material in order to modify the trajectory in such a way as to produce a second sub-stream that branches off. The blow-out nozzles (20) can be controlled according to the sensor coil scanning results relating to the bulk material particles. A plurality of sensor coils (18) is provided underneath an essentially horizontal section of the stream of bulk material in the form of an LC oscillating circuit. Said sensor coils are provided for detecting the eddy currents that are induced. Optoelectronic means (14) are also provided for determining the blow-out position and for determining the location of each of the particles of bulk material.

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— mit internationalem Recherchenbericht

Zur Erklärung der Zweibuchstaben-Codes, und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(57) Zusammenfassung: Vorrichtung und Verfahren zum Ausblasen von metallischen Fraktionen aus einem durch schüttgutfördernde Mittel (10) bewegten Schüttgutstrom, mit an einer Fallstrecke angeordneten Ausblasdüsen (20), die entlang der Breitenerstreckung des Schüttgutstromes zum Anblasen einzelner Schüttgutteilchen angeordnet sind, zur Veränderung der Flugbahn in einen zweiten, abgezweigten Teilstrom hinein, wobei die Ausblasdüsen (20) in Abhängigkeit von Sensorspulenabtastungsergebnissen der Schüttgutteilchen ansteuerbar sind, wobei eine Mehrzahl von als LC-Schwingkreis ausgeführten Sensorspulen (18) unter einem im Wesentlichen horizontalen Abschnitt des Schüttgutstrom vorgesehen sind zur Erfassung der induzierten Wirbelströme und weiter zur Bestimmung der Ausblasposition zusätzlich optoelektronische Mittel (14) zur Ortserfassung eines jeden Schüttgutteilchens vorgesehen sind.

APPARATUS AND METHOD FOR SORTING OUT METAL FRACTIONS
FROM A BULK MATERIAL STREAM

The invention relates to an apparatus and a method for sorting out or extracting metal fractions from a bulk material stream according to the preamble of the independent claims.

It is necessary to sort out or separate metal fractions from the most varied bulk material streams. In the simplest case they are constituted by crown corks of beer bottles and aluminium parts from a broken glass bulk material stream. However, it is also necessary to sort on the basis of their different metal and non-metal fractions non-homogeneous bulk material streams, e.g. shredded car parts. In particular, the stainless steel fraction has to be separated from other fractions. In the same way as nonferrous metals, stainless steel is not very ferromagnetic.

Such a method is described in DE-A1-35 13 664, in which an inductance-variable detector coil on a refuse chute controls a compressed air nozzle, which blows away nonferrous metals. Quite apart from the limited local resolution, which is just sufficient for the detection of aluminium cans, the problem arises that varying inductance changes for different materials and also different object sizes do not allow clear information to be provided with regards to the optimum blow-out point. It is always only possible to blow out a specific fraction and not, if different compositions exist, the smaller fraction for whose blowing out only reduced costs are involved.

It is impossible to blow out non-metals, although this is highly desirable in the case of crushed car scrap.

As a result of saturation effects particles bringing about a strong inductance change can desensitize the coil for such a long time that it is necessary to accept a significant level of incorrect sorting or extremely slow feed rates.

Methods of the type described e.g. in DE-A1-40 14 969 are consequently not very suitable for correctly detecting metal and for the different handling of different metal fractions.

The parallel detection of both the colour and the presence of metal requires a considerable amount of time which, as described in DE-A1-40 17 129, gives rise to slow bulk material conveying rates.

Other proposals, such as e.g. those of DE-A1-42 35 956, in which the fine surface structure of the materials are determined by bombarding with electromagnetic waves, are much too complicated and costly during evaluation

and require a time-consuming logic consideration. In addition, proposals have already been made for increasing the separation efficiency of material mixtures, such as e.g. in German utility model DE-U-93 09 786.

