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(54) **METHOD OF DRYING AND POST-GRINDING OF PRE-GROUND MATERIALS, IN PARTICULAR BROWN COAL OR COAL, AND APPARATUS FOR DRYING AND POST-GRINDING OF PRE-GROUND MATERIALS, IN PARTICULAR BROWN COAL OR COAL**

(57) In the drying and post-grinding method of pre-ground materials, in particular brown coal or coal, according to the invention the feed of the pre-ground material is supplied into the electromagnetic mill (1). Then the feed is ground in the electromagnetic mill (1) and pre-dried in the electromagnetic mill (1) with the pre-drying medium, supplied to the electromagnetic mill (1). Sequentially, the feed is supplied from the electromagnetic mill (1) on the vibrating conveyor (12) of the fume exhaust

chamber (11) and is finally dried on a vibrating conveyor (12), wherein the feed is finally dried on a vibrating conveyor (12) comprising a ferromagnetic plate (13), on which magnets (14) are arranged, with the N poles directed towards the ferromagnetic plate (13), while at the S poles of the magnets (14) the feed transport plate (15) is arranged. The present invention also relates to the apparatus for the accomplishment of the above mentioned method.

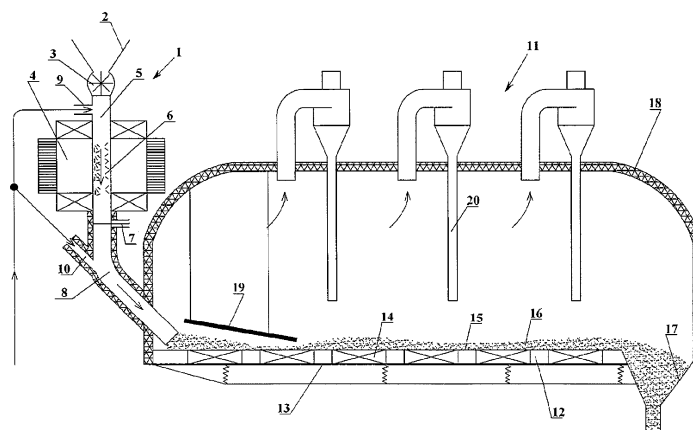


fig. 1

Description

Technical field

[0001] The present invention relates to a method of drying and post-grinding of pre-ground materials, in particular brown coal or coal, and apparatus for drying and post-grinding of pre-ground materials, in particular brown coal or coal. The present invention is used in power generation and in coal briquette factories and formed fuels plants.

Background of the Art

[0002] Known methods for drying brown coal involve drying of the material in dryers with membrane heating, such as: shelf or tube dryers, and in dryers with heating without membrane, such as tube, drum or pneumatic dryers, in which the drying medium are hot combustion gases. Fluidized-bed dryers are also used, which are generally used for drying bulk materials, in which the fluidizing gas of reduced oxygen content ($5 \div 18\%$) is used. In these dryers the heat is supplied through the gas, hence its temperature at the inlet of the apparatus is high and is typically between 400 and 800°C. In this type of heating a local overheating of the dried material is occurred, and a self-ignition phenomenon may occur in particular near the gas distributor. Probably it is the reason of avoiding of a fluidized-bed drying of a brown coal, in which the oxidation and self-ignition phenomena are occurred at lower temperatures than in the case of coal.

[0003] It is also known in the art an apparatus for drying and post-grinding of a brown coal, which comprises a screw coal feeder, an electromagnetic mill and a product receiving and fume exhaust chamber. The brown coal is transported by the screw feeder to the inlet of the working chamber of the electromagnetic mill where from it is gravitationally transported through the working area of the mill in which it is ground and pre-dried. Then, the brown coal enters into the product receiving and fume exhaust chamber. This chamber is equipped with a vibrating conveyor and exhaust fans. After leaving the mill the brown coal is transported through the chamber by the vibrating conveyor, where it is post-dried and the exhaust fans extract moisture released in the process.

[0004] From the Polish patent application No. 382610 it is known the electromagnetic mill for post-grinding of fine-grained materials comprising a working chamber provided with a shutter fixed inside thereof, which protects grinding media from falling out of the working area, and an inductor for generating an electromagnetic field. The mill has the ability to adjust the slope of the working chamber and change the feed rate of the feed.

