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(71) Applicant: **Nilsson, Ulf**
5700 Zell am See (AT)

(72) Inventor: **Nilsson, Ulf**
5700 Zell am See (AT)

(74) Representative: **Lind, Urban Arvid Oskar**
AWAPATENT AB
P.O. Box 11394
404 28 Göteborg (SE)

(54) Storage silo for storing a reclaimed fine graded filler material

(57) The present invention relates to a storage silo (200) for storing a reclaimed fine graded filler material (107) used in an asphalt plant (100), said storage silo (200) having an inlet (202) for receiving the reclaimed fine graded filler material (107) and an outlet (205) for outputting the reclaimed fine graded filler material (107) out of the storage silo (200), said storage silo (200) comprising a hollow storage body (204) adapted to receive a portion of the reclaimed fine graded filler material (107) received by the storage silo (200), characterized by an essentially vertical channel structure (203) arranged in the vicinity of the storage body (204), said channel structure (203) being adapted to provide a direct passage between the inlet (202) and the outlet (205) of the storage silo (200) and adapted to receive a portion of the reclaimed fine graded filler material (107) received by the storage silo (200), wherein the storage silo (200) is adapted such that, in use, the reclaimed fine graded filler material (107) being outputted through the outlet (205) of the storage silo (200) consists of reclaimed fine graded filler material (107) from the storage body (204) and the channel structure (203).

Furthermore, the present invention also relates to a method for producing asphalt products (113) comprising a silo (200) as described above.

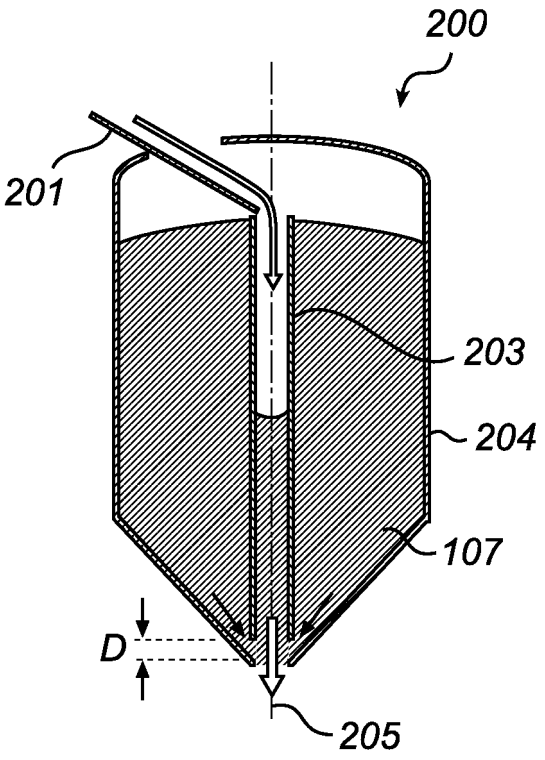

Fig. 2c

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Description

Technical field

[0001] The present invention relates to a storage silo for storing a reclaimed fine graded filler material. The present invention also relates to a method for producing an asphalt product in an asphalt plant.

Technical background

[0002] Typically, the production of asphalt products, such as hot mix asphalt for asphalt paving, requires various ingredients, including mineral fill or fines to obtain the desired physical characteristics. Plants for producing the asphalt products generally utilize a rotary drum dryer wherein a hot gas stream is directed through the drum dryer to dry and heat materials. As the hot gas stream interacts with the materials in the drum, particulate matter, generally referred to as filler material, becomes entrained in the hot gas stream and is exhausted from the drum along with the hot gases from the hot gas stream.

[0003] The filler material, generally exceeding a temperature of 80 to 120 degrees Celsius, is often removed in two steps from the exhausted hot gases by passing the hot gases through a cyclone separator (in a first step, thereby producing a coarse graded filler material) and there after through a filter media (in a second step, thereby producing a fine graded filler material). The coarse graded filler will be transported back to the mainstream of material coming out of the drying drum, and the fine graded filler material being separated over the filter media will be reclaimed and stored for later use.

[0004] Unfortunately, the rate at which the filler material is separated from the hot gases may vary or differ from the rate that filler material is needed for the particular design mix concurrently being produced by the asphalt plant. Therefore, a relatively large buffer arrangement for buffering the filler material, such as a relatively large storage silo, is needed.