Finally, DE-A1-40 17 274 describes an apparatus for detecting and separating metal particles, in which different down pipes are provided with detector coils, which in each case control a flap mechanism for deflecting fluid bulk material. In the case of shredded material, e.g. car scrap, unavoidably there are certain parts which are well above the nominal size and which would immediately block such pipes. However, even in the case of bulk material such pipes tend to become blocked.

It is also desirable, as a function of the bulk material to be sorted, to be able to readjust the separation efficiency in order to take account of different bulk material prerequisites and enable the sorting out of the in each case desired fractions.

Thus, it is e.g. known that there can be considerable differences in shredded car scrap as a function of the country of origin. Whereas European car scrap contains a large amount of light alloys and plastic parts, in the scrap from US cars there are far more stainless steel parts, whose sorting out is correspondingly worthwhile.

It is also known that the size and shape of the parts to be sorted are dependent on the nature of the shredding machine, quite apart from the materials used in the vehicles. However, once a first batch has been supplied by a particular preprocessing plant, it is generally to be assumed that over a long period (the next years) parts with a similar size and shape will arrive and the sorting parameters when operating the sorting apparatus consequently remain substantially the same.

The problem of the invention is to provide a method and an apparatus for sorting out such metal fractions, sorting out having to take place rapidly and also reliably in the case of larger parts.

Specifically in the case of larger parts, it is necessary control the blow-out nozzles in such a way that the parts are correctly blown out, because too sort or too early blowing (such as arises with large objects through a premature response of the prior art metal detectors) will not lead to the parts being correctly brought into a new trajectory. In the case of shredders there are also many elongated parts, which are difficult to blow out.

According to the invention this problem is solved by the features of the main claim. The subclaims provide advantageous embodiments of the invention.

It is in particular advantageous that as a result of the inventive arrangement of an electromagnetic sensor below advantageously a horizontally directed conveyor belt, it is not only possible to determine the digital signal metal: YES/NO, but also a signal pattern, from whose details, particularly its edge rise, conclusions can if necessary be drawn concerning the size and the material of the individual parts.

As a result of the position of the essentially flat parts on the conveyor belt, it is possible to consider the distance between the mass centre and the sensor to be identical for all the parts.

By means of the sensor described in the second part of the description relative to the drawings, it is possible to generate eddy currents in a metal part to be separated, particularly an aluminium or stainless steel part, which then in turn builds up a magnetic field acting in opposition to the excitation field. As a result of the buildup of the field, but in particular through line losses to which the eddy currents are exposed in the metal, an energy loss is brought about in the field-generating sensor, which as damping of said oscillator is an order for the size, spacing and dimensions of the object. The individual particles to be sorted out are slightly heated by the eddy currents.

Admittedly use has already been made of the generation of opposing fields by eddy currents, induced by very strong fields in order to deflect from the trajectory in which the rotational fields arise, but this deflection is determined by the geometry of the object and the eddy currents flowing in said object and less by the actual material and is not of an optimum nature in its directional component.

However, the invention "misses" the particle and controls a blow-out nozzle bar, which provides the particle with a suitable air stream for ejection during a drop section, which e.g. follows a horizontally directed conveyor belt. Thus, for the selected particles an always identical trajectory is much more reliably ensured than by a very strong field, which induces eddy currents in all the objects with a different intensity for ejection purposes.

In addition, the invention makes it possible to mathematically evaluate the data detected for an object, namely the size, the strength of the eddy current caused (the steepness of an edge rise in the signal pattern enabling conclusions to be drawn thereon), in which the strength of the back-indication of the object, i.e. either its weight or in the case of comparable weights of the particles its material,

- 1.) can be determined by mathematical integration over the surface area of a "peak",
or, which can be easily implemented from the apparatus standpoint in the plant, by
- 2.) can be taken into account by modifying the distance from the changed sensor and the bulk material stream,

so that in both cases the response limits for separation can be easily changed.

