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(54) **HEAT PRODUCTION PLANT SUPPLIED WITH WOOD FUEL, WOOD-SHELL FRUIT RESIDUES AND OTHER SIMILAR VEGETABLE RESIDUES**

(57) The present invention relates to a heat production plant (10) supplied with wood fuel, wood-shell fruit residues and other similar vegetable residues, comprising:

- a first containment tank (11) for storing standard wood chips (A);
- a shredding mill, or refiner (14) configured to reduce the size of said standard wood chips (A), having an outlet chamber (15) for collecting reduced wood chips (B);
- first transfer means for conveying the standard wood chips (A) from the bottom (11a) of the first containment tank (11) to the shredding mill, or refiner (14);
- a second containment tank (16), for the reduced wood

- chips (B);
- second transfer means for conveying the reduced wood chips (B) from the outlet chamber (15) to the second containment tank (16);
- a combustion module (17), comprising a pellet burner (18);
- third transfer means for conveying the reduced wood chips (B) from the bottom (16a) of the second containment tank (16) to the pellet burner (18);
- a heat exchange module (20), for heat exchange between the flue gases exiting the combustion module (17) and a flow of a fluid to be heated;
- a module (21) for pumping the fluid to be heated.

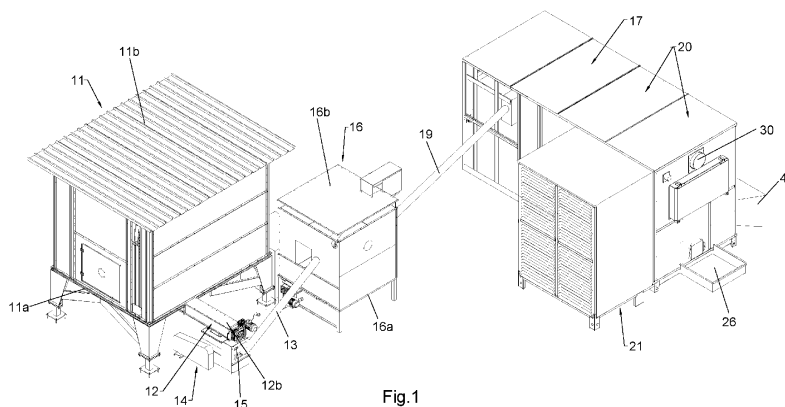


Fig. 1

Description

[0001] The invention relates to a heat production plant supplied with wood fuel, wood-shell fruit residues and other similar vegetable residues.

[0002] Nowadays, forage drying plants are well known and widespread, which comprise one or more drying modules, within which a plurality of hay bales to be dried is housed, and a thermo-ventilation plant; forage drying plants in special drying buildings for loose hay, also served by a thermo-ventilation plant, are also widespread.

[0003] Such a thermo-ventilation plant needs a heat source, which is usually a diesel or gas burner, a biogas plant sending hot water, or a biomass power plant. The biomass power plants today known and existing on the market for drying forage include wood boilers, or wood chip boilers or pellet burners.

[0004] The term 'wood chips' means a mass of chopped natural wood, with or without bark, coming from woodlands, comprising pieces of widely varying sizes, from about 2 cm up to 10 cm in length.

[0005] The term 'pellets' means a mass of powder cylinders from wood processing waste, which powder is pressed so as to form cylinders having regular and small size, i.e. a diameter of between 6 mm and 10 mm and a length of between 1 cm and 2 cm, about; pellets have a high calorific value and are the most advantageous wood fuel in terms of size and heat yield.

[0006] It is known from the international tables on Energy and Volumetric Equivalences that 1 litre of diesel oil produces as many kWh of energy as 2 Kg of pellets, where the price difference between the two fuels is such that 7.76 kWh of energy produced from diesel oil, or 16.6 kWh of energy produced from pellets can be purchased with 1€.

[0007] This means that, for the same energy output, pellets provide an economic saving higher than 50%.

[0008] With a biomass generator supplied by wood chips, on the other hand, for the same amount of energy and heat provided, it is possible to save even more, up to 70% compared to diesel oil and up to 60% compared to natural gas.

[0009] The Energy and Volumetric Equivalences show that 1 litre of diesel oil produces as many kWh of energy as 3 Kg of wood chips.

[0010] Wood chips therefore have a much lower production cost than pellets.

[0011] Known biomass thermo-ventilation plants, although widespread, have some limitations and drawbacks.