[0005] Such a buffering arrangement and the use of such a buffering arrangement in an asphalt plant is disclosed in US 5 820 257. The buffering arrangement provides a temporary storage, wherein filler material being removed at a greater rate than needed for filler material in concurrently produced asphalt products can be temporarily accumulated for subsequent use, and where temporarily stored filler material can be used to satisfy a deficiency wherein filler material needed for producing asphalt products is greater than the quantity of filler material being concurrently provided by the asphalt plant producing the asphalt products.

[0006] However, the disclosed buffering arrangement is not adapted to take care of the energy losses that are introduced due to the fact that the hot filler material is cooling down in the buffering arrangement. This is especially apparent when the rate at which the filler material is generated is higher than the rate at which the filler material is needed.

[0007] There is therefore a need for an improved storage silo for storing a filler material, substantially overcoming at least some of the disadvantages of the prior art, and more specifically that overcome or at least alleviate the problem with energy loss due to the temporary storage of hot filler material in a storage silo.

Summary of the invention

[0008] The above object is met by a storage silo for storing a reclaimed fine graded filler material as defined in claim 1 below, and a method for producing asphalt products in an asphalt plant as defined in claim 9. The appended sub-claims define advantageous embodiments in accordance with the present invention.

[0009] According to an aspect of the invention, there is provided a storage silo for storing a reclaimed fine graded filler material used in an asphalt plant, the storage silo having an inlet for receiving the reclaimed fine graded filler material and an outlet for outputting the reclaimed fine graded filler material out of the storage silo, the storage silo comprising a hollow storage body adapted to receive a portion of the reclaimed fine graded filler material received by the storage silo An essentially vertical channel structure is furthermore arranged in the vicinity of the storage body, the channel structure being adapted to provide a direct passage between the inlet and the outlet of the storage silo, and adapted to receive a portion of the reclaimed fine graded filler material received by the storage silo, wherein the storage silo is adapted such that, in use, the reclaimed fine graded filler material being outputted through the outlet of the storage silo consist of reclaimed fine graded filler material from the storage body and the channel structure.

[0010] The term "reclaimed fine graded filler material" is understood to mean, in the context of this application, the filler material produced through the separation process by a filter media by heating a stone aggregate in a rotary drum dryer in an asphalt plant.

[0011] A storage silo arranged in the above-described manner fulfills at least some of the intended objects. Reclaimed fine graded filler material provided to the storage silo may be transported from the inlet to the outlet, via the channel structure, without being stored in the storage body. Hence, the reclaimed fine graded filler material may not have to be subject to any substantial heat loss before it is re-transferred to the asphalt production process, and will therefore not need to be re-heated to the same extent as reclaimed fine graded filler material that has been stored in a silo according to prior art. Preferably, with an adequate throughput of filler material and an adequate distribution of filler material between the storage body and the channel structure, the filler material may not need to be re-heated at all. This is advantageous both in terms of cost and in terms of quality of the asphalt being produced.

[0012] Preferably, the storage silo is arranged essen-

tially vertical, however, the person skilled in the art realizes that other constructions are possible, such as for example and storage container that has been arranged in a horizontal position.

[0013] Furthermore, since at least a major part of the reclaimed fine graded filler material may be re-transferred to the process without being stored in the storage body of the silo, it is possible to re-transfer filler material with substantially the same composition as the material already being used in the process. This gives better control of the composition of the asphalt being produced, and a better possibility to control the quality of the produced asphalt.

[0014] Even further, the above described arrangement of a storage silo is, due to the combination of storage body and vertical channel structure, capable of handling large fluctuations in the amount of filler material being transferred into and out of the silo. If, for example, more filler material is being provided through the inlet than is desired to feed out through the outlet, the surplus may be stored in the storage body. On the other hand, if less filler material is being fed into the silo than is desired to feed out, filler material from the storage body may be fed out in combination with the directly re-transferred filler material to provide the desired amount of filler material from the silo to the process.

[0015] The filler material as being referred to in this application is intended to include filler material such as mineral fill dust or fines.

