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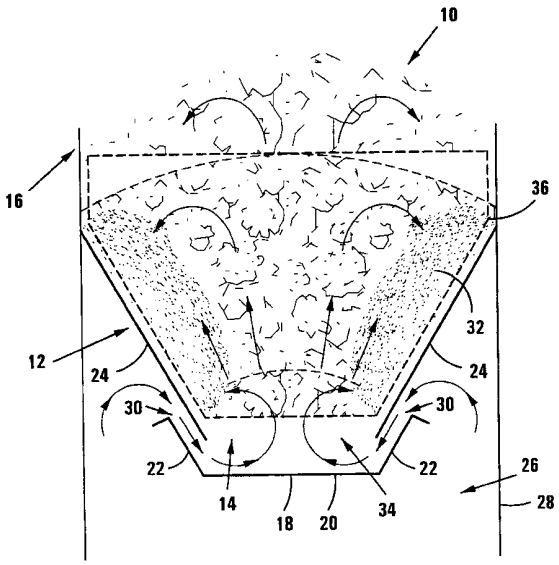
(54) Title: A PROCESS FOR PRODUCING PARTICULATE PRODUCTS



(57) Abstract: The invention relates to a process for producing particulate products from a slurry. The process is carried out in a virtual bed apparatus which includes a hollow body (10) within the lower section (12) of which a fluidized bed (32) of particles can be formed by a gaseous medium displaced through the hollow body. The slurry is fed onto the fluidized bed (32) of particles and by effective drying of the slurry, either by using high temperature steam as the gaseous medium or via a heat exchanger arrangement (36), the growth of particles in an "onion layer" fashion occurs. This growth of particles occurs either by slurry particles attaching to existing particles or by the equivalent growth of new dry slurry particles that do not attach to existing particles. Particles grown to a desired size are then discharged from the hollow body in a controlled fashion.

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A PROCESS FOR PRODUCING PARTICULATE PRODUCTS

THIS INVENTION relates to a process for producing particulate products.

The invention relates in particular to a process for producing particulate products from a slurry and to apparatus for use in carrying out the process. This process can be employed particularly for producing a compact particle fertilizer product from a slurry in the form of a wet organically enriched inorganic fertilizer mix.

Central to the process for producing particulate products is a dryer apparatus, which comprises a fluidized bed apparatus, of which details are disclosed in the Applicant's co-pending International Patent Cooperation Treaty Patent Application Nºs PCT/IB00/01648 and PCT/IB00/01649. This apparatus essentially comprises the following components:

a hollow body that has a downwardly tapering lower section defining a longitudinal axis, a truncated V-shaped profile in cross section along the length thereof and an elongate slot-like gas inlet opening at its lower end, and an upper section extending operatively upwardly from the upper end of the lower section, leading to a

gas outlet, the hollow body having a product inlet for feeding product into the lower section thereof;

an elongate tray formation which is positioned operatively beneath the gas inlet opening defined at the operative lower end of the lower section of the hollow body, the tray formation having a base platform spaced from the operative lower end of the lower section of the hollow body and side walls extending upwardly in an overlapping, preferably parallel, spaced configuration with respect to the walls defining the tapering lower section of the hollow body, to define slot-like passages along opposite sides of the tray formation through which gases can pass to enter the hollow body via the said gas inlet opening thereof;

a plenum chamber that surrounds at least partially the lower section of the hollow body and that defines a gas inlet connectable to a gas supply to permit a gas to enter the chamber and pass into the hollow body via the said slot-like passages and the said gas inlet opening; and

a particulate product discharge means for discharging particulate product from the hollow body.

In use, the slot-like passages defined between the side walls of the tray formation and the lower section of the hollow body will guide gases passing through the slot-like passages onto the base platform of the tray formation, deflecting these gases towards a central region disposed intermediate between opposite sides of the tray formation, where the gases will impinge and be directed operatively upwardly through the said gas inlet opening, into the hollow body. With particulate product contained within the lower section of the hollow body, the upwardly directed gases will flow through the particulate product, providing for the formation of a fluidized bed. The particulate product simultaneously will be lifted from the tray formation to a raised level above which the fluidized bed will be defined. The motion of the particles forming the

fluidized bed otherwise will be essentially conventional, following essentially a cyclic path within the fluidized bed, with spouting particles dropping back into the fluidized bed, as is commonly associated with a spouting fluidized bed apparatus.

The fluidized bed formed within the hollow body at a raised level above the tray formation, as above described, is specifically referred to by the Applicant as a virtual fluidized bed and, as such, the apparatus is generally referred to as "virtual bed apparatus". Any reference hereinafter to a virtual bed apparatus must accordingly be interpreted as a reference to an apparatus of the above defined type and which has the components and defines the configuration as above described.

It is envisaged also that a heat exchanger arrangement comprising at least one fluid conduit defining an elongate fluid flow path may be located in the tapering lower section of the hollow body of a virtual bed apparatus, through which conduit a heated medium can pass to transfer heat from the conduit to particulate product in the said lower section, in use of the apparatus, for enhancing drying of the particulate product. The fluid conduit forming the heat exchanger arrangement particularly has opposite ends thereof disposed externally of the hollow body, providing for the feed of a heated medium through the conduit, which will thus define a conduit section located in the lower section of the hollow body, where heat transfer to particulate product within the hollow body can take place. The said conduit section located within the lower section of the hollow body will define a configuration which maximises the exposed surface of the conduit to transfer heat, while not inhibiting the formation of a fluidized bed of particles in the lower section. A virtual bed apparatus as herein envisaged and which includes a heat exchanger as defined, shall hereinafter merely be referred to as "virtual bed apparatus including a heat exchanger arrangement".