A major advantage is provided by the optional, optical determination of the particles on the belt or at the start of the drop section, because it provides the possibility of more precise positional information to blow against the centres of gravity of the particles by means of the air nozzles which are provided with precisely determined action points and much more densely provided than the coils, so as to bring about an optimum trajectory change.

Through a plurality of sensors, which can be juxtaposed at right angles to the bulk material stream, it is possible to monitor the entire bulk material stream and provide a further metal/no metal information concerning the optically detected objects and in the case of an adequate separation efficiency to permit a decision to be made concerning the nature of the metal by means of the object size and sensor information.

As the field distribution of any LC sensor coil drops strongly towards the edge, it is proposed that there are at least two mutually displaced rows.

The invention also proposes, in addition to the sensors equidistantly spaced with respect to the bulk material stream, the provision of further sensors with different spacings with respect to said stream, so as in this way to detect fractions with significantly different response ranges in the bulk material stream and consequently permit the sorting out of certain fractions between the upper and lower limits.

However, it is also possible to provide additional optoelectronic sensors, which can qualify the signals obtained from the electromagnetic detection with optoelectronically detected signals, i.e. for example the size and colour of the object.

Another advantage of the invention is the possibility of logical reversal, i.e. either the blowing out of utilizable metal fractions or the blowing out of utilizable plastic fractions, as a function of which provides the desired, marketable fraction in the most type-pure form.

Further features and advantages of the invention can be gathered from the attached drawings, wherein show:

Fig. 1 A diagrammatic representation of a sorting apparatus.

Fig. 2 The geometry of the coil arrangement.

As is diagrammatically indicated in fig. 1, the apparatus has bulk material-conveying means 10, namely a conveyor belt, to which is optionally connected a gravity chute 12 in the first part of a drop section for parallelizing the individual particles.

In free fall the individual objects are then detected by a line camera 14, which linewise images the object flow and passes the signals thereof to an electronic system, which detects with an evaluating means a plurality of lines of individual objects and subdivides said objects into colour and possibly shape classes and in particular for each object determines the sensor information in question from the detector coils 18 in order on the basis thereof to supply a positionally precise blow-out command to a row of blow-out nozzles 20.

Thus, the blow-out nozzles 20 can also blow out elongated objects and those for which the sensor coils 18 did not respond, in that the trajectory is modified, e.g. to the right behind a partition 22.

As the sensor coils 18 have a worse response behaviour at the edge than in the centre, it is proposed that they be arranged in two, mutually displaced rows. The time displacement on response (from top to bottom in fig. 2) to bulk material particles can be compensated without great expense by signal processing means on the way to the control electronics.

Due to the fact that the plurality of sensor coils 18 in the form of LC resonant circuits is located under a substantially horizontal portion of the bulk material stream, has the advantage that the spacing variable with respect to the coil, which has a very marked effect on the result, varies to a minimum degree between individual objects, because they generally come with their centre of gravity closest to the conveyor belt. The resonant circuits induce high frequency eddy currents, whose presence gives rise to a damping of the coils 18, which indicates the presence of a metal particle, but not yet suitable for determining the blow-out position. Even a plurality of sensor rows only supplies this information in an inadequate form, so that additional optoelectronic means, namely the line camera 14 are provided for determining the position of each bulk material particle. A lighting means 16 can be provided in transmitted light or in incident light. The camera 14, lighting system 16 and blow-out nozzles 20 can also be located on the

trajectory side opposite to that shown in fig. 1, or two or more cameras can be used for observing both the front and rear. Such a variant is particularly suitable for the correct sorting out of composite materials, such as increasingly occur in car scrap.

Thus, in the case of composite materials it is possible to detect whether e.g. there are hoses with metal clips, so that a predetermination can take place in the software of the plant regarding their supply to one of the fractions. It can be desirable either as a result of the small metal part to supply them to the metal fraction or due to the preponderant rubber part to the nonferrous fraction.