[0016] The silo may have a substantially circular cross-section, however, it would be possible to use a different form, such as a square cross-section. Furthermore, it may be advantageous if a radius of the hollow storage body is essentially larger than a radius of the vertical channel structure.

[0017] Advantageously, the channel structure is arranged inside of the storage body. When the channel structure is arranged inside the storage body, it may be positioned either centrally in the storage silo or at any side of the storage body. However, it is also possible to arrange the channel structure outside, but in the vicinity, of the storage body. The flexibility in how to arrange the channel structure in relation to the storage body of the silo simplifies retro-fitting of or upgrading conventional silos in accordance with the present invention.

[0018] Preferably, the storage silo further comprises means for adjusting a composition of filler material being outputted through the outlet of the storage silo.

[0019] This is advantageous in order to control the composition of the material being used in the process for producing asphalt, and hence to control the composition and quality of the produced asphalt. It is also advantageous in order to handle different ratios of incoming and outgoing filler material to and from the silo. As described above, if a surplus of filler material is inputted to the silo, the surplus may be stored in the storage body. This stored filler material may then be re-transferred to the process later. By means for adjusting the composition of filler material being outputted, it is possible to alter the amount of stored filler material being fed into the process. This is useful in order to handle a situation where it is desired to output a larger quantity of filler material than is being fed into the silo.

[0020] In one embodiment of the present invention, the storage silo further comprises means for adjusting the vertical position of the channel structure, such that the composition of filler material is adjusted.

[0021] Preferably, the hollow storage body according to this embodiment has a lower tapered end. The inlet of the storage silo is then preferably positioned in the upper region of the silo, and the outlet is positioned at the lower tapered, or conical, end of the silo. Furthermore, according to this embodiment the hollow storage body and the channel structure are essentially circular and the channel structure is preferably arranged substantially centrally inside the storage body of the silo. By adjusting the height of the bottom end of the channel structure arranged inside the silo, the amount of filler material that is transferred from the storage body surrounding the channel structure to the outlet is adjusted. Hence, it becomes possible to adjust the composition of filler material being fed out through the outlet of the silo. This possibility is advantageous both for handling fluctuations of filler material being fed into the silo and also for obtaining the desired characteristics of the asphalt being produced.

[0022] The capacity of the channel structure may be set such that it relates to the capacity of the rotary drum dryer and the time period for the mixing cycle for the asphalt plant or the hot storage capacity of aggregate in the asphalt plant. In one embodiment, the storage capacity of the channel structure is arranged to be less than a 1/5 of a total storage capacity of the storage silo. The channel structure is not intended to be used as a storage area and, hence, it does not need to have a large volume. In fact, a large volume may even be a disadvantage. Filler material may then be gathered in the channel structure, resulting in heat loss before the filler material is re-transferred to the process, and that the desired filler material, i.e. filler material with the same composition as the material being processed, does not become re-transferred to the process. It may of course be specific situations where a large volume channel structure is beneficial. This may for instance be in situations where a large throughput of filler material through the silo is anticipated.

[0023] It may be beneficial to use a storage silo as described above in an arrangement for producing asphalt.

[0024] Furthermore, it may also be beneficial, in an asphalt plant for producing asphalt products wherein a rotary drum thereof generates filler material that is reusable for producing the asphalt products, that the asphalt plant further comprises a storage silo as described above, wherein said storage silo is adapted to receive the filler material generated by the rotary drum, and adapted to dispense the filler material as needed for producing the asphalt product.

[0025] By utilizing a storage silo as described above in an asphalt plant, it will be possible to gain the benefits of reduced need for re-heating of stored reclaimed fine graded filler material and also the benefits of using reclaimed fine graded filler material with the same composition as the stone aggregate being processed. The asphalt produced in the plant will therefore have a desired composition at a lower cost than with conventional prior art silos in asphalt plants.

[0026] According to another aspect of the invention, there is provided a method for producing asphalt products in an asphalt plant, comprising the steps of generating a reclaimed fine graded filler material by means of a rotary drum, transferring the reclaimed fine graded filler material to a storage silo, wherein the temperature of the reclaimed fine graded filler material has a first temperature when entering the storage silo, and direct re-transferring of the reclaimed fine graded filler material from the storage silo to the asphalt plant, such that re-transferred reclaimed fine graded filler material has a second temperature when leaving the storage silo, wherein a difference between the first and the second temperature is less than 10 degrees Celsius.