[0012] Indeed, pellet power plants have a high efficiency, up to 90%, and pellets have a much smaller volume than wood chips in terms of storage. In general, therefore, high energy density and ease of handling make pellets the most suitable vegetable fuel for automatic heating plants of all sizes.

[0013] On the other hand, pellets cost about three

times as much as wood chips.

[0014] Wood chip power plants comprise large, automatically loaded boilers that use a cheap fuel such as wood chips, i.e. ground wood which however takes up around three times the space of pellets. Therefore, wood chip boilers are cheap, but require storage facilities of at least 100 m³ that can be reached by tipper means, and wood chip burners do not have the thermal yield as pellet burners.

[0015] The task of the present invention is to develop a heat production plant supplied by wood fuel, wood-shell fruit residues and other similar vegetable residues, which is capable of overcoming the mentioned drawbacks and limitations of the prior art.

[0016] In particular, an object of the invention is to develop a heat production plant that allows to optimise savings in terms of wood fuel employed.

[0017] Another object of the invention is to develop a heat production plant with an optimum heat yield with reference to similar biomass plants of the known type. A further object of the invention is to develop a structurally simple, easy-to-maintain and cost-effective heat production plant.

[0018] Furthermore, an object of the invention is to develop a heat production plant which is completely safe with respect to possible risks of events such as "backfiring" at the combustion chamber.

[0019] The above-mentioned task and objects are achieved by a heat production plant supplied with wood fuel, wood-shell fruit residues and other similar vegetable residues, according to claim 1.

[0020] Further characteristics of the plant according to claim 1 are described in the dependent claims.

[0021] The aforesaid task and objects, together with the advantages which will be mentioned hereinafter, are highlighted by the description of an embodiment of the invention, which is given by way of non-limiting example with reference to the attached drawings, where:

- figure 1 represents a perspective view of a plant according to the invention;
- figure 2 represents a schematic side view of a plant according to the invention;
- figure 2A represents a section rear view of a portion of the plant according to the invention;
- figure 3 represents a perspective detail of the plant of the preceding figures according to the invention;
- figure 4 represents a schematic example of an embodiment of a plant according to the invention.

[0022] With reference to the mentioned figures, a heat production plant supplied by wood fuel, wood-shell fruit residues and other similar vegetable residues according to the invention is referred to as a whole by number **10**.

[0023] Such a plant **10** comprises:

- a first containment tank **11** for storing standard wood chips **A**;

- a shredding mill **14** configured to reduce the size of said standard wood chips **A**, said shredding mill, or refiner, **14** comprising an outlet chamber **15** for collecting reduced wood chips **B** exiting the same shredding mill **14**;
- first transfer means, for conveying said standard wood chips **A** from the bottom **11a** of said first containment tank **11** to said shredding mill **14**;
- a second containment tank **16**, for storing said reduced wood chips **B**;
- second transfer means, for conveying said reduced wood chips **B** from said outlet chamber **15** to said second containment tank **16**;
- a combustion module **17**, comprising a pellet burner **18**;
- third transfer means, for conveying said reduced wood chips **B** from the bottom of said second containment tank **16** to said pellet burner **18**;
- a heat exchange module **20**, configured for the heat exchange between the flue gases exiting said combustion module **17** and a flow of a fluid to be heated;
- a module **21** for pumping said fluid to be heated, configured to draw said fluid to be heated and to push it through said heat exchange module **20**.

[0024] In the present embodiment, the pumping module **21** is configured to draw air from outside and push it through the heat exchange module **20**.

[0025] Such a pumping module **21** comprises, for example, a centrifugal fan, and again, for example, a double-intake centrifugal fan, driven by an electric motor or a diesel engine.

[0026] Such a plant **10** according to the invention is intended to be used for heating air, water or other fluids in either a gas or liquid state.

[0027] The term 'standard wood chips' means wood chips with a size of between 1 cm and 10 cm in length.

[0028] The term 'reduced wood chips' means wood material whose bodies, i.e. elements, have an average size of between 3 mm and 5 mm in diameter and a length of between 10 mm and 15 mm, i.e. a size comparable to the size of a pellet piece.

[0029] The first transfer means comprise, for example and not exclusively, a first auger **12**; in an alternative embodiment, not shown for simplicity, the first transfer means comprise a conveyor belt, or another similar and equivalent transport device.