According to the invention there is provided a process for producing a dry particulate product from a slurry with the use of a virtual bed apparatus that comprises

a hollow body that has a downwardly tapering lower section defining a longitudinal axis, a truncated V-shaped profile in cross section along the length thereof and an elongate slot-like gas inlet opening at its lower end, and an upper section extending operatively upwardly from the upper end of the lower section, leading to a gas outlet, the hollow body having a product inlet for feeding product into the lower section thereof;

an elongate tray that is positioned operatively beneath the gas inlet opening defined at the operative lower end of the lower section of the hollow body, the tray formation having a base platform spaced from the operative lower end of the lower section of the hollow body and side walls extending upwardly in an overlapping spaced configuration with respect to the walls defining the tapering lower section of the hollow body, to define slot-like passages along opposite sides of the tray formation through which gases can pass to enter the hollow body via the said gas inlet opening thereof;

a plenum chamber that surrounds at least partially the lower section of the hollow body and that defines a gas inlet connectable to a gas supply to permit a gas to enter the chamber and pass into the hollow body via the said slot-like passages and the said gas inlet opening of the hollow body; and

a particulate product discharge means for discharging particulate product from the hollow body,

which process includes the steps of:

displacing a gaseous medium at a controlled rate through the hollow body from the gas inlet opening to the gas outlet, providing for particulate product within the hollow body to form a virtual fluidized bed within the lower section of the hollow body above the tray formation of the apparatus;

feeding the slurry at a controlled rate into the lower section of the hollow body of the virtual bed apparatus and permitting the growth of particles in an "onion layer" fashion by drying slurry particles, fed into the hollow body and attaching to particles that form the virtual fluidized bed in the hollow body and that follow a cyclic path within the virtual fluidized bed, in layers while in motion within the hollow body and by the formation of new particles by drying slurry particles that do not attach to existing particles in the hollow body and permitting the growth of these particles in the same "onion layer" fashion; and

discharging dried particulate product particles from the hollow body at a controlled rate which is determined by the feed rate of slurry into the hollow body and the pressure drop of the gaseous medium through the virtual fluidized bed, which is representative of the average size of particles discharged.

The process of the invention may provide for the gaseous medium displaced through the hollow body to be high temperature steam and the high temperature steam may hence provide for the said growth of particles in an "onion layer" fashion.

The high temperature steam displaced through the hollow body may follow a closed cycle path and, as such, the process may include re-heating the steam within a heat exchanger located in line with the closed cycle path.

The process also may include bleeding-off vaporised moisture generated during the particulate product forming process in the virtual bed apparatus and condensing the moisture. Still further, the process may include separating a portion of the steam, having exited from the hollow body via the gas outlet thereof and which contains fine particle materials, from the closed cycle path, discharging the said portion of steam to a venturi scrubber for condensing the major portion of the steam separated and treating remaining non-condensible gas and water before venting to the atmosphere. The process particularly may provide for treating of the said remaining non-condensible

gas and water by either one of a thermal treatment process and a chemical scrubbing process.

Instead of the gaseous medium displaced through the hollow body being high temperature steam, the process of the invention may provide for the virtual bed apparatus to include a heat exchanger arrangement comprising at least one fluid conduit defining an elongate fluid flow path located in the tapering lower section of the hollow body and for the process to include feeding a heated medium through the conduit of the heat exchanger arrangement, with resulting heat transfer to the particulate product forming the fluidized bed of particles providing for the said growth of particles in an "onion-layer" fashion.

The process of the invention may result in fine particle materials separating from the fluidized bed to be suspended above the fluidized bed, by the gaseous medium passing through the hollow body, and the process accordingly may include elutriating the fine particle materials from the hollow body of the virtual bed apparatus with a dust collector-type apparatus which communicates with the upper section of the hollow body. The process of the invention may hence include mixing fine particle materials elutriated from the hollow body back into the slurry from which particulate product is being produced.

The process of the invention may include still further reducing the slurry, prior to being fed into the hollow body, to a coarse spray and then feeding the spray into the hollow body uniformly across the virtual fluidized bed formed in the hollow body.

The process of the invention still further may include separating oversized particulate product formed in and discharged from the hollow body of the virtual bed apparatus from products falling within a determined size range and breaking-up the oversized product into a fine particulate form suitable to serve as a substrate within the fluidized

bed apparatus for initially generating a virtual fluidized bed by displacing the gaseous medium through the hollow body.

The process of the invention clearly will be associated with the use of a virtual bed apparatus of the type herein envisaged and suitably adapted to accommodate the process steps as hereinabove defined.

Further features of this invention are described hereinafter, by way of examples, with reference to and as illustrated in the accompanying diagrammatic drawings. In the drawings:

Figure 1 illustrates schematically in end view a segment of the hollow body of a virtual bed apparatus for use in the process for producing particulate products, in accordance with the invention;

Figure 2 illustrates in block diagram form a first example of a process for producing particulate products, in accordance with the invention;

Figure 3 illustrates in block diagram form a second example of a process for producing particulate products, in accordance with the invention;

Figure 4 illustrates in block diagram form a third example of a process for producing particulate products, in accordance with the invention;

Figure 5 shows in side view a feed apparatus for feeding a slurry into the hollow body of the virtual bed apparatus of Figure 1;

Figure 6 shows a cross-sectional side view of the feed apparatus of Figure 5; and

Figure 7 illustrates in end view the blade configuration of the feed apparatus of Figure 5.

Referring initially to Figure 1 of the drawings, a segment of the hollow body of a virtual bed apparatus for use in the process of producing a particulate product, in accordance with the invention, is designated generally by the reference numeral 10. The hollow body defines a downwardly tapering lower section 12 that defines a longitudinal axis and a truncated V-shaped profile in cross section along the length thereof. The lower section 12 thus terminates in an elongate slot-like gas inlet opening 14. The hollow body further has an upper section 16 extending operatively upwardly from the lower section 12, the upper section leading to a gas outlet (not shown). The upper section 16 also defines a particulate product inlet through which particulate product can be fed into the hollow body, in the manner described in more detail hereafter.

Operatively beneath the gas inlet opening 14 defined by the lower section 12 of the hollow body of the virtual bed apparatus, there is provided an elongate tray formation 18, the tray formation 18 having a base platform 20, disposed operatively beneath the opening 14, and side walls 22 extending from the base platform 20 in a parallel, spaced, overlapping relationship with respect to the operative bottom segments of the walls 24 that define the lower section 12 of the hollow body. Passages 30 for gases are thus defined between the respective walls 24 and their adjacent side walls 22 of the tray formation 18, which gases can then enter the hollow body via the gas inlet opening 14, as described in more detail hereafter.