[0027] Preferably, for accomplishing such a re-transferring of the filler material, a storage silo as described above may be used. As described above in relation to the first aspect of the present invention, this provides for the possibility to, having an adequate throughput of filler material and an adequate distribution of reclaimed fine graded filler material between the storage body and the channel structure, not having to re-heat the reclaimed fine graded filler material at all.

[0028] Further features of, and advantages with, the present invention will become apparent when studying the appended claims and the following description. Those skilled in the art realize that different features of the present invention may be combined to create embodiments other than those described in the following.

Brief description of the drawings

[0029] These and other aspects of the present invention will now be described in more detail, with reference to the appended drawings showing currently preferred embodiments of the invention, wherein:

Figure 1 schematically illustrates a partial view of an asphalt plant comprising a storage silo according to a currently preferred embodiment of the present invention; and

Figure 2a - c illustrates detailed views of the use of a storage silo for storing a reclaimed fine graded filler material according to the invention.

Detailed description of the preferred embodiment

[0030] In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

[0031] Referring now to the drawings and to figure 1 in particular, there is schematically illustrated a partial view of an asphalt plant 100 comprising a storage silo 200 according to a currently preferred embodiment of the present invention. A more detailed description of the silo 200, and its functions, will be given below in relation to figure 2.

[0032] The asphalt plant 100 further comprises an first elevator bucket 101 for transporting stone aggregate material and coarse graded filler material provided by a rotary drum dryer (not shown), and a mesh sieve 102 for separating the stone aggregate material and coarse graded filler material into a hot storage compartment 103 comprising a plurality sections for storing the stone aggregate material and coarse graded filler material based on dimensional grading.

[0033] In one implementation, the storage compartment 103 comprises four sections, storing aggregate material having a dimension between 11 - 16 mm, 8 - 11 mm, 4 - 8 mm, and 0 - 4 mm, respectively. The divided material is fed to a balance unit 104 adapted to separately weigh the divided materials, and provide the materials to a mixer unit 105.

[0034] Furthermore, the asphalt plant 100 comprises a second bucket elevator 106 for transporting reclaimed fine graded filler material 107 from the rotary drum dryer to the storage silo 200. The reclaimed fine graded filler material 107 is transported to the second bucket elevator 106 by means of a first worm conveyer 108. An inclined ramp 109 transports the reclaimed fine graded filler material 107 from the second bucket elevator 106 to an inlet of the silo 200.

[0035] The silo 200 comprises a hollow storage body adapted to receive a portion of the reclaimed fine graded filler material 107 received by the storage silo 200, and an essentially vertical channel structure arranged inside of the storage body. The channel structure is adapted to receive a portion of the reclaimed fine graded filler material 107, and to provide a direct passage between the inlet of the silo and an outlet of the silo.

[0036] The output of the silo is connected to a second worm conveyer 110, feeding the reclaimed fine graded filler material 107 to a second balance unit 111, adapted to weigh the reclaimed fine graded filler material 107. The weighed reclaimed fine graded filler material 107 is provided to the mixer unit 105, where the weighed reclaimed fine graded filler material 107 is mixed together with the coarse grade divided material, as described above, and a bituminous binder 112 provided to the mixer 105.

[0037] During operation, described in a simplified manner, an operator of the asphalt plant 100 sets the asphalt plant 100 to produce an asphalt quality based on a predetermined recipe. Stone aggregate is provided to the rotary drum dryer where it is heated. The majority of the heated stone aggregate is provided to the first bucket elevator 101 where it is transported to the mesh sieve

102 separating the aggregates into the different sections of storage compartment 103.

[0038] Hot gases from the rotary drum dryer are passed through a cyclone separator and a filter media, generating a coarse graded filler material and a fine graded filler material. The fine graded filler material 107 is reclaimed and transported by the first worm conveyer 108 to the second bucket elevator 106. The fine graded reclaimed filler material 107 is received by the inlet of the silo 200.