[0030] Still as an example, and not exclusively, the second transfer means comprise a second rigid or flexible auger **13**; in an alternative embodiment, not shown for simplicity, the second transfer means comprise a conveyor belt, or another similar and equivalent transport device.

[0031] Still as an example, and not exclusively, the third transfer means comprise a third rigid or flexible auger **19**; in an alternative embodiment, not shown for simplicity, the third transfer means comprise a conveyor belt, or another similar and equivalent transport device.

[0032] The shredding mill **14** is thus configured to reduce a wood material of the standard wood chip type **A** from standard dimensions to a wood material of the reduced wood chip type **B** having volume dimensions with a diameter of between 3 mm and 5 mm and a length of between 10 mm and 15 mm.

[0033] The first auger **12** is arranged, for example but not exclusively, on a horizontal axis, with the inlet **12a** placed below the bottom of the first containment tank **11** and the discharge mouth **12b** placed above the shredding mill **14**.

[0034] The first auger **12** is connected to a corresponding drive motor.

[0035] The second auger **13** extends from the outlet chamber **15** of the shredding mill **14** to a high part of the second containment tank **16**; such high part is intended as the part extending from half of the distance between the bottom **16a** and the lid **16b** to the lid **16b** itself of the second containment tank **16**.

[0036] As the reduced wood chips **B** are not regular in shape, as well as for ease of construction and installation, the second auger **13** is preferably of the flexible type, and is shown in hatched form in Figure 2, where it is referred to as **13a**.

[0037] The second auger **13** or **13a** is obviously also connected to a respective drive motor.

[0038] The third auger **19** extends from below the bottom **16a** of said second containment tank **16** to the combustion module **17**.

[0039] The third auger **19** is also connected to a drive motor.

[0040] The third auger **19** is also preferably of the flexible type, and is referred to in figure 2 by number **19a**.

[0041] The combustion module **17** comprises an arrival chamber **25** into which the reduced wood chips **B** lifted by the third auger **19** arrive.

[0042] The arrival chamber **25** is placed above a star valve **26**, configured to adjust and govern the descent of the reduced wood chips **B** towards an underlying fourth auger **27** for introducing the reduced wood chips **B** into the pellet burner **18**.

[0043] The star valve **26** is also configured with cutting edges to further shred reduced wood chips **B** that have not been shredded as intended by the shredding mill **14**.

[0044] The star valve **26** is of the type configured to block backfiring from the pellet burner **18**.

[0045] The heat exchange module **20** is, for example and not exclusively, of the shell and tube type.

[0046] Such a plant **10** according to the invention enables wood material of the standard wood chip type **A** to be used and processed in such a way that it can be used in the pellet burner **18**.

[0047] The heat exchange module **20** is connected with an outlet duct **40** configured for connection to an inlet of another machine or of a plant which the heated fluid is intended for.

[0048] Figure 4 exemplifies a bale forage dryer of the opposite airflow type **50**, connected to the outlet duct **40**

of a plant **10** according to the invention.

[0049] It is also obvious that the outlet duct **40** may be connected in such a way as to serve a dryer for loose forage, or a dryer for cereals, or a dryer for timber, or a dryer for wood chips, or a dryer for any other dryable product.

[0050] The outlet duct **40** may obviously also be connected to a heating system of a building, premise, warehouse, stable as well as other similar constructions. The plant **10** according to the invention operates as described hereinafter. The standard wood chips **A** are introduced into the first containment tank **11**, which is provided with a lifting lid **11b**.

[0051] The standard wood chips **A** are conveyed from this first containment tank **11** by the first auger **12** to the shredding mill, or refiner, **14**.

[0052] Reduced wood chips **B** exit the shredding mill **14**.

[0053] The reduced wood chips **B** are transferred, by means of the second auger **13** or **13a**, into said second containment tank **16**, whose containment compartment has a smaller volume than the containment compartment of the first containment tank **11**.

[0054] The plant **10** is thus able to operate autonomously for a very long time, since the larger standard wood chips, once they have been shredded and transformed into reduced wood chips **B**, having sizes comparable to pellets, are collected into the second containment tank **16**.

[0055] The second containment tank **16** serves as a loading container for the pellet burner **18**.

[0056] Thus, the reduced wood chips **B** are brought, by means of a second auger **19** or **19a**, from the second containment tank **16** to the inlet of the pellet burner **18**.

[0057] The invention is thus determined by a plant **10** as described above which allows common wood chips, i.e. standard wood chips **A**, to be used as fuel for a pellet burner **18**, disengaging from the constraints of pellet size.