The lower section 12 of the hollow body is surrounded by a plenum chamber 26 which is defined by walls 28, the plenum chamber having a gas inlet through which gases can be fed into the chamber to pass from the chamber via the passages 30 into the hollow body of the virtual bed apparatus.

The apparatus also includes a particulate product discharge means for discharging particulate product from the hollow body, this discharge means not being illustrated in the drawings. The discharge means is essentially conventional, being equivalent to the discharge means that is commonly associated with spouting fluidized bed apparatus, which is already well known. The discharge means accordingly may comprise an overflow weir, or suitable feed pipes, that can feed particulate product from the hollow body to a required destination where further processing, or the like, can occur.

In use, and as is described in more detail hereinafter with reference to examples of the process of the invention, particulate product will be contained in the lower section 12 of the hollow body 10, the particles forming the particulate product thus resting on the tray formation 12. As such, by displacing a gaseous medium into the plenum chamber 26 and from the chamber via the passages 30 into the space beneath the inlet opening 14, the gases so entering the space will be deflected along the base platform 20 of the tray formation 18 towards the central region intermediate between the opposite sides of the base platform, where the gases will impinge on one another and be directed operatively upwardly to pass through the bed of particulate product contained above the base platform 20. By increasing the flow rate of the gaseous medium into the hollow body 12, a fluidized bed of particles will be generated in a conventional manner, further increasing of the flow rate simultaneously providing for the entire body of particles to be lifted from the base platform, thus forming a virtual fluidized bed 32. The gases will follow a circulating path within the space 34 beneath the virtual fluidized bed 32, to generate the configuration of the fluidized bed of particles as shown. The passage of the gaseous medium through to bed of particles will also cause spouting of particles, particularly in the central region of the bed. Such particles will drop back into the bed in a location towards the outer sides of the bed, the arrows illustrated in the drawing illustrating both the direction of gas flow through the fluidized bed, as well as the direction of particle movement which, in combination, will provide for an extremely effective fluidized bed operation for drying particles within

the apparatus, as is hereinafter described. The virtual bed apparatus as described with reference to Figure 1 accordingly comprises a virtual bed apparatus as herein envisaged.

The apparatus also may include a heat exchanger arrangement located in the lower section 12 of the hollow body 10, the heat exchanger arrangement comprising an elongate conduit through which a heated medium can pass. The conduit will define an extended flow path within the lower section 12 and particularly within the parameters identified by the dotted line 36, particularly in a configuration in which heat transfer through the conduit will provide for drying of particulate product within the lower section 12, while in a fluidized bed state. The configuration of the conduit clearly is such that the formation of the virtual fluidized bed is not unduly impeded, while an extended surface area for heat transfer is defined by the conduit to provide for effective heat transfer to particles within the fluidized bed, for drying thereof. The apparatus, when including the heat exchanger arrangement accordingly comprises a virtual bed apparatus including a heat exchanger arrangement, as herein envisaged.

Referring also to Figure 2 of the drawings, within a process of producing particulate products, in accordance with the invention, the virtual bed apparatus is identified by the reference numeral 50, whereas a flow line 52 provides for high temperature steam to pass through the apparatus 50 via the plenum chamber thereof, to form a fluidized bed of particles within the apparatus in the manner described above. The flow line 52 optionally has a combustion chamber 53 (shown in dotted lines) located in line therewith for providing high temperature steam at a required temperature to fulfil its purpose within the apparatus 50. A slurry feed 54 for feeding a slurry into the apparatus 50 also is provided, as well as a discharge arrangement 56 for discharging pelletized product from the apparatus 50. The flow line 52 for heated steam defines a closed path with steam having passed through the apparatus 50 being guided through a high efficiency dust collector such as a cyclone filter 58. A recycle fan 60 provides for the displacement of the steam, also via a heat exchanger 62 which

provides for steam to pass through the apparatus 50 at a desired temperature. The heat exchanger 62 communicates with a combustion and incineration apparatus 64 within which air is heated to an elevated temperature, by the combustion of a natural gas fuel, and which air then passes through the heat exchanger 62 for the heating of the steam that passes through the apparatus 50.

A scrubber 66 provides for the treatment of vaporized moisture which is bled-off from the high temperature steam flow line 52, the gas vented from the scrubber being incinerated in the combustion and incineration apparatus 64, as is clearly illustrated.

The process of the invention accordingly provides for the feed of a slurry at a controlled rate into the lower section of the hollow body of the virtual bed apparatus 50 within which a fluidized bed of the particulate material which is to be produced has already been generated by passing high temperature steam at a suitable rate through the apparatus 50. The slurry particularly is fed into the hollow body of the apparatus 50 in a coarse spray form, which is described in further detail hereafter. Through the displacement of the high temperature steam through the fluidized bed of particles, the growth of particles is permitted in an "onion layer" fashion by drying slurry particles, fed into the hollow body and attaching to particles forming the virtual fluidized bed in the hollow body and following a cyclic path within the virtual fluidized bed, in layers while in motion within the hollow body. Slurry particles not attaching to particles already in the fluidized bed will also be dried and will serve as a substrate on which further particles can grow in the manner envisaged above. The process thus provides not only for the growth of particles to a required size, but also for the creation of new particles that can grow to a required size.

Dried particles can then be discharged from the hollow body at a controlled rate, which is determined by the feed rate of slurry into the hollow body and the pressure drop of the high temperature steam through the virtual fluidized bed, which in practice will determine the average size of particles discharged.

The apparatus 50, together with the components and parts as described with reference to Figure 2, therefore provides for a continuous process for producing dry particulate products where the particulate products can be provided in suitable sizes in which they are ordinarily required.

It is envisaged in this regard that particulate products discharged from the apparatus 50 can be screened for separating oversized particles and these can then be broken up in a pellet granulator, or the like, for effectively reducing the size of these particles, which can then be returned to the slurry, or which can then form a substrate within the apparatus 50 with which the formation of a virtual fluidized bed within the apparatus 50 can be initiated, before initiating the actual process by feeding slurry into the apparatus 50.