[0039] Next, the fine graded reclaimed filler material 107 and the separated coarse graded stone aggregate are weighed and mixed by the mixer 105, together with the bituminous binder 112, forming a hot mix asphalt product 113. Since the majority of the reclaimed fine graded filler material is directly re-transferred to the mixer 105 without being stored for a longer time period in the storage silo, the re-transfer reclaimed fine graded filler material has substantially the same composition as the stone aggregate material provided from the storage compartment 103. This provides for a higher homogeneity of the stone aggregate material in the hot mix asphalt product 113 being produced, and furthermore provides for a better possibility to control the quality of the produced asphalt product.

[0040] The hot mix asphalt product mixed in the mixer 105 is generally loaded onto a truck (not shown), transported to a construction site, and then, for example, used for paving a road.

[0041] The warm reclaimed fine graded filler material 107 provided by the silo 200 according to the present invention, as compared to cold reclaimed fine graded filler material provided by a prior art silo, furthermore improves the possibilities to obtain technical demands put by the road administrations.

[0042] Figure 2a - c illustrates detailed views of the silo 200 according to a currently preferred embodiment of the present invention, when used in an asphalt plant 100 as described above.

[0043] In a first state, as is illustrated in figure 2a, the inclined ramp 201, which is arranged in connection with an inlet 202 of the silo 200 receives the fine graded reclaimed filler material 107 from the second bucket elevator 106 (shown in figure 1). The fine graded reclaimed filler material 107 is arranged to fall into the essentially vertical channel structure 203, having a circular cross section, which has been arranged essentially centrally inside of a hollow storage body 204, also having a circular cross section. The storage body 204 forms the outer shell of the silo 200.

[0044] The channel structure 203 is adapted to provide a direct passage between the inlet 202 and an outlet 205. In figure 2a, the outlet 205 of the silo 200 is closed, why none of the filler material received by the silo 200 will be outputted out of the silo 200.

[0045] In a second state, as is illustrated in figure 2b, the outlet 205 of the silo 200 is still closed, and the centrally arranged channel structure 203 has been completely filled with the reclaimed fine graded filler material 107, such that the filler material 107 starts to fall outside of the channel structure 203. The storage body 204 instead starts to fill up towards the maximal capacity of the silo 200. This possibility to fill up not only the channel structure 203, but also the storage body 204 is necessary for handling large fluctuations in the amount of reclaimed fine graded filler material 107 being transferred into and out of the silo 200.

[0046] In a third state, which is depicted in figure 2c, the outlet 205 of the silo is opened, and a composition of reclaimed fine graded filler material 107 from the channel structure 203 and the storage body 204 is feed back to the production process of the asphalt product. As in figure 2a, the fine graded reclaimed filler material 107 falls into the essentially vertical channel structure 203.

[0047] A lower tapered end 206 of the storage body 204 is adapted to cooperate with the lower end of the channel structure 203 such that a majority of composition of the reclaimed fine graded filler material 107 being feed out of the outlet 205 comes from the channel structure 203. In one embodiment, the composition of the reclaimed fine graded filler material 107 being feed out of the outlet 205 consists of more than or equal to 90% filler material from the channel structure 203, and less than or equal to 10% of filler material from the storage body 204.

[0048] Preferably, the silo 200 comprises means such that it is possible to raise the channel structure 203, thereby adjusting the composition of the filler material 107 being feed out from the silo 200, i.e. a distance D between the lower end of the channel structure 203 and the lower end of tapered end 207 of the storage body 204. The distance D is preferably set such that the majority of the reclaimed fine graded filler material 107 being feed out of the silo 200 comes from the channel structure 203.

[0049] It is generally not necessary, but still possible, to conduct adjustments, i.e. raise the channel structure 203 during use of the silo 200, since the rate at which the filler material 107 is being feed into the silo 200 generally is set by the receipt used for the production of the asphalt product, and hence is known by the operator of the asphalt plant. Instead, the distance D of the channel structure 203 is therefore generally only set at before the a production cycle.

[0050] The person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims. For example, it is not necessary to arrange the silo/storage body in a vertical manner as is described above. The silo/storage body may instead be arranged in the form of a horizontally arranged construction, for example using a horizontally arranged container construction. Furthermore, the silo can comprise means for dynamically adjust the distance D during the production and processing process, thereby dynamically adjust the composition of the reclaimed fine graded

filler material being feed out from the silo to the production process.