[0005] From the Polish Patent No 211435 it is known a method and apparatus for simultaneously drying and post-grinding of the brown coal which is characterized in that the wet feed is fed to the working chamber subjected to the action of the vortex magnetic field in which it is

subjected to simultaneously drying, post-grinding and activation processes and modifications of the water contained in it by the action of electromagnetic field, and after removal of the fumes the product is post-dried at a temperature of 110°C under vacuum, and then the product is gravitationally or by a feeder received.

[0006] From the Polish patent No. 141797 it is known a method and apparatus for drying of the brown coal. In this process a wet brown coal ground to a grain size of $> 1 \text{ mm}$ is dried in two stages in a fluidized bed, wherein in the first stage a heat is applied both by means of a membrane and contained in the fluidizing gas of a flux density $\geq 0.25 \text{ kg/m}^2\text{s}$ and a temperature 80 to 160° C, and in a second stage a heat is supplied only by means of a membrane, and the bed is fluidized by a gas at ambient temperature. The fluidizing apparatus has two chambers arranged side by side and separated by a vertical barrier, which are equipped with separate heating elements disposed on the outer surfaces of the apparatus and/or heating elements immersed in a fluidized bed and independently fed by a gas, wherein only one chamber is equipped with a heater through which the gas is fed to the bed.

[0007] The aim of the invention is to provide a method and an apparatus for effective and quick removal of moisture from pre-ground materials, in particular brown coal or coal, while simultaneously their post-grinding to obtain a fuel for power boilers to increase their efficiency.

Summary of the invention

[0008] The method of drying and post-grinding of pre-ground materials, in particular brown coal or coal, according to the invention comprises the steps of: supplying the feed of the pre-ground material to the electromagnetic mill; grinding of the feed in the electromagnetic mill and pre-drying of the feed in the electromagnetic mill with a pre-drying medium, supplied to the electromagnetic mill; supplying the feed from the electromagnetic mill to a vibrating conveyor of the fume discharge chamber; and the final drying of the feed on the vibrating conveyor. The feed is finally dried on a vibrating conveyor comprising a ferromagnetic plate on which magnets are arranged with N poles directed towards the ferromagnetic plate, while at S poles of the magnets a plate for transporting of the feed is provided.

[0009] Preferably, lamellar anisotropic ceramic magnets are used as the magnets.

[0010] Preferably, fumes formed at the final drying stage of the feed are discharged from the fume exhaust chamber by means of a fume exhaust unit arranged in the upper part of the fume exhaust chamber.

[0011] Preferably, the feed is dried in the electromagnetic mill with a pre-drying medium, which is air at a temperature of 80-100°C and a flux density $\geq 0.15 \text{ kg/m}^2\text{s}$.

[0012] The apparatus for drying and post-grinding of pre-ground materials, in particular brown coal or coal, according to the invention comprises: an electromagnetic

mill having an inlet and an outlet, wherein both the inlet and the outlet are provided with stub pipes for supplying the pre-drying medium; and the fume exhaust chamber, which is connected to the outlet of the electromagnetic mill, wherein the fume exhaust chamber comprises a vibrating conveyor for receiving of the feed from the electromagnetic mill, a fume exhaust unit in its upper part and a receiving container for the pre-dried feed located at the end of the vibrating conveyor. The vibrating conveyor includes a ferromagnetic plate on which magnets are arranged with N poles directed towards the ferromagnetic plate, while at S poles of the magnets a plate for transporting of the feed is provided.

[0013] Preferably, the magnets are lamellar anisotropic ceramic magnets.

[0014] Preferably, the fume exhaust unit includes exhaust fans.

[0015] Preferably, the fume exhaust unit includes cyclones.

[0016] Preferably, the fume exhaust chamber includes further a thermal insulation.

[0017] Preferably, the fume exhaust chamber further comprises a guiding baffle for the pre-drying medium in the region of a chute of the feed from the electromagnetic mill.

[0018] Preferably, the fume exhaust chamber is connected to the outlet of the electromagnetic mill by means of an elbow coupling which is provided with a thermal insulation, wherein the stub pipe is arranged at the elbow coupling.