Referring to Figure 3 of the drawings, a second example of a process for producing particulate products provides for the use of a virtual bed apparatus 70 which includes a heat exchanger arrangement 72 in the lower section of the hollow body thereof. Within this process, instead of utilizing high temperature steam for forming the virtual fluidized bed within the apparatus and for drying particulate product within the apparatus, any suitable gaseous medium such as air can be recycled through the apparatus 70 for forming the virtual fluidized bed, the medium following a flow line 74, once again via a high efficiency dust collector 76 and with the aid of a recycle fan 78. A scrubber 80 can serve a purpose similar to that of the scrubber 66. Material discharged from the scrubber 80 can then be displaced by a fan 82 to a thermal or chemical treatment apparatus before being vented to the atmosphere.

Still further, the process provides for a heating medium to be displaced through the heat exchanger arrangement 72, which can then provide for the necessary heat transfer to particles within the apparatus 70 in order to provide for the growth and drying of particles within the apparatus 70, essentially in the same manner as before.

Referring to Figure 4 of the drawings, a third example of a process for producing particulate products is illustrated, the process being essentially the equivalent of the processes described with reference to Figures 2 and 3 of the drawings, with the virtual bed apparatus utilised not including a heat exchanger arrangement. This virtual bed apparatus 90 communicates with a closed high temperature steam flow line 92, the steam passing through a heat exchanger 94 for raising the temperature thereof to a desired level prior to being introduced into the apparatus 90. The heat exchanger 94 communicates with a fluidized bed combustion and incineration apparatus 96 which is fueled with a solid waste fuel, whereas a heat exchanger and scrubber combination 98 provides for the treatment of heated air having passed through the heat exchanger 94, in order to permit the venting thereof to the atmosphere. In relation to the formation of particulate product within the apparatus 90 and the growth and drying thereof, the process associated with Figure 4 is essentially equivalent to that of the earlier described process and, as such, is not again described.

Referring particularly to Figures 5 to 7 of the drawings, a slurry feed arrangement for feeding slurry into the virtual bed apparatus utilized in conjunction with a process, in accordance with the invention, is designed generally by the reference numeral 100. The feed arrangement 100 comprises a body 102 within which a blade arrangement 104 is located. The body has a slurry inlet 108 and a slurry outlet 110, the outlet being connected in communication with the operative top end of the hollow body of the virtual bed apparatus used in conjunction with the processes above described. The shearing action performed by the blades of the blade arrangement, during rotation thereof, on slurry material entering the body 102 via the inlet opening 108 will provide for the slurry to form a relatively coarse spray that will drop into the hollow body and onto the fluidized bed of particles already generated within the virtual bed apparatus. This spray will provide for a uniform distribution of the slurry across the entire virtual fluidized bed. Clearly, the growing process of particles and also the formation of new particles to be grown into larger particles will be enhanced thereby.

It must be appreciated that the processes for producing particulate products, as described above, may be utilized in combination with many applications where a slurry material is to be converted into a particulate product, for example, for producing a compact particle fertilizer product from a slurry in the form of a wet organically enriched inorganic fertilizer mix. The Applicants believe that the production processes as above defined and described and which utilize a virtual bed apparatus are extremely efficient and cost effective, particularly when compared with known processes that provide for slurry-type materials to be formed into particulate products, i.e. by utilizing conventional pelletizing apparatus.

CLAIMS

1. A process for producing a dry particulate product from a slurry with the use of a virtual bed apparatus that comprises

a hollow body that has a downwardly tapering lower section defining a longitudinal axis, a truncated V-shaped profile in cross section along the length thereof and an elongate slot-like gas inlet opening at its lower end, and an upper section extending operatively upwardly from the upper end of the lower section, leading to a gas outlet, the hollow body having a product inlet for feeding product into the lower section thereof;

an elongate tray formation which is positioned operatively beneath the gas inlet opening defined at the operative lower end of the lower section of the hollow body, the tray formation having a base platform spaced from the operative lower end of the lower section of the hollow body and side walls extending upwardly in an overlapping, spaced configuration with respect to the walls defining the tapering lower section of the hollow body, to define slot-like passages along opposite sides of the tray formation through which gases can pass to enter the hollow body via the said gas inlet opening thereof;

a plenum chamber that surrounds at least partially the lower section of the hollow body and that defines a gas inlet connectable to a gas supply to permit a gas to enter the chamber and pass into the hollow body via the said slot-like passages and the said gas inlet opening of the hollow body; and

a particulate product discharge means for discharging particulate product from the hollow body,

which process includes the steps of:

displacing a gaseous medium at a controlled rate through the hollow body from the gas inlet opening to the gas outlet, providing for particulate product within the hollow body to form a virtual fluidized bed within the lower section of the hollow body above the tray formation of the apparatus;

feeding the slurry at a controlled rate into the lower section of the hollow body of the virtual bed apparatus and permitting the growth of particles in an "onion layer" fashion by drying slurry particles, fed into the hollow body and attaching to particles that form the virtual fluidized bed in the hollow body and that follow a cyclic path within the virtual fluidized bed, in layers while in motion within the hollow body and by the formation of new particles by drying slurry particles that do not attach to existing particles in the hollow body and permitting the growth of these particles in the same "onion layer" fashion; and

discharging dried particulate product particles from the hollow body at a controlled rate which is determined by the feed rate of slurry into the hollow body and the pressure drop of the gaseous medium through the virtual fluidized bed, which is representative of the average size of particles discharged.

2. A process as claimed in Claim 1, in which the gaseous medium displaced through the hollow body is high temperature steam and the high temperature steam provides for the said growth of particles in an "onion layer" fashion.

3. A process as claimed in Claim 2, in which the high temperature steam displaced through the hollow body follows a closed cycle path and in which the process includes re-heating the steam within a heat exchanger located in line with the closed cycle path.

4. A process as claimed in Claim 3, which includes bleeding-off vaporised moisture generated during the particulate product forming process in the virtual bed apparatus and condensing the moisture.

5. A process as claimed in Claim 3 or Claim 4, which includes separating a portion of the steam, having exited from the hollow body via the gas outlet thereof and which contains fine particle materials, from the closed cycle path, discharging the said portion of steam to a venturi scrubber for condensing the major portion of the steam separated and treating remaining non-condensible gas and water before venting to the atmosphere.

6. A process as claimed in Claim 5, which includes treating the said remaining non-condensible gas and water by either one of a thermal treatment process and a chemical scrubbing process.