Claims

1. A storage silo (200) for storing a reclaimed fine graded filler material (107) used in an asphalt plant (100), said storage silo (200) having an inlet (202) for receiving the reclaimed fine graded filler material (107) and an outlet (205) for outputting the reclaimed fine graded filler material (107) out of the storage silo (200), said storage silo (200) comprising a hollow storage body (204) adapted to receive a portion of the reclaimed fine graded filler material (107) received by the storage silo (200), **characterized by** an essentially vertical channel structure (203) arranged in the vicinity of the storage body (204), said channel structure (203) being adapted to provide a direct passage between the inlet (202) and the outlet (205) of the storage silo (200) and adapted to receive a portion of the reclaimed fine graded filler material (107) received by the storage silo (200), wherein the storage silo (200) is adapted such that, in use, the reclaimed fine graded filler material (107) being outputted through the outlet (205) of the storage silo (200) consists of reclaimed fine graded filler material (107) from the storage body (204) and the channel structure (203).

2. Storage silo (200) according to claim 1, wherein the channel structure (203) is arranged inside of the storage body (204).

3. Storage silo (200) according to any of claims 1 or 2, wherein the storage silo (200) further comprises means for adjusting a composition of reclaimed fine graded filler material (107) being outputted through the outlet (205) of the storage silo (200).

4. Storage silo (200) according to any of claims 2 or 3, wherein the storage silo (200) further comprises means for adjusting the vertical position of the channel structure (203), such that the composition of reclaimed fine graded filler material (107) is adjusted.

5. Storage silo (200) according to any one of the preceding claims, wherein a storage capacity of the channel structure (203) is less than a 1/5 of a total storage capacity of the storage silo (200).

6. Storage silo (200) according to any one of the preceding claims, wherein the hollow storage body (204) has a lower tapered end.

7. Use of a storage silo (200) according to any one of the preceding clams in an arrangement for producing asphalt.

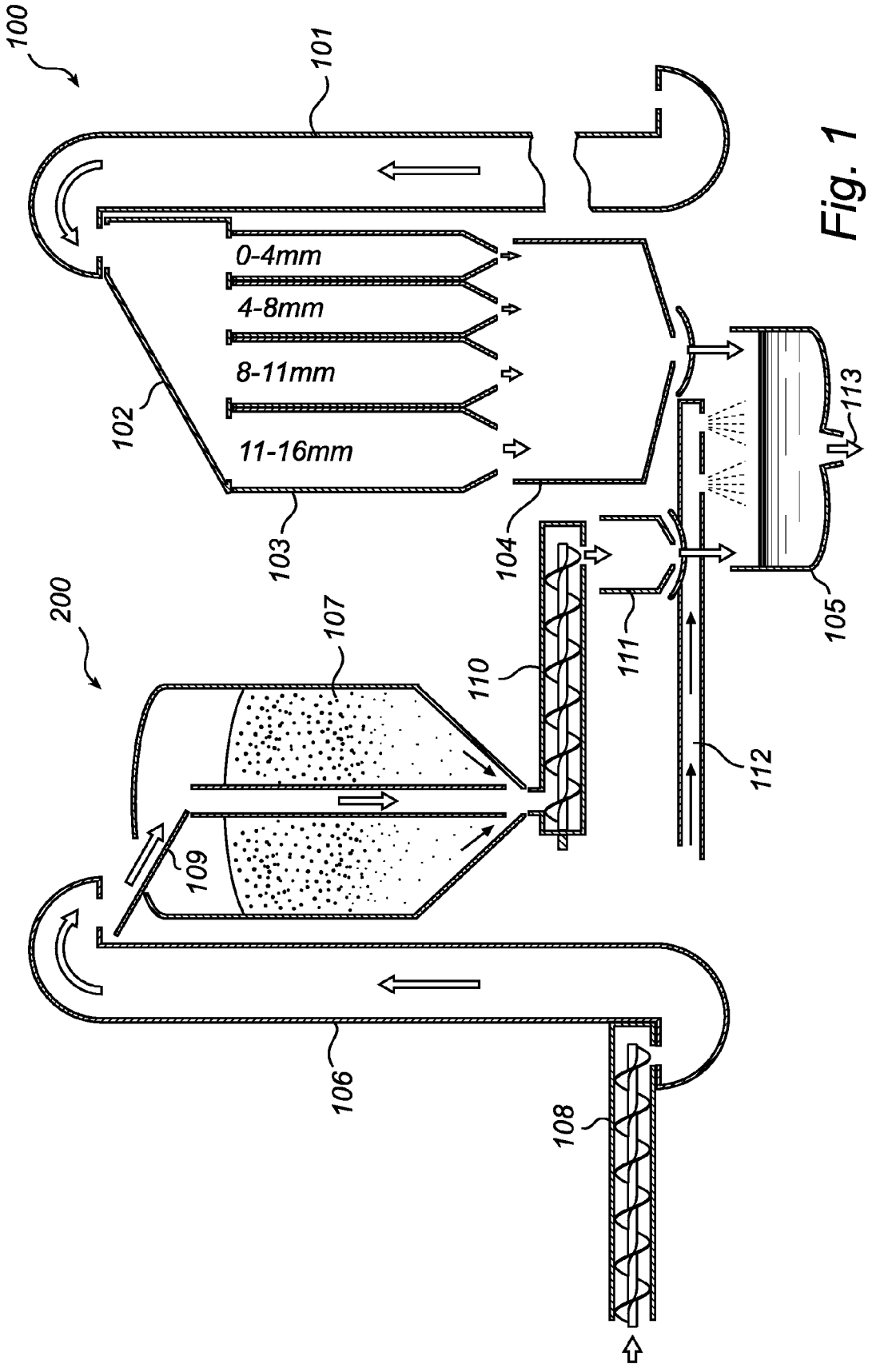
8. An asphalt plant (100) for producing asphalt products (113) wherein a rotary drum thereof generates reclaimed fine graded filler material (107) that is reusable for producing the asphalt products (113), wherein the asphalt plant (100) further comprises a storage silo (100) according to any one of claim 1 - 6, said storage silo (200) being adapted to receive the reclaimed fine graded filler material (107) generated by the rotary drum, and adapted to dispense the reclaimed fine graded filler material (107) as needed for producing the asphalt product (113).

