INNOVATION OF APPARATUS FOR PROCESSING METALS OF LOOSE NATURE TENDING TO AIR OXIDATION, ESPECIALLY ALKALINE EARTH METALS

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Abstract

The paper deals with an experience with innovation process of a technical solution of apparatus for processing metals of loose nature tending to air oxidation, especially alkaline earth metals. The aim of this technical solution is to design a device facilitating the process of treating rare earth metals in a way that would prevent their air oxidation and thus facilitate their handling in the next technological process. The utility model called "apparatus for processing metals of loose nature tending to air oxidation, especially alkaline earth metals" has been created of a standard device to prevent air oxidation without the use of protective devices and thus to facilitate their further handling.

Keywords: Innovation, rare earth metals, apparatus, oxidation

1. INTRODUCTION

The rare-earth metals (hereinafter referred to as "REM") [12,28-30] come from a group of elements with very similar chemical properties [1-3,8,16]. In their metallic form [1,5,7,24], they are soft and chemically reactive metals. The handling and storage of reactive metals in the bulk form, in particular REM, faces a problem caused by air oxidation [31]. This adverse phenomenon makes handling of REM in the bulk form more difficult. This is a reason why these metals [17,20,21,25] are closed and protected against air oxidation by a section (e.g. in the form of a hollow section - tube). During processing the metal is melted together with the section. The section thus subsequently "contaminates" further processing process [22]. It is therefore required to modify them in a way to prevent air oxidation without the use of a protective section, and thus to facilitate further handling of them.

2. A PROBLEM NEEDED TO SOLVE- INNOVATION OF EQUIPMENT FOR TREATMENT OF BULK METALS LIABLE TO AIR OXIDATION, ESPECIALLY RARE-EARTH METALS

Generally known equipment dealing with the transport or dosing of bulk materials to a technological process [4,24], which may be, for example, their surface treatment [19], are described in the following documents.

The patent application no. PV 2013-204 [10] describes a solution which concerns a turnstile feeder which allows fluidization of bulk materials. The solution is from the field of transport of difficult-to-flow materials, and it specifically concerns a new type of the turnstile feeder allowing material fluidization. A friction is formed between the fed bulk material and the rotary drum blade, which adversely affects transport of the bulk material. By combining the movement of the rotary drum [11], and blades featuring grooves and channels with a supplied fluidization medium, the transport of the fed bulk material can be significantly positively affected. The turnstile feeder comprises a hopper fitted with a load-bearing structure, in which a rotary drum is situated, comprising a hollow shaft which is fitted with blades to transport the bulk material. Grooves are milled in the lower part of the blades, in which channels to supply air are situated. The hollow shaft is driven by an electric drive and air is supplied to its channels in the lower part of the blades, which ensures fluidization of the transported material in combination with the movement of the rotary drum blades. The turnstile feeder according to the invention is applicable in the field of transport of bulk materials and in their processing, such as metal treatments [6,14].

The utility design application no. PUV 2010-22540 [10] describes a technical solution which relates to the feeding of bulk compressible material from a storage area to a technological area, where the pressure in the storage differs from the pressure in the technological area. The technical solution consists of a storage area and a technological area. The storage area is intended for the collection of a light bulk compressible material in the loose state. Commonly, there is an atmospheric pressure in the storage area. A technological area means a bordered environment with different pressure parameters than those in the storage area. Typically, these are pneumatic supply pipelines or supply shafts. A feature of the technological area is that it is equipped with a pressure proof cover which separates the technological area from its vicinity and from the storage area. A pushing conveyor is led from the storage area, whose outlet leads to the input end of the compressing chamber, arranged at the interface of the storage area and the technological area. The pushing conveyor can be of various models. It can be a rotary, plunger etc. pushing conveyor. The pushing conveyor contains a pushing element which is designed to push the bulk compressible material to the compressing chamber in the direction of its longitudinal axis. Every pushing conveyor is equipped with a driving unit. Opposite the discharge end of the compressing chamber, leading to the technological area, there is a compression stopper. The compression stopper is fitted on a closing plate with a contour line at least as large as the clearance of the discharge end of the compressing chamber. A cutting tool with a blade is fitted in the gap between the output end of the compressing chamber and the front face of the closing plate. The cutting tool is movably fitted in the direction perpendicular to the direction of the compressing chamber longitudinal axis. The output end of the compressing chamber, the closing plate and the cutting tool are fitted in a pressure proof cover which is adjusted for being connected to the technological area, which is an input shaft leading to the combustion equipment in the example of invention embodiment. The blade can make a shifting movement against the output end of the compressing chamber, similar to the movement of a guillotine, or a rotary movement with the axis which is in parallel with the longitudinal axis of the compressing chamber. During operation the bulk compressible material gets by gravity to the bottom of the channel where a helix rod of the worm pushing conveyor is turning [11]. It transports the bulk compressible material to the compressing chamber. As the closing plate of the compression closure is led opposite to the bulk compressible material, a working pressure is formed in the compressing chamber, by the effect of which a dense packer is formed from the bulk compressible material, which fills in the whole compressing chamber up to the compression closure. The packer therefore separates, in terms of pressure, the storage space from the technological one. The cutting tool on the closing plate turns at the same speed as the helix rod, and therefore a relative speed is formed between the cutting tool and the packer, which carries the blade of the cutting tool against the packer. The cutting tool thus continuously cuts the coming packer, thereby loosening it. After the temporary dense phase the original bulk compressible material thus becomes bulk raw material again, although with a different lumpiness. This bulk raw material, which passed under the effect of the compression closure and the cutting tool to the technological area, can be transported to the point of destination in the technological area by means of any means of transport.