It is advantageous to operate very small sensor coils 18 with a high frequency of approximately 100 kHz. Thus, as shown in fig. 2, for coil dimensions of 35 mm and a centre-to-centre spacing in a row of 50 mm, there is a sensor grid scale of 25 mm, i.e. an overlap of in each case 10 mm on each side of the coil, which corresponds to the hatched outer area.

With a working width of e.g. 1200 mm and a product speed of 2.0 m/s, in the case of 48 sensors per line and a scanning rate of 0.2 kHz with a particle size of 50 mm, there are 8 measured values per particle, which readily permits an evaluation of the signal edges.

Image processing can then improve the vertical resolution of the metal sensor means from 10 to 1 mm, because here working can take place with a grid scale of 0.5 mm and a scanning rate of 2 kHz.

The sensor coils 18 are arranged in a pot emitting the flux lines in closely concentrated manner upwards through an open end side and which is constructed in one piece with a centrally, perpendicularly positioned ferrite core 24 (diameter approx. 10 mm).

The operating voltage is advantageously 20 to 30 V DC and for adjusting the response sensitivity, besides a potentiometer, there are means for the displacement of the sensor coils 18 of a line away from the bulk material stream at different distances therefrom.

From the apparatus standpoint this is brought about by means of a vertical drawer precisely adjustable by means of spindle drives for in each case one line of sensor coils 18, displaceable in program-controlled manner more rapidly by electromagnets in at least two different planes.

The signals received by each coil are supplied via a demodulator to a trigger circuit for signal evaluation with respect to the signal level.

CLAIMS:

1. Method for sorting out metal fractions from a bulk material stream moved by bulk material-conveying means, in that the bulk material particles move away in a predetermined maximum width, with blow-out nozzles located on a drop section, arranged along the width extension of the bulk material stream for the selective blowing against individual bulk material particles for modifying the trajectory into a second, branched partial stream, the blow-out nozzles being individually controllable as a function of the scanning results of sensors, wherein the determination of the edge rise of the dampening of in each case one of the numerous high frequency fields induced by LC resonant circuits and formed on a horizontal portion of the bulk material stream, mathematical evaluation of the edge rise and the control of one or more suitable blow-out nozzles for deflecting the particle into the branched partial stream.
2. Method according to claim 1, wherein the correlation of the determined electromagnetic characteristics of a particle with optically determined data for determining the class of a particle.
3. Method according to one of the preceding claims 1 to 2, wherein the correlation of the determined electromagnetic characteristics of a particle with high resolution colour data optically determined in the case of a particle.
4. Apparatus for blowing out metal fractions from a bulk material stream moved by bulk material-conveying means, with blow-out nozzles located on a drop section and arranged along the width extension of the bulk material stream for blowing against individual bulk material particles, for modifying the trajectory into a second, branched partial stream, the blow-out nozzles being controllable as a function of sensor coil scanning results of the bulk material particles, wherein a plurality of sensor coils constructed in LC resonant circuit form are provided under a substantially horizontal portion of the bulk material stream for detecting the induced eddy currents, calculating means for evaluating the signal pattern of the