9. Method for producing asphalt products in an asphalt plant (100), said method comprising the steps of:

   - generating a reclaimed fine graded filler material (107) by means of a rotary drum;
   - transferring the reclaimed fine graded filler material (107) to a storage silo (200), wherein the temperature of the reclaimed fine graded filler material (107) has a first temperature when entering the storage silo; and
   - direct re-transferring of the reclaimed fine graded filler material (107) from the storage silo (200) to the asphalt plant (100), such that re-transferred reclaimed fine graded filler material (107) has a second temperature when leaving the storage silo (200),

   wherein a difference between the first and the second temperature is less than 10 degrees Celsius.

10. Method according to claim 9, wherein the storage silo (200) has an inlet (202) for receiving the reclaimed fine graded filler material (107) and an outlet (205) for outputting the reclaimed fine graded filler material (107) out of the storage silo (200), said storage silo (200) comprising a hollow storage body (204) adapted to receive a portion of the reclaimed fine graded filler material (107) received by the storage silo (200), and an essentially vertical channel structure (203) arranged in the vicinity of the storage body, said channel structure (203) being adapted to provide a direct passage between the inlet (202) and the outlet (205) of the storage silo (200) and adapted to receive a portion of the reclaimed fine graded filler material (107) received by the storage silo (200), wherein the storage silo (200) is adapted such that, in use, the reclaimed fine graded filler material (107) being outputted through the outlet (205) of the storage silo (200) consist of reclaimed fine graded filler material (107) from the storage body (204) and the channel structure (203).