[0019] Preferably, the feed carrying plate is made of aluminium.

[0020] Preferably, the vibrating conveyor (12) is inclined relative to the horizontal direction at an angle $1 \div 2^\circ$.

[0021] The gradient magnetic field generated by lamellar anisotropic ceramic magnets significantly influences a change of a ratio of free water molecules to associated molecules. Free water molecules are characterized by an increased mobility and their considerable amount in the water modified in a magnetic field significantly accelerates the process of its evaporation and transport by the fuel particles. The water is discharged by diffusion through the fuel particles on its surface, first from macrospores, then capillaries and mesopores into the gas surroundings from the fuel surface. The dried coal is discharged through a dump from the apparatus to a product receiving container and through the feeder (screw and/or pneumatic) is discharged into a tank, for example, the buffer tank, and/or outside. Dusty fumes are exhausted by the fumed exhaust unit installed in the upper wide part of the fume exhaust chamber. The use of magnets in the vibrating conveyor located in the fume exhaust chamber significantly increases the productivity and speed of the drying process of the pre-ground materials.

Brief description of the drawings

[0022] The present invention is shown in non-limiting

embodiment in the drawings, in which:

Fig. 1 shows a schematic side view in cross-section of the apparatus for drying and post-grinding of pre-ground materials according to the invention, while Fig. 2 shows schematically a top view of an exemplary arrangement of the magnets on the surface of 1 m^2 of the ferromagnetic plate of the vibrating conveyor.

Preferred embodiments of the invention

[0023] The apparatus for drying and post-grinding of pre-ground materials, in particular brown coal or coal, according to the invention comprises two main units, namely the electromagnetic mill 1 and the fume exhaust chamber 11.

[0024] At the inlet of the electromagnetic mill 1 are provided, in turn, wet feed container 2 and the feed dispenser 3. The electromagnetic mill 1 is provided with a vortex magnetic field single pole inductor 4 in the axis of which a tubular working chamber 5 is arranged. The interior of the working chamber 5 is filled with rod-shaped ferromagnetic grinding media 6. The grinding media 6 rotate and circulate in the bed under influence of the magnetic field rotation and collide each other as well as with the wall of the working chamber 5, and also with the feed subjected to a drying and grinding process, with the intensity depended on the square of the magnetic induction. As a result of the process carried out in such a way, in the working chamber 5 are local micro-regions of a pulsating pressure exerted by the grinding media 6 on the feed. A gate valve 7 is installed just behind the inductor 4 of the vortex magnetic field in the outlet pipe of the electromagnetic mill 1. It protects of the grinding media 6 against falling out from the operational zone of the electromagnetic mill 1 after turning off supplying of the feed and power supply of the vortex magnetic field inductor 4. The end of the electromagnetic mill 1 is an elbow bent of the outlet pipe at an angle 45° by an elbow connector 8 with the stub pipe 10 supplying part of the hot air being the pre-drying medium. The second part of the pre-drying medium is supplied to the second stub pipe 9 at the inlet of the electromagnetic mill 1. Preferably, the outlet pipe of the electromagnetic mill 1 is provided with a thermal insulation.

[0025] The ground and partially pre-dried feed is supplied from the electromagnetic mill 1 through the elbow connector 8 to the fume exhaust chamber 11, which in this way is connected to the outlet of the electromagnetic mill 1.

[0026] The ground and partially pre-dried feed is gravitationally transferred to the vibrating conveyor 12 arranged in the fume exhaust chamber 11 and inclined with respect to the horizontal, preferably at an angle of $1 \div 2^\circ$. The vibrating conveyor 12 includes a ferromagnetic plate 13 on a main surface of which the magnets 14, preferably lamellar anisotropic ceramic magnets are arranged lon-

gitudinally and symmetrically, with the "N" poles directed towards the surface of the ferromagnetic plate 13 (i.e. downwardly in fig. 1), while on the upper surface of the magnets 14, i.e. at the "S" poles of the magnets 14, there is the feed transport plate 15, preferably of aluminium, on which the feed 16 to be dried is disposed. Of course, the feed transport plate 15 doesn't have to be made of aluminium; it can be of any other material which does not limit the magnetic field strength.