7. A process as claimed in Claim 1, in which the virtual bed apparatus includes a heat exchanger arrangement comprising at least one fluid conduit defining an elongate fluid flow path located in the tapering lower section of the hollow body and which process includes feeding a heated medium through the conduit of the heat exchanger arrangement, with resulting heat transfer to the particulate product forming the fluidized bed of particles providing for the said growth of particles in an "onion layer" fashion.

8. A process as claimed in any one of the preceding claims, in which fine particle materials separate from the fluidized bed to be suspended above the fluidized bed and in which the process includes elutriating the fine particle materials from the hollow body of the virtual bed apparatus with a dust collector-type apparatus which communicates with the upper section of the hollow body.

9. A process as claimed in Claim 8, which includes mixing fine particle materials elutriated from the hollow body back into the slurry from which particulate product is being produced.

10. A process as claimed in any one of the preceding claims, which includes reducing the slurry, prior to being fed into the hollow body, to a coarse spray and feeding the spray into the hollow body uniformly across the virtual fluidized bed formed in the hollow body.

11. A process as claimed in any one of the preceding claims, which includes separating oversized particulate product formed in and discharged from the hollow body of the virtual bed apparatus from product falling within a determined size range and breaking-up the oversized product into a fine particulate form suitable to serve as a substrate within the fluidized bed apparatus for initially generating a virtual fluidized bed by displacing the gaseous medium through the hollow body.

12. A process as claimed in any one of Claims 1 to 11, in the slurry is a wet, organically enriched inorganic fertilizer mix and the product produced is a compact particle fertilizer.

13. A process for producing a dried particulate product from a slurry with the use of a virtual bed apparatus substantially as described in the specification with reference to and as illustrated in the accompanying drawings.