100
101
0-4mm
4-8mm
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102
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200

Fig. 1

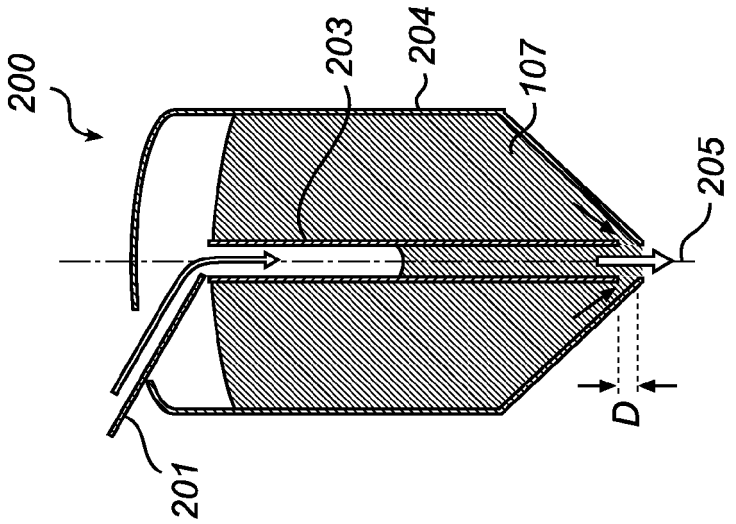

Fig. 2c

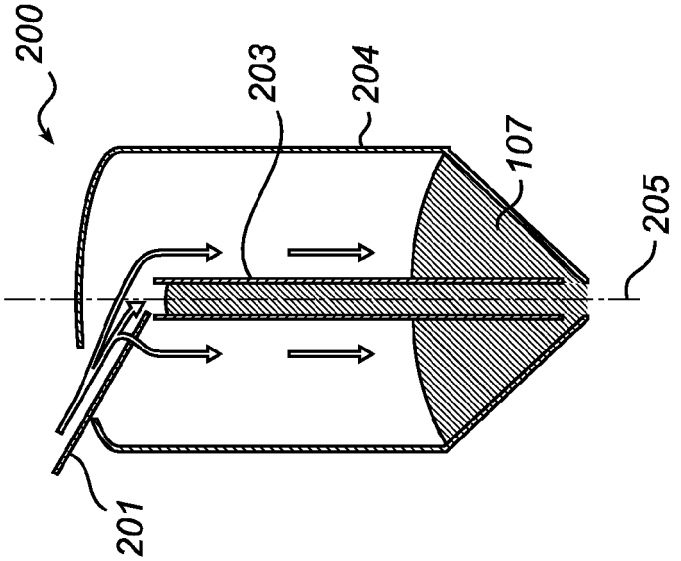

Fig. 2b

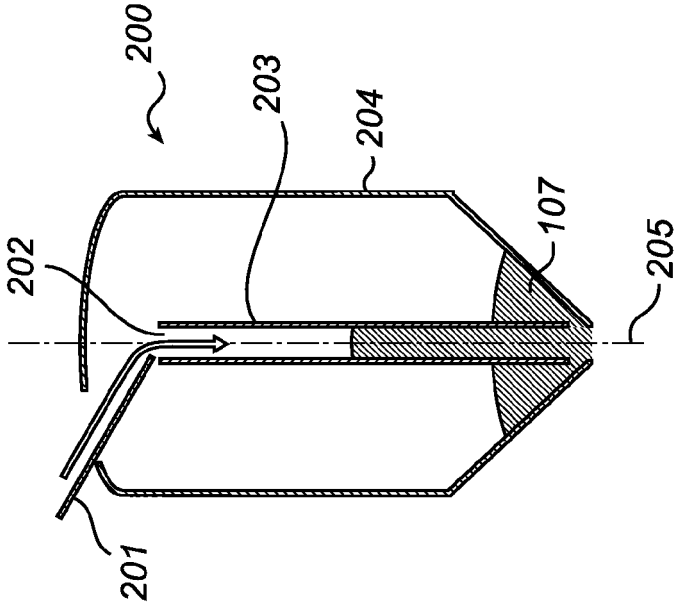

Fig. 2a

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 12 1490

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	GB 257 211 A (CLEMENT GAUKROGER HODGSON; MILLARS MACHINERY COMPANY LTD) 19 August 1926 (1926-08-19) * the whole document *	1-3,6,7 4	INV. E01C19/10 B01F5/24
Y	DE 28 12 092 A1 (PETERS AG CLAUDIUS) 4 October 1979 (1979-10-04) * page 8, line 23 - page 9, line 5; figures 3,4 *	4	
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TECHNICAL FIELDS SEARCHED (IPC)

E01C
B01F
B65D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 May 2007	Dijkstra, Gerard

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 12 1490

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09-05-2007

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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