[0058] Figure 1 highlights that the heat exchange module **20** comprises a connection hole **30** for a flue gases exhaust funnel, and an ash collector **26**.

[0059] The entire plant **10** described above, comprising a first containment tank **11**, a shredding mill, or refiner, **14**, a second containment tank **16**, a first auger **12**, a second auger **13** and a third auger **19**, may be arranged in a compact manner, i.e., so as to reduce as much as possible the overall volume, within a carriageable container of the standard type.

[0060] In practice, it has been established that the invention achieves the intended task and objects.

[0061] In particular, the invention has developed a heat production plant which is able to operate starting from a wood material of the standard wood chip type, which standard wood chips cost much less than pellets and are 'chopped' so as to have an optimal yield, typical of the pellet burner plants.

[0062] In addition, the invention has developed a plant with lower maintenance costs than similar plants of the

known type.

[0063] Moreover, the invention has developed a plant capable of operating in complete safety at all times, thanks to the star valve placed upstream of the pellet burner, so as to reduce as much as possible the risk of "backfiring".

[0064] Last but not least, the invention has developed an 'eco-friendly' plant, which uses wood material as well as other wood-shell fruit residues and other similar vegetable residues, as long as they are comparable in size to reduced wood chips **B**, i.e. to a pellet piece.

[0065] The invention thus conceived is susceptible to numerous modifications and variants, all of which are within the scope of the inventive concept; moreover, all the details may be replaced by other technically equivalent elements.

[0066] In practice, the components and materials used, as well as the dimensions and shapes, as long as they are compatible with the specific use, can be any according to requirements and the state of the art.

[0067] If the features and techniques mentioned in any claim are followed by reference signs, such reference signs are to be intended for the sole purpose of increasing the intelligibility of the claims and, consequently, such reference signs have no limiting effect on the interpretation of each element identified by way of example by these reference signs.

Claims

1. A heat production plant (10) supplied with wood fuel, wood-shell fruit residues and other similar vegetable residues, comprising:
 - a first containment tank (11) for storing standard wood chips (A);
 - a shredding mill, or refiner (14) configured to reduce the size of said standard wood chips (A), said shredding mill, or refiner (14) comprising an outlet chamber (15) for collecting reduced wood chips (B) exiting the shredding mill itself, or refiner (14);
 - first transfer means for conveying said standard wood chips (A) from the bottom (11a) of said first containment tank (11) to said shredding mill, or refiner (14);
 - a second containment tank (16) for storing the reduced wood chips (B);
 - second transfer means for conveying the reduced wood chips (B) from said outlet chamber (15) to said second containment tank (16);
 - a combustion module (17), comprising a pellet burner (18);
 - third transfer means for conveying said reduced wood chips (B) from the bottom (16a) of said second containment tank (16) to said pellet burner (18);

- a heat exchange module (20), configured for heat exchange between the flue gases exiting said combustion module (17) and a flow of a fluid to be heated;
- a module (21) for pumping said fluid to be heated, configured to draw said fluid to be heated and to push it through said heat exchange module (20),

characterised in that said third transfer means comprise a third auger (19, 19a), said combustion module (17) comprising an arrival chamber (25) wherein said reduced wood chips (B) lifted by said third auger (19, 19a) arrive.

2. The plant according to claim 1, **characterised in that** it is arranged inside a standard carriageable container.

3. The plant according to one or more of the preceding claims, **characterised in that** said first transfer means comprise a first auger (12), said first auger (12) being arranged with an inlet (12a) placed below the bottom (11a) of the first containment tank (11) and with an outlet (12b) placed above the shredding mill, or refiner (14).

4. The plant according to one or more of the preceding claims, **characterised in that** said second transfer means comprise a second auger (13), said second auger (13) extending from said outlet chamber (15) of the shredding mill, or refiner (14) to a high part of the second containment tank (16).

5. The plant according to one or more of the preceding claims, **characterised in that** said third auger (19, 19a) extends from below the bottom (16a) of said second containment tank (16) to said combustion module (17).

6. The plant according to one or more of the preceding claims, **characterised in that** said shredding mill, or refiner (14) is configured to reduce a wood material of the wood chip type of standard size (A) to reduced wood chips (B) having overall volume dimensions of between 3 mm and 5 mm in diameter and between 10 mm and 15 mm in length.