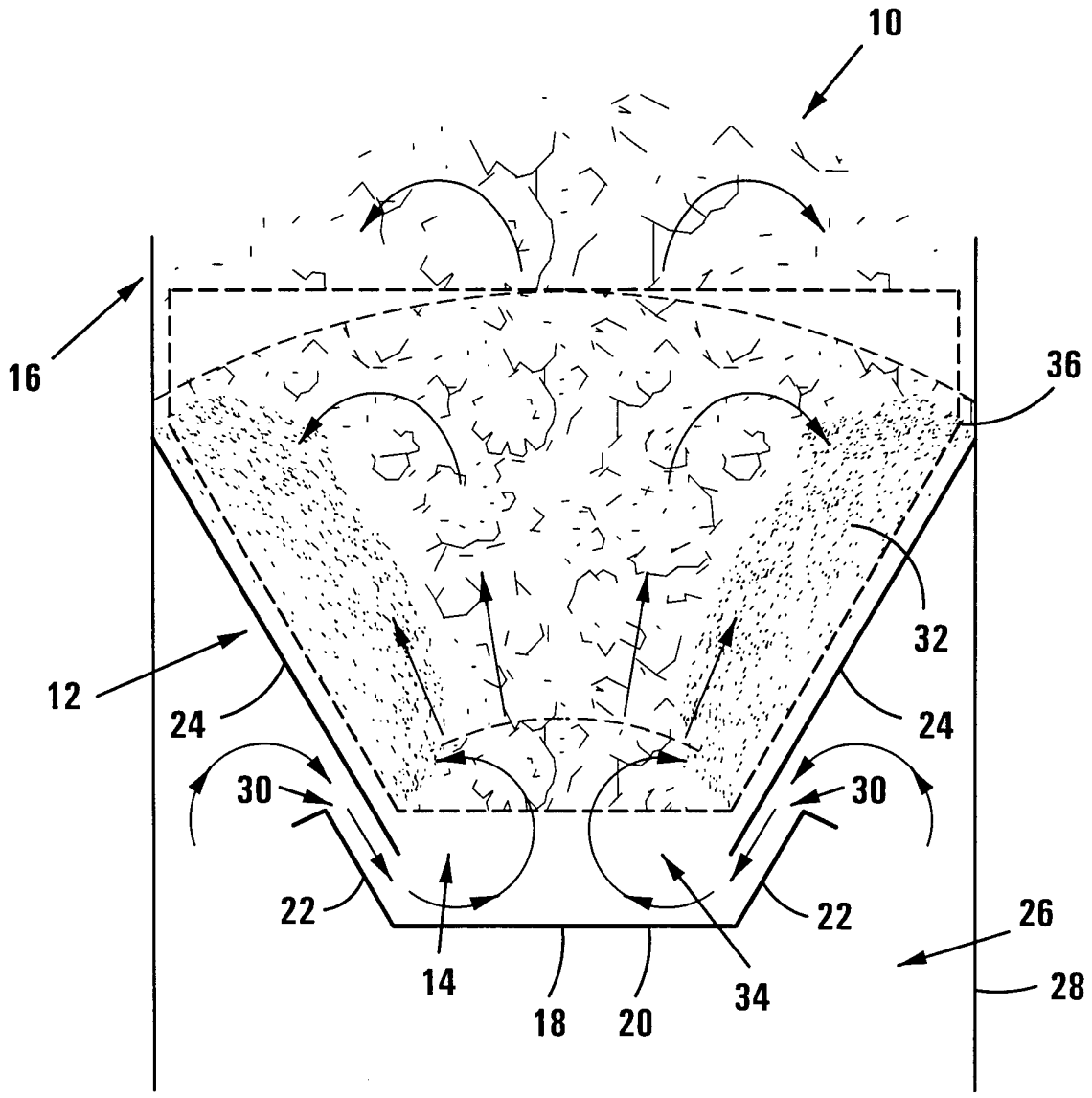

FIG 1

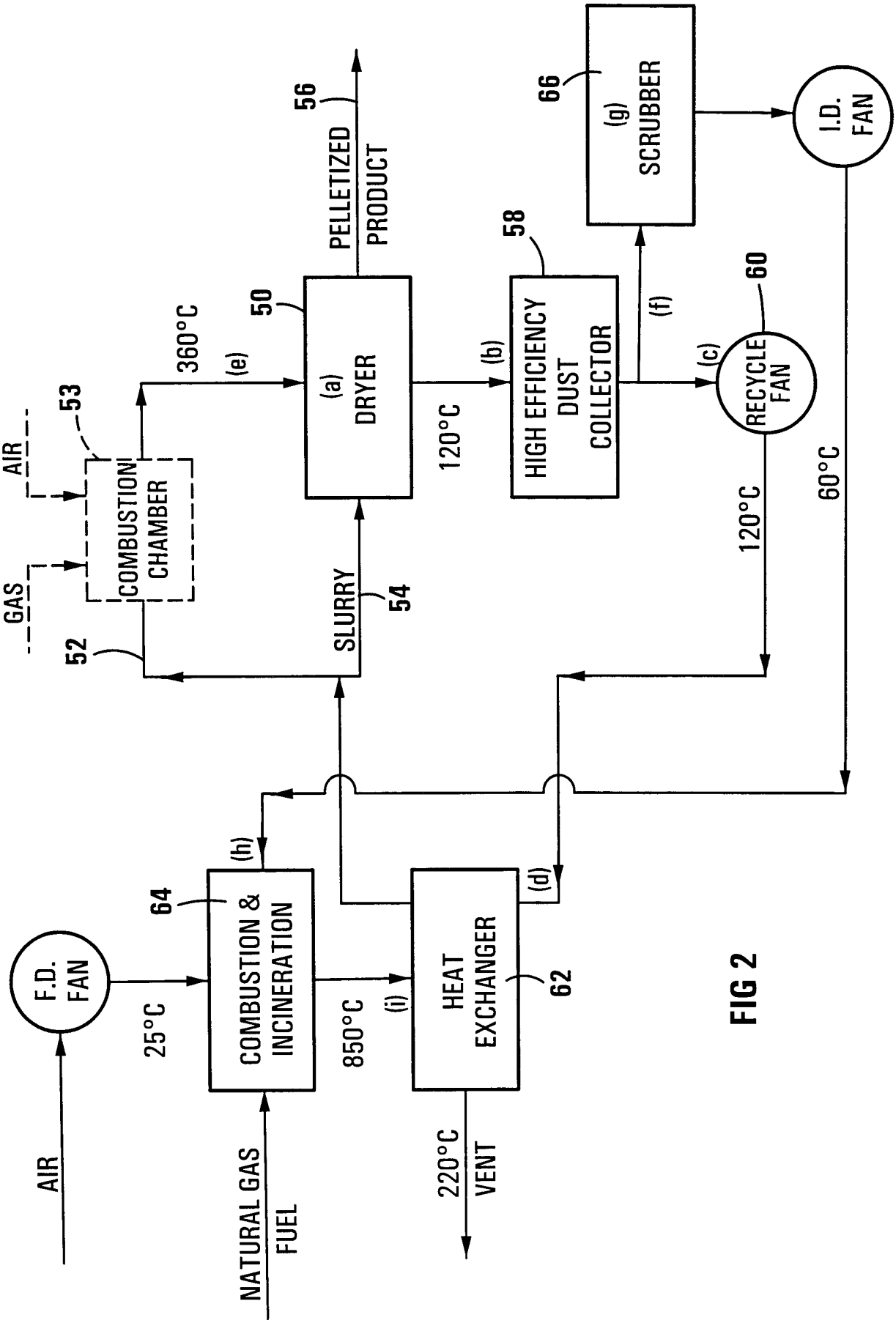
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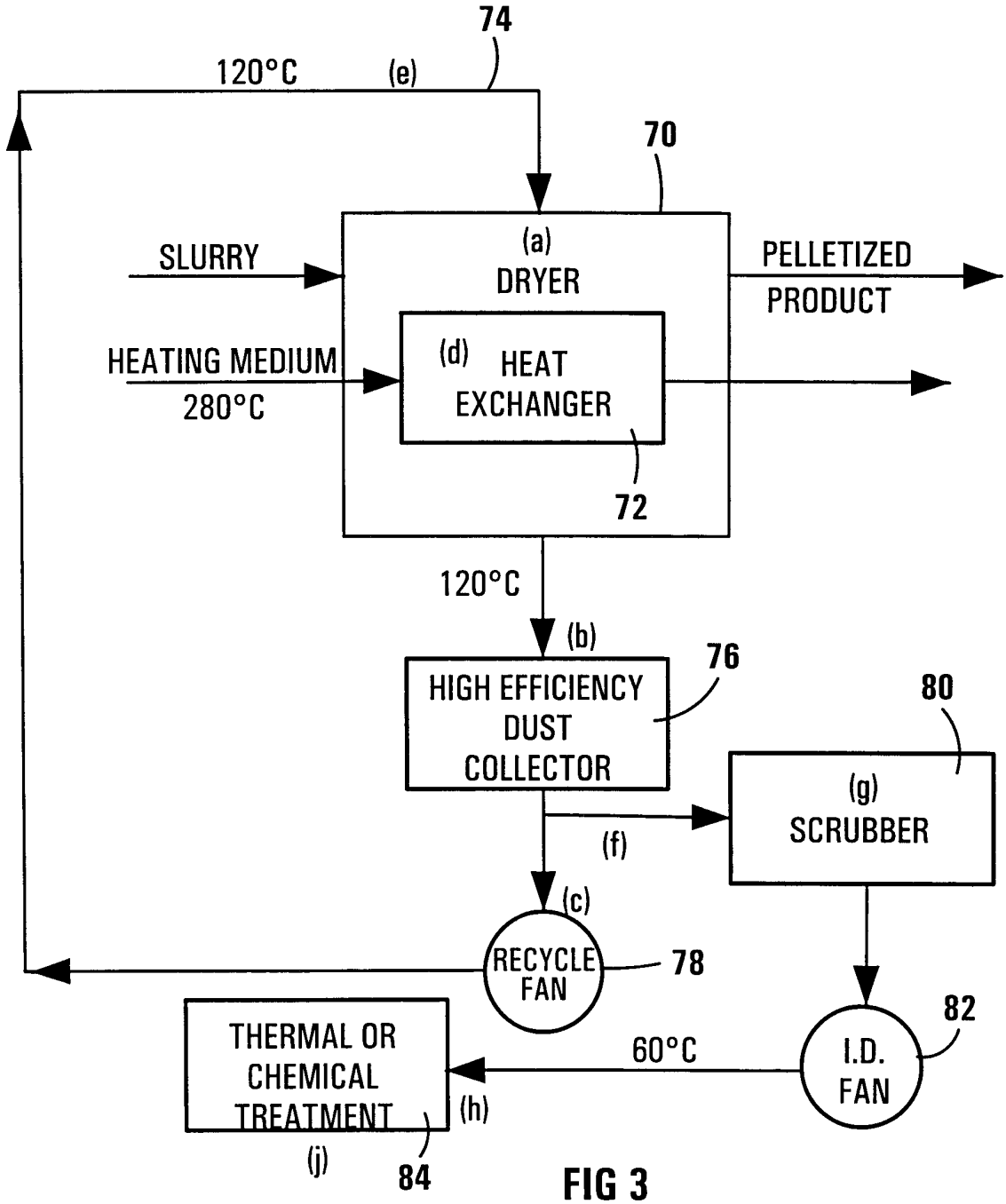
FIG 2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(h)
(j)
84