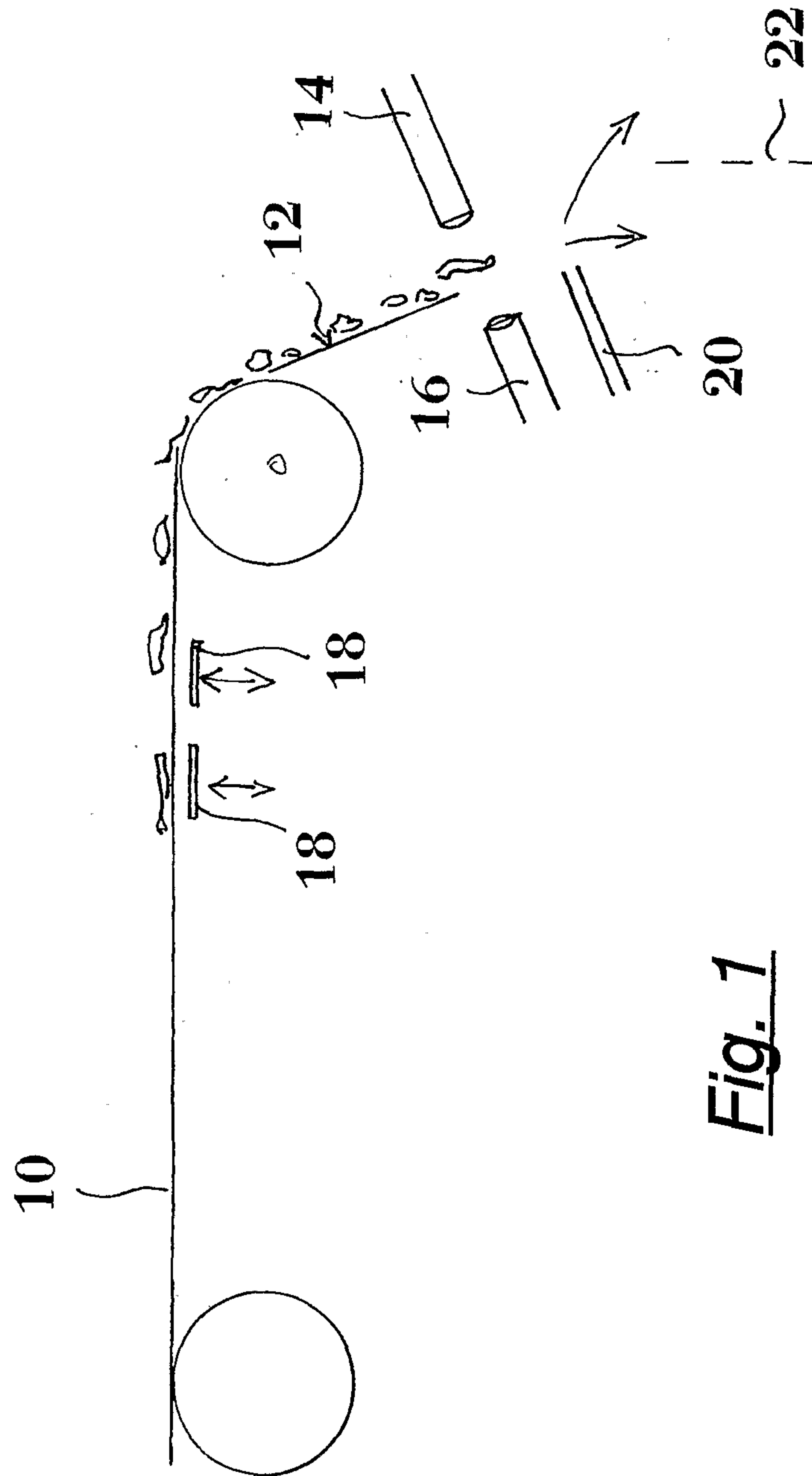
induced eddy currents and for determining the blow-out position, additional optoelectronic means are provided for determining the location of each bulk material particle, wherein the sensor coils are located in a pot emitting the flux lines upwards in a closely concentrated manner through an open end side and constructed in one piece with a centrally and vertically positioned ferrite core.