[0027] The coverage ratio of 1 m² of the ferromagnetic plate 13 of the vibrating conveyor 12 by the magnets 14 is from 50% to 80%, wherein the distances between longitudinally and symmetrically arranged magnets 14 are in the range from 25 mm to 100 mm. The lamellar anisotropic ceramic magnets 14 with dimensions of 100×50×20 mm are characterized by the remanence induction B_r in the range of 380 to 420 mT and energy density BH_{max} in the range of 27.1 ÷ 30.3 kJ/m³ and working temperature up to 250°C.

[0028] The vibrating conveyor 12 is provided with an amplitude and vibration frequency variation controller (not shown) for adjusting of the transport speed of the feed 16 to be dried to the pre-dried feed receiving container 17 located at the end of the vibrating conveyor 12. The vibrating conveyor 12 is built-up in the fume exhaust vacuum chamber 11. Preferably, the fume exhaust chamber 11 is provided with a thermal insulation 18. Inside the fume exhaust chamber 11, in the region of the chute of the partly pre-dried feed from the electromagnetic mill 1 the guiding baffle 19 for the pre-drying medium/ hot air and the feed, preferably in the form of a plate, is installed. At the upper, extended part of the fume exhaust chamber 11 a fume exhaust unit 20 is installed. As the fume exhaust unit 20 can be used both exhaust fans and cyclones separating fine particles of the feed from the fumes and discharging the fumes outside. Advantageously, at least three cyclones are provided.

[0029] A method for drying and post-grinding of the pre-ground materials according to the invention is as follows. The pre-ground material, preferably brown coal or coal with a moisture content of 50-60% by weight, is fed by means of the wet feed container 2 and the feed dispenser 3 to the electromagnetic mill 1, in which the feed is post-ground and pre-dried with the pre-drying medium, preferably air at a temperature of 80-100°C and a flux density of $\geq 0.15 \text{ kg/m}^2\text{s}$, supplied through the stub pipe 9 at the inlet of the electromagnetic mill 1 concurrently with the feed material. The post-ground and pre-dried feed at the outlet of the electromagnetic mill 1 has moisture content about 20-30% by weight and is fed by means of a second stream of the pre-drying medium which is supplied to the outlet of the electromagnetic mill 1 through the stub pipe 10, on the vibrating conveyor 12 of the fume exhaust chamber 11, where it is then post-dried and fed to the pre-dried feed receiving container 17. The magnets 14 arranged in the vibrating conveyor 12, and in particular their positioning, accelerate the precipitation of the water particles outside the coal pores and further upwards into

the fume exhaust chamber 11, towards the fume exhaust system 20.

5 Claims

1. A method of drying and post-grinding of pre-ground materials, in particular brown coal or coal, the method comprises the steps of:

supplying the feed of said pre-ground material to the electromagnetic mill (1);
grinding of said feed in said electromagnetic mill (1) and pre-drying of said feed in said electromagnetic mill (1) with a pre-drying medium, supplied to said electromagnetic mill (1);
supplying said feed from said electromagnetic mill (1) to a vibrating conveyor (12) of a fume discharge chamber (11); and
final drying of said feed on said vibrating conveyor (12);

characterized in that:

said feed is finally dried on said vibrating conveyor (12) comprising a ferromagnetic plate (13) on which magnets (14) are arranged with N poles directed towards said ferromagnetic plate (13), while at S poles of said magnets (14) a plate (15) for transporting of the feed is provided.

2. The method according to claim 1, **characterized in that** the lamellar anisotropic ceramic magnets are used as said magnets (14).
3. The method according to claim 1 or 2, **characterized in that** the fumes formed at the final drying step of said feed are discharged from said fume exhaust chamber (11) by means of a fume exhaust unit (20) arranged in the upper part of said fume exhaust chamber (11).
4. The method according to any one of claims 1-3, **characterized in that** said feed is dried in said electromagnetic mill (1) by means of said pre-drying medium being an air at a temperature of 80-100°C and a flux density $\geq 0.15 \text{ kg/m}^2\text{s}$.
5. An apparatus for drying and post-grinding of pre-ground materials, in particular brown coal or coal, said apparatus comprises:

the electromagnetic mill (1) having an inlet and an outlet, wherein both said inlet and said outlet are provided with stub pipes (9, 10) for supplying the pre-drying medium, respectively; and
a fume exhaust chamber (11), which is connect-

ed to said outlet of said electromagnetic mill (1),
 wherein said fume exhaust chamber (11) comprises a vibrating conveyor (12) for receiving of
 said feed from said electromagnetic mill (1), a
 fume exhaust unit (20) in its upper part and a
 pre-dried feed receiving container (17) located
 at the end of said vibrating conveyor (12);

characterized in that:

said vibrating conveyor (12) includes the
 ferromagnetic plate (13) on which magnets
 (14) are arranged with N poles directed to-
 wards the ferromagnetic plate (13), while at
 S poles of said magnets (14) a plate (15)
 for transporting of the feed is provided.

6. The apparatus according to claim 5, **characterized in that** said magnets (14) are lamellar anisotropic ceramic magnets.
7. The apparatus according to claim 5 or 6, **characterized in that** said fume exhaust unit (20) comprises exhaust fans.
8. The apparatus according to claim 5 or 6, **characterized in that** said fume exhaust unit (20) comprises cyclones.
9. The apparatus according to any one of claims 5-8, **characterized in that** said fume exhaust chamber (11) further comprises thermal insulation.
10. The apparatus according to any one of claims 5-9, **characterized in that** said fume exhaust chamber (11) further comprises a guiding baffle of said pre-drying medium in the area of a chute of said feed from said electromagnetic mill (1).
11. The apparatus according to any one of claims 5-10, **characterized in that** said fume exhaust chamber (11) is connected to said outlet of said electromagnetic mill (1) by an elbow connector (8) which has a thermal insulation, wherein said stub pipe (10) is located on said elbow connector (8).
12. The apparatus according to any one of claims 5-11, **characterized in that** said feed transport plate (15) is made of aluminium.
13. The apparatus according to any one of claims 5-12, **characterized in that** said vibrating conveyor (12) is inclined relative to the horizontal direction at an angle of $1 \div 2^\circ$.