7. The plant according to one or more of the preceding claims, **characterised in that** said second auger (13a) is of a flexible type.

8. The plant according to one or more of the preceding claims, **characterised in that** said third auger (19a) is of a flexible type.

9. The plant according to one or more of the preceding claims, **characterised in that** said arrival chamber

(25) is placed above a star valve (26), said star valve (26) being configured to adjust and govern the descent of reduced wood chips (B) towards an underlying fourth auger (27) for introducing reduced wood chips (B) into said pellet burner (18).

10. The plant according to claim 9, **characterised in that** said star valve (26) is of the type configured to block backfiring from the pellet burner (18).

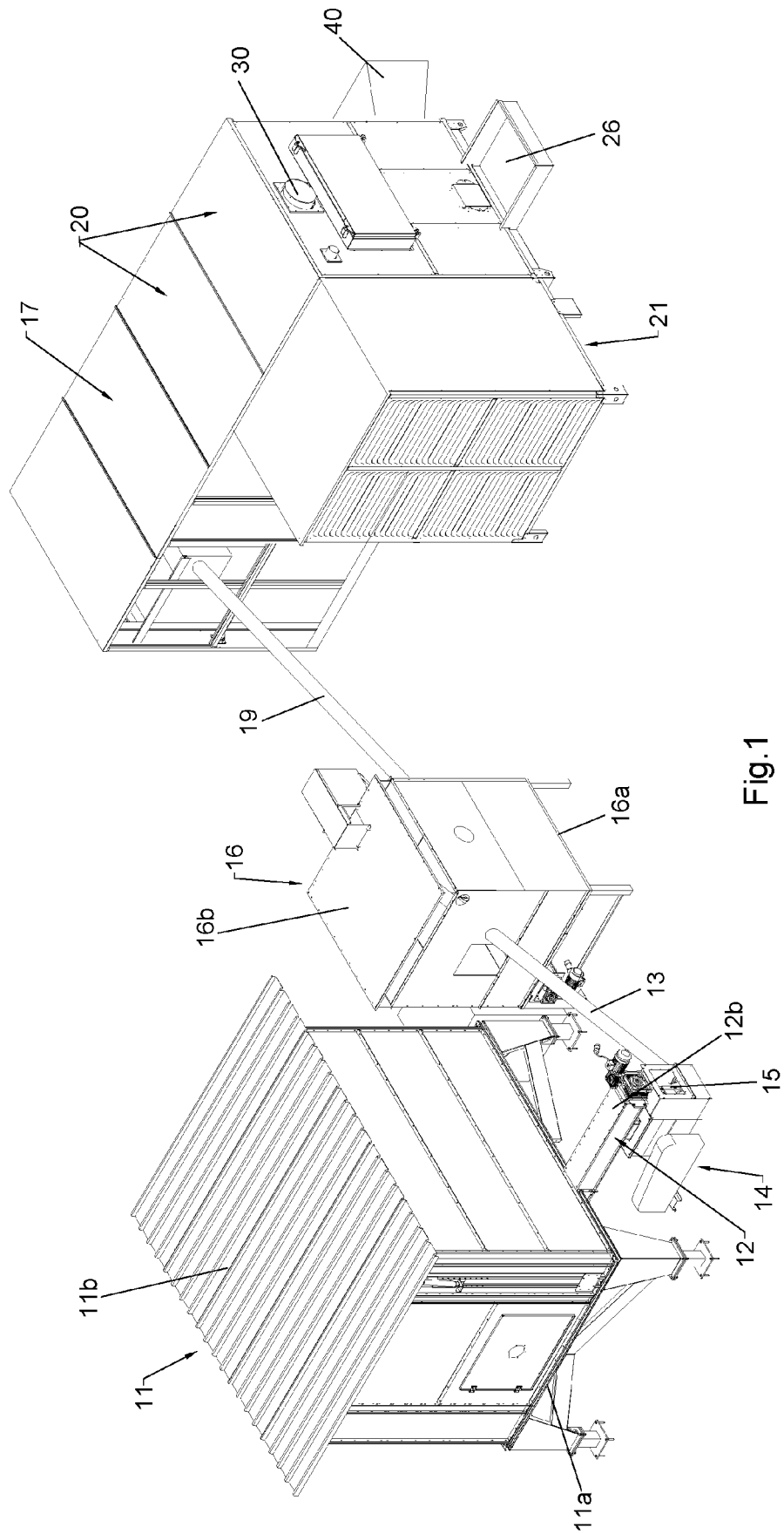


Fig.1

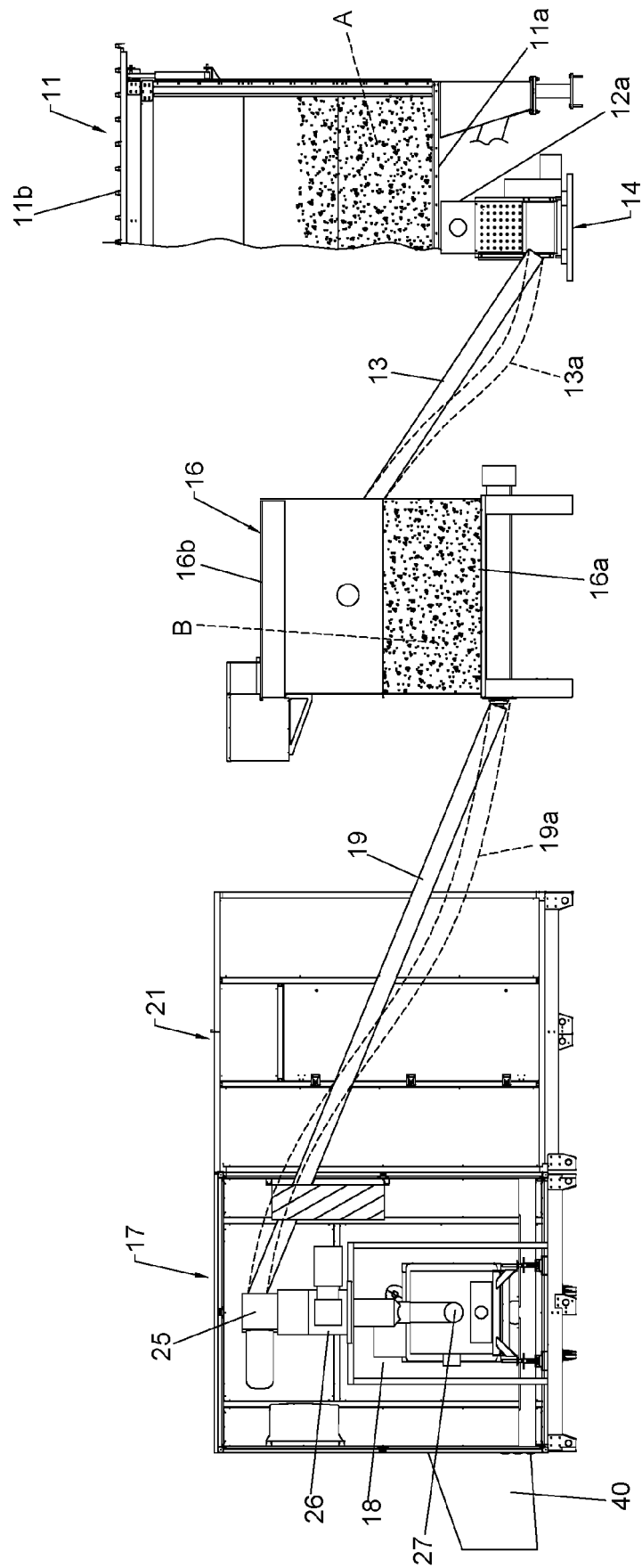


Fig. 2

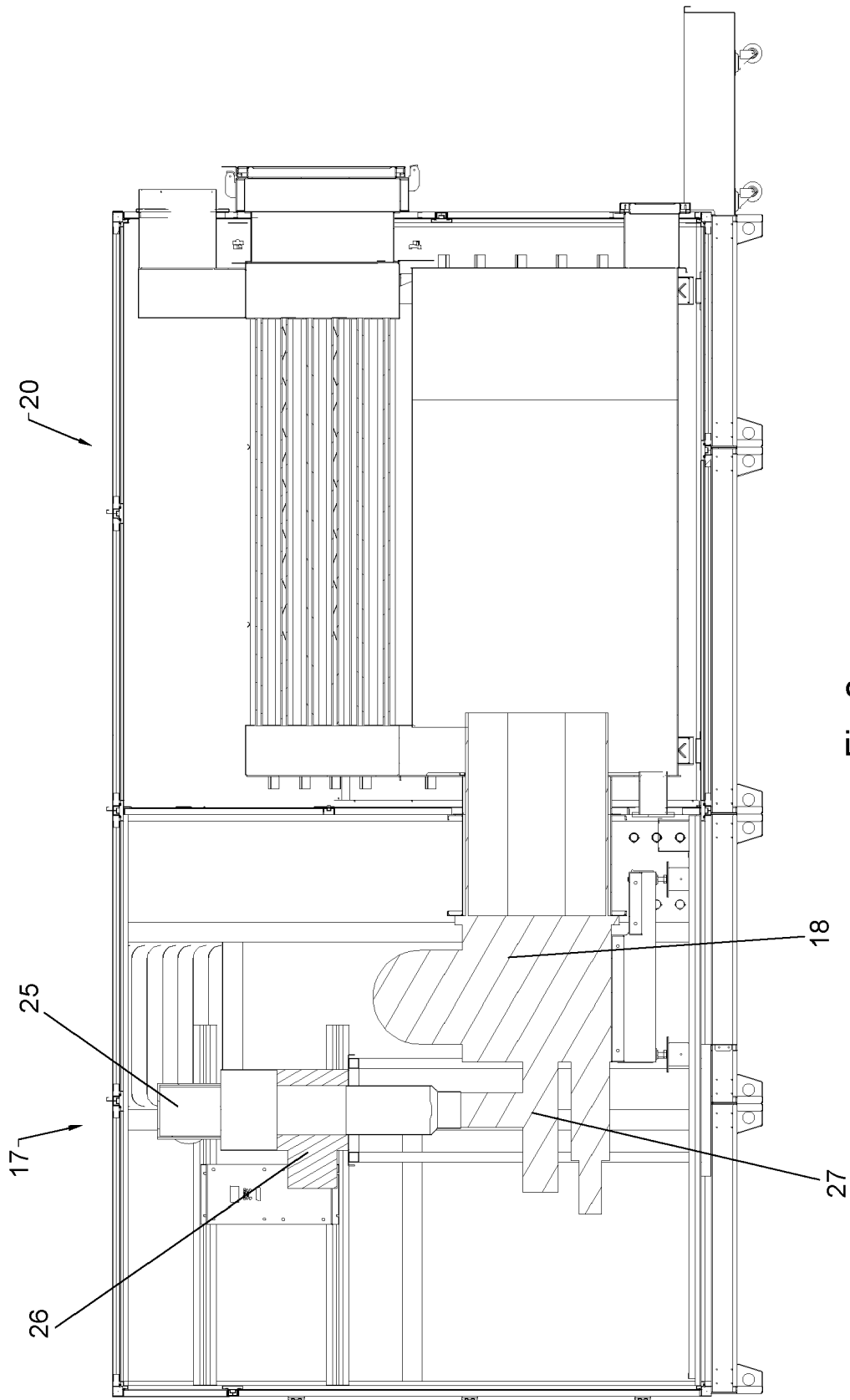
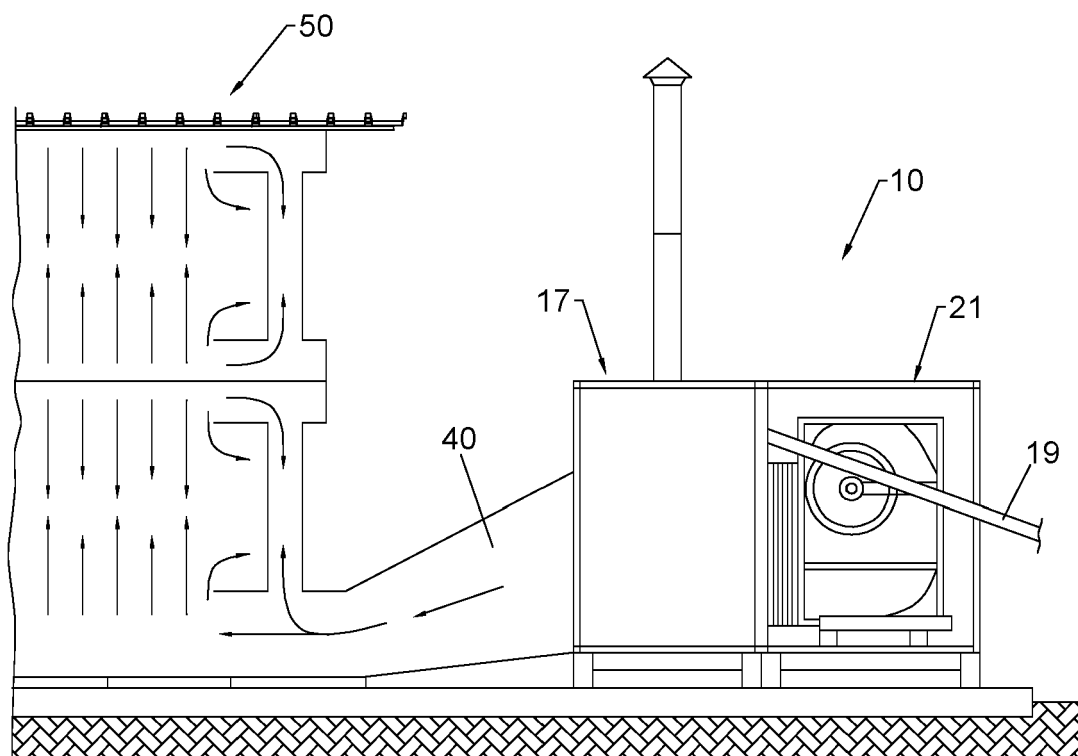
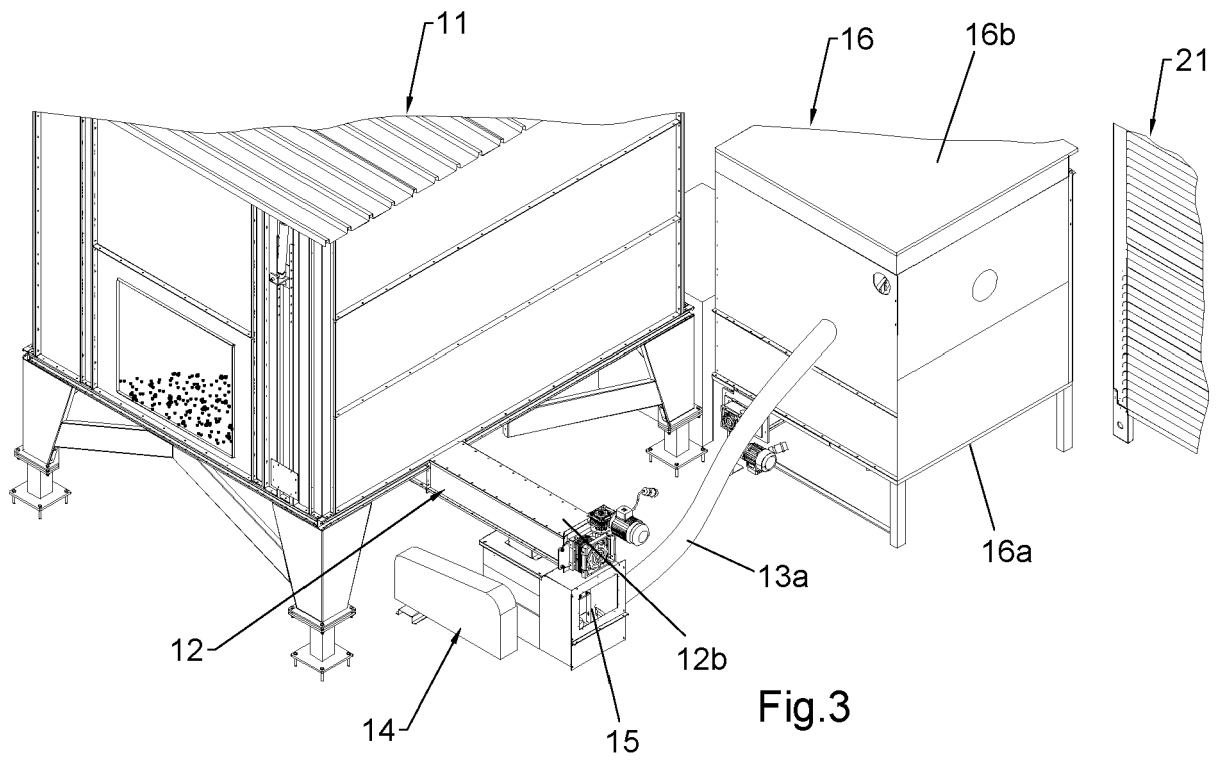


Fig.2a





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Application Number

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Place of search Munich		Date of completion of the search 18 May 2022	Examiner Hauck, Gunther
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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