The patent application no. PV 2013-121 [10] describes an invention which solves transport of difficult-to-flow materials, and it specifically deals with a helix rod and fluidization worm conveyor. The helix rod comprises a hollow shaft around which a helix is wound. The hallow shaft features small, evenly distributed channels in the longitudinal direction at contact points with the helix, for feeding a fluidization medium to the chambers of the helix, which end with openings through which the fluidization medium is transported and distributed to the transported material. The fluidization worm conveyor consists of a hopper, a helix rod situated in a channel or tube and a discharge chute. The helix rod rotates around its axis, thereby moving the material from the hopper to the discharge chute, where the transported material is concurrently fluidized under the pressure supplied by the fluidization medium. The embodiment according to the invention is suitable for transporting difficult-to-flow or bulk materials.

The most frequently used possibility of REM surface treatment is the application of a protective coat in the form of other metals [13,15,18], the so-called metal-plating, such as zinc, nickel, silver and gold plating. There are numerous technologies for the coat application [9], starting from brush painting, dipping spraying, electrostatic painting, galvanization etc. The application of another layer of a different metal on the REM surface is an invasive method and it causes contamination in the following technological process.

The goal of the technical solution is to propose a design of equipment facilitating REM treatment in a way which would prevent their air oxidation, and thus facilitate handling of them in further technological process and particle characterization [26,27].

2.1. Technical solution

The technical solution deals with the design of the equipment for REM treatment which allows their treatment in the bulk form.

The aforementioned deficiencies are eliminated by the equipment for the treatment of bulk metals liable to air oxidation, especially of alkaline-earth metals, the essence of which rests in the fact that it comprises a load-bearing structure on which there is a storage tank equipped with a protective gas supply and a hopper, where the storage tank includes a feeder including a shaft with a helix which partly reaches into a heated tube with a flange, and the shaft is further connected to a drive, where the heated tube is surrounded by a heating system and the heated tube is connected to the storage tank by the flange and to the load-bearing structure by supports.

The equipment for the treatment of bulk metals liable to air oxidation, especially of alkaline-earth metals, the essence of which is that it consists of a turnstile feeder with a hopper equipped with a valve, where the turnstile is connected to the inlet pipeline which contains an axis-free worm, where the inlet pipeline is connected to a heated tube on one end by flanges, the tube is surrounded by a heating system, while on the other end, it is equipped with a protective gas inlet.

In each embodiment of the equipment it is a solution which uses completely non-invasive REM surface treatment which suppresses air oxidation of REM and facilitates handling of rare metals. It is a thermal sintering of bulk material in a protective atmosphere. This prevents oxidation of individual grains of bulk metals and the material treated in this manner need not be protected or closed in sections, and therefore there is no danger of contamination etc.

There is a significant difference from the prior art in that the equipment is composed - a continuous line - which moves REM under high temperatures in a protective atmosphere through a worm conveyor, and subsequently sintering occurs under high temperatures. The material - metal sintered into a solid form - continuum and it further does not oxidize. A protective section therefore need not be further used.