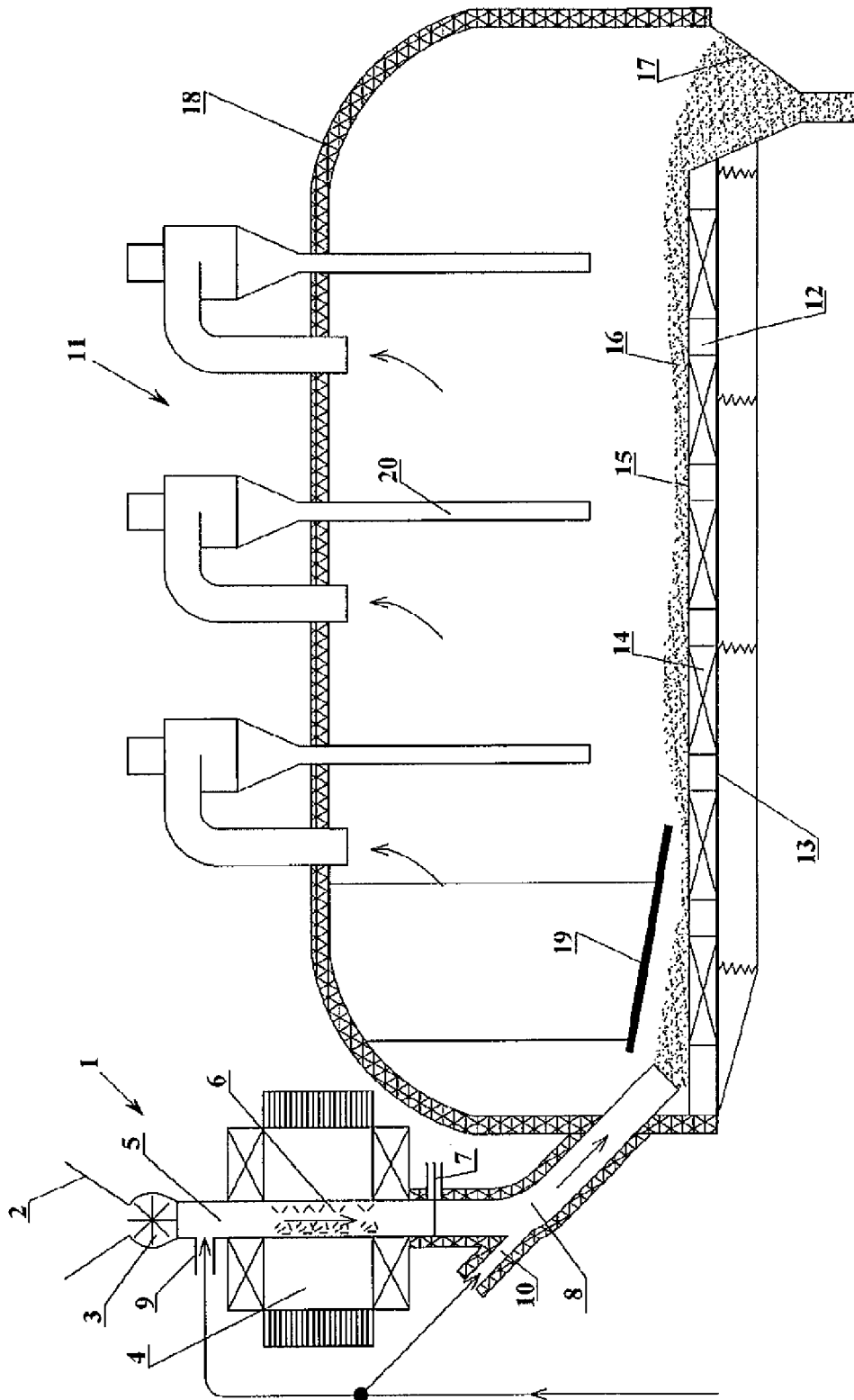


fig. 1

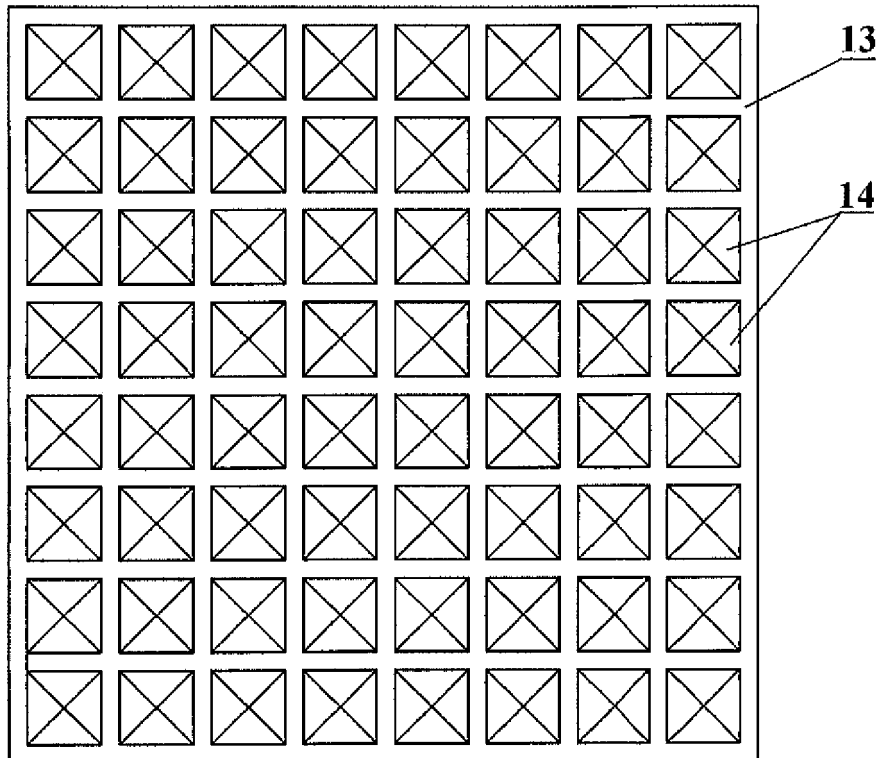


fig. 2



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Application Number
EP 15 18 3864

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 22 November 2016	Examiner De Meester, Reni
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