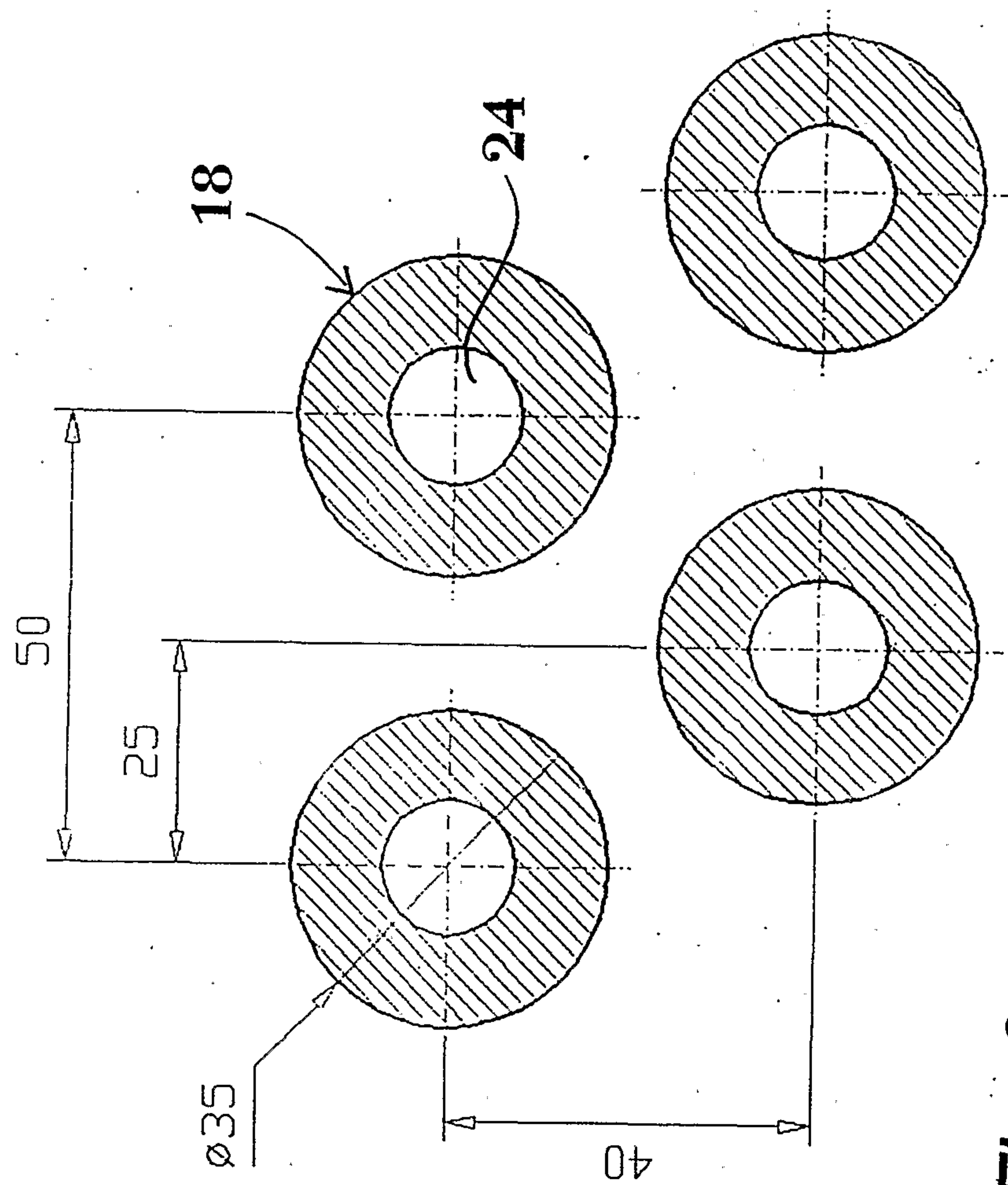
5. Apparatus according to claim 4, wherein the sensor coils can be operated with a high frequency of approximately 100 kHz.

6. Apparatus according to one of the preceding claims 4 to 5, wherein the sensor coils are arranged in at least two lines staggered at right angles to the bulk material stream.

7. Apparatus according to one of the preceding claims 4 to 6, wherein the sensor coils in each line can be jointly displaced away from the bulk material stream with different distances.

8. Apparatus according to one of the preceding claims 4 to 7, wherein the signals produced by a sensor coil are supplied by means of a demodulator to a trigger circuit for evaluation regarding the signal level and the sensor coils are displaceable in their vertical spacing to a horizontally positioned bulk material conveyor belt.



**Fig. 2**