FIG 3

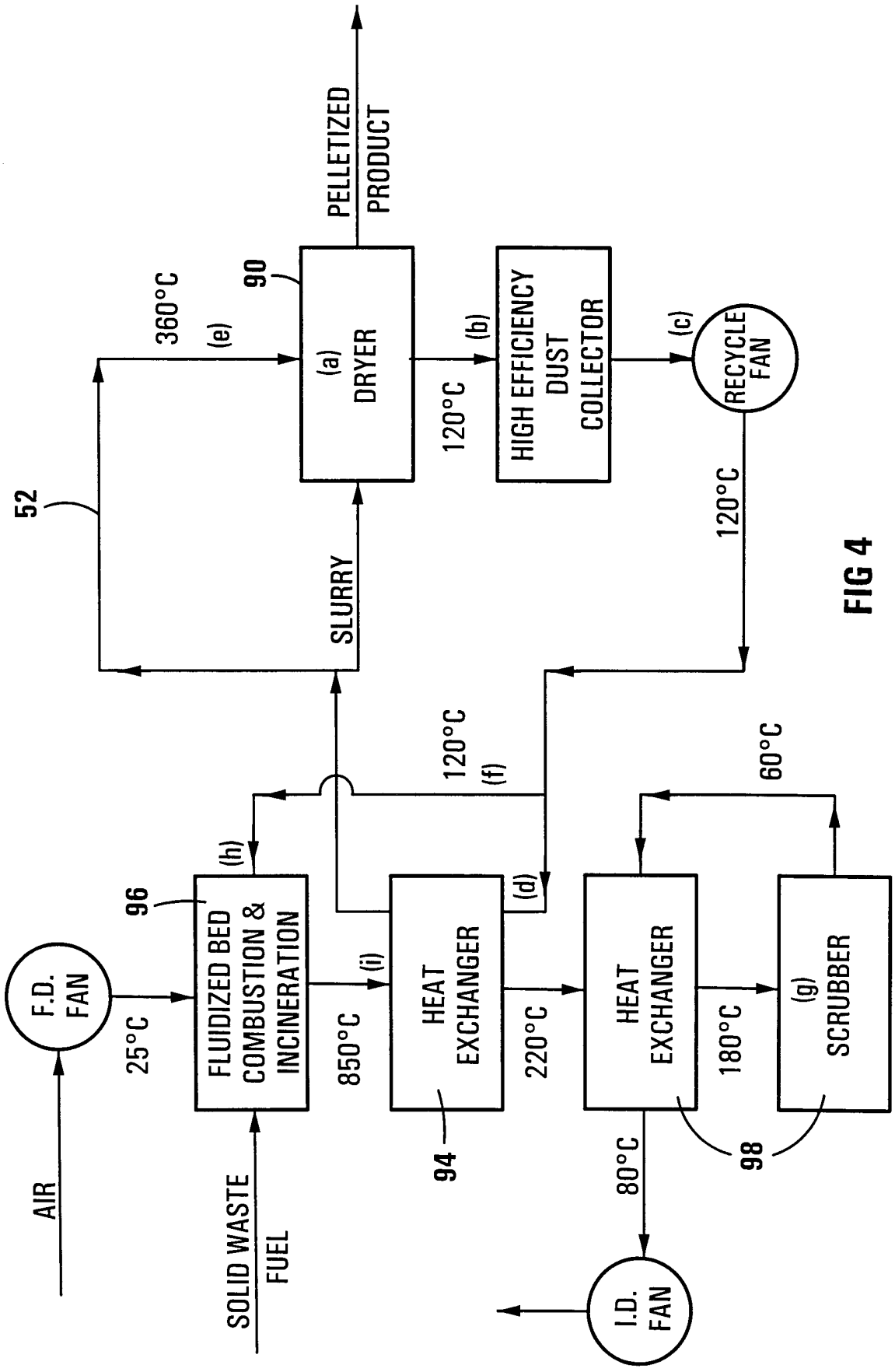
PELLETIZED PRODUCT
90
360°C
(e)
(a) DRYER
120°C
(b)
HIGH EFFICIENCY DUST COLLECTOR
(c)
RECYCLE FAN
52
SLURRY
120°C
120°C
(f)
60°C
(h)
96
(d)
F.D. FAN
25°C
FLUIDIZED BED COMBUSTION & INCINERATION
850°C
(i)
HEAT EXCHANGER
220°C
HEAT EXCHANGER
180°C
(g) SCRUBBER
AIR
SOLID WASTE FUEL
94
98
80°C
I.D. FAN

FIG 4

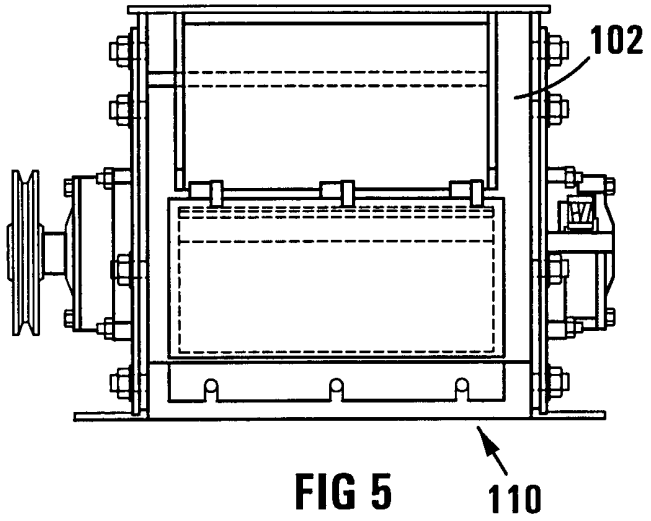

FIG 5

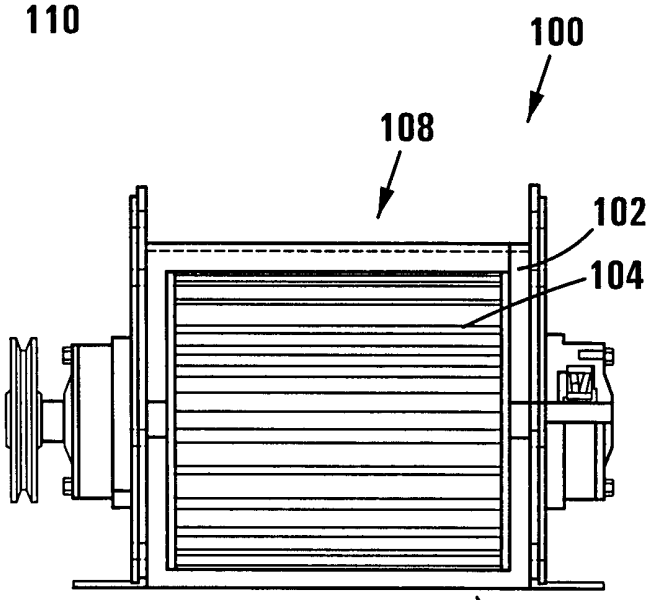

FIG 6

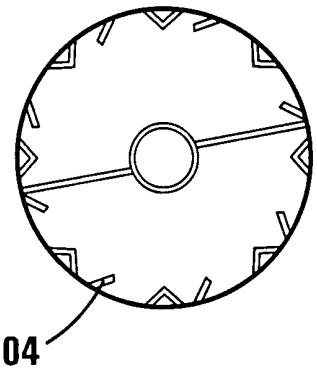

FIG 7

INTERNATIONAL SEARCH REPORT

Intern ıal Application No
PCT/IB 01/00345

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F26B3/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F26B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1 014 205 A (BASF AG) 22 December 1965 (1965-12-22) the whole document ---	1,8
A	US 4 115 929 A (MORGAN PETER A ET AL) 26 September 1978 (1978-09-26) the whole document ---	1
A	EP 0 894 526 A (GEN KINEMATICS CORP) 3 February 1999 (1999-02-03) the whole document ---	1
A	GB 1 022 070 A (NI SKY I MONOMEROV DLIA SINT K) 9 March 1966 (1966-03-09) the whole document --- -/--	1,10,11

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 July 2001	03/08/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Silvis, H

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INTERNATIONAL SEARCH REPORT

Intern ıal Application No
PCT/IB 01/00345

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	DE 34 00 397 A (THAELMANN SCHWERMASCHBAU VEB) 22 November 1984 (1984-11-22) the whole document	1,7
A	EP 0 537 637 A (TSUKISHIMA KIKAI CO) 21 April 1993 (1993-04-21) the whole document	2-6,8,9
A	EP 0 203 059 A (WAAGNER BIRO AG) 26 November 1986 (1986-11-26) the whole document	2-5,7,8
A	EP 0 595 378 A (METALLGESELLSCHAFT AG) 4 May 1994 (1994-05-04) the whole document	10
A	US 4 949 735 A (CLIFT ROLAND ET AL) 21 August 1990 (1990-08-21)	
A	US 4 910 880 A (COLE KEITH) 27 March 1990 (1990-03-27)	

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern ial Application No
PCT/IB 01/00345

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 1014205 A	22-12-1965	BE 648601 A	30-11-1964
		DE 1208736 B	
US 4115929 A	26-09-1978	NONE	
EP 0894526 A	03-02-1999	US 6241951 B	05-06-2001
		BR 9706458 A	08-06-1999
		JP 11057453 A	02-03-1999
GB 1022070 A	09-03-1966	DE 1250787 B	
DE 3400397 A	22-11-1984	DD 217004 A	02-01-1985
		AT 384349 B	27-10-1987
		AT 5384 A	15-04-1987
		DK 73384 A,B,	19-11-1984
EP 0537637 A	21-04-1993	JP 5104098 A	27-04-1993
		AT 132613 T	15-01-1996
		DE 69207332 D	15-02-1996
		DE 69207332 T	30-05-1996
		ES 2083050 T	01-04-1996
		US 5283959 A	08-02-1994
EP 0203059 A	26-11-1986	AT 386071 B	27-06-1988
		AT 153885 A	15-11-1987
		DE 3665628 D	19-10-1989
EP 0595378 A	04-05-1994	DE 4232110 A	31-03-1994
		AU 661197 B	13-07-1995
		AU 4754693 A	31-03-1994
		CA 2101368 A	26-03-1994
		DE 59304537 D	02-01-1997
		ES 2094467 T	16-01-1997
		GR 3021754 T	28-02-1997
		US 5325607 A	05-07-1994
US 4949735 A	21-08-1990	AU 563778 B	23-07-1987
		AU 5158485 A	31-07-1986
		BE 904049 A	02-05-1986
		BR 8600129 A	23-09-1986
		CA 1240899 A	23-08-1988
		CH 668198 A	15-12-1988
		CN 86100029 A,B	23-07-1986
		DE 3600831 A	31-07-1986
		DK 36486 A	26-07-1986
		ES 551144 D	16-04-1987
		ES 8704842 A	01-07-1987
		FI 860254 A,B,	26-07-1986
		FR 2576522 A	01-08-1986
		GB 2170305 A,B	30-07-1986
		IT 1188236 B	07-01-1988
		JP 61178034 A	09-08-1986
		NL 8600012 A	18-08-1986
		TR 23581 A	06-04-1990
		ZA 8600078 A	27-08-1986
US 4910880 A	27-03-1990	NONE	