An advantage of the presented technical solution is that it allows to eliminate air oxidation of rear-earth metals, or bulk metals liable to air oxidation, and thus facilitates further handling of them. This is achieved by the development of the equipment for sintering metals of bulk character under a protective atmosphere, which results in the elimination of oxidation of individual grains of bulk metals. Furthermore, the treated material need not be protected and closed in sections, and therefore the danger of contamination does not arise etc.

2.2. Description of the innovation features and functionalities

The presented technical solution will be explained in detail in a drawing in which **Figure 1** shows an embodiment of the bulk metal treatment equipment, **Figure 2** shows a ground plan of the equipment, **Figure 3** shows the front view of the equipment.

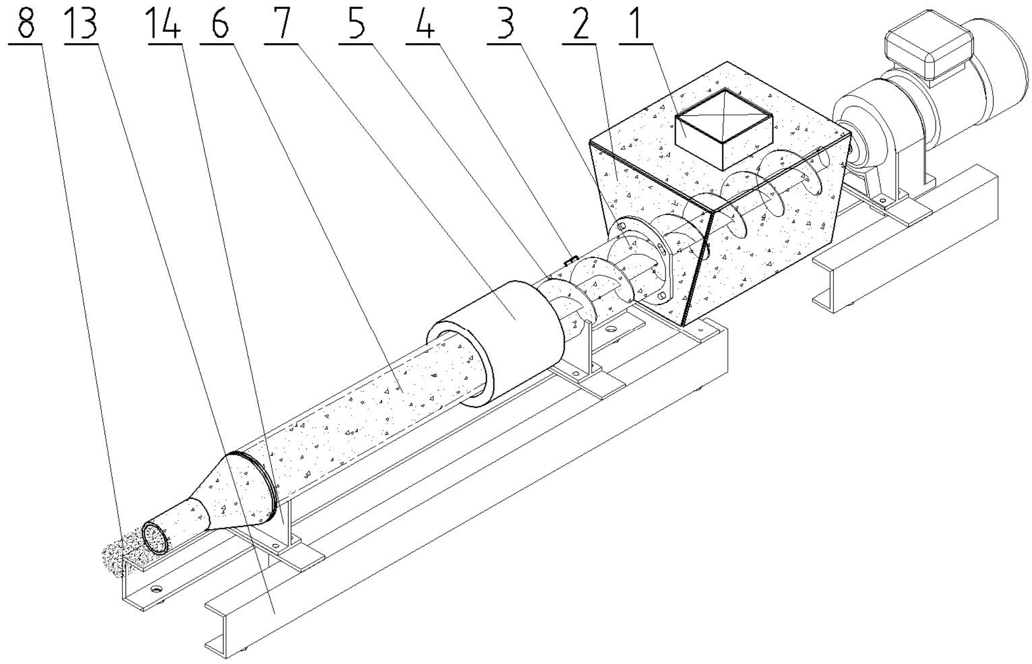

Figure 1 Embodiment of the bulk metal treatment equipment

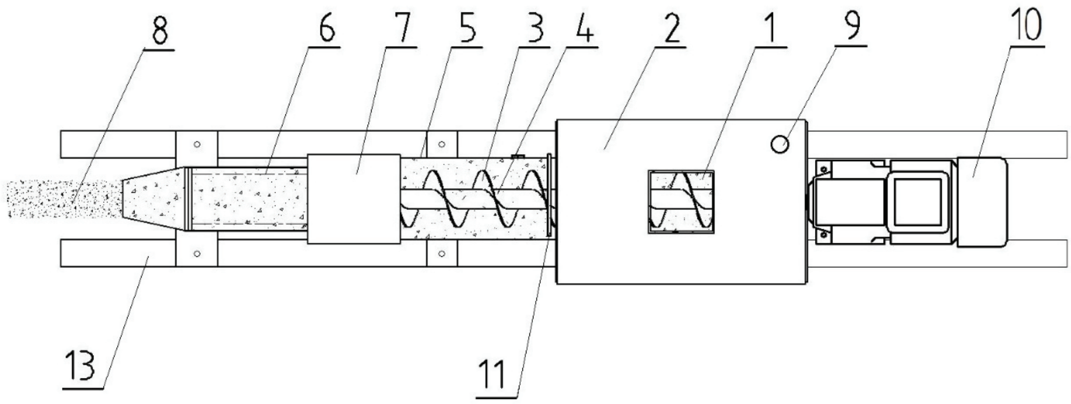

Figure 2 Embodiment of the bulk metal treatment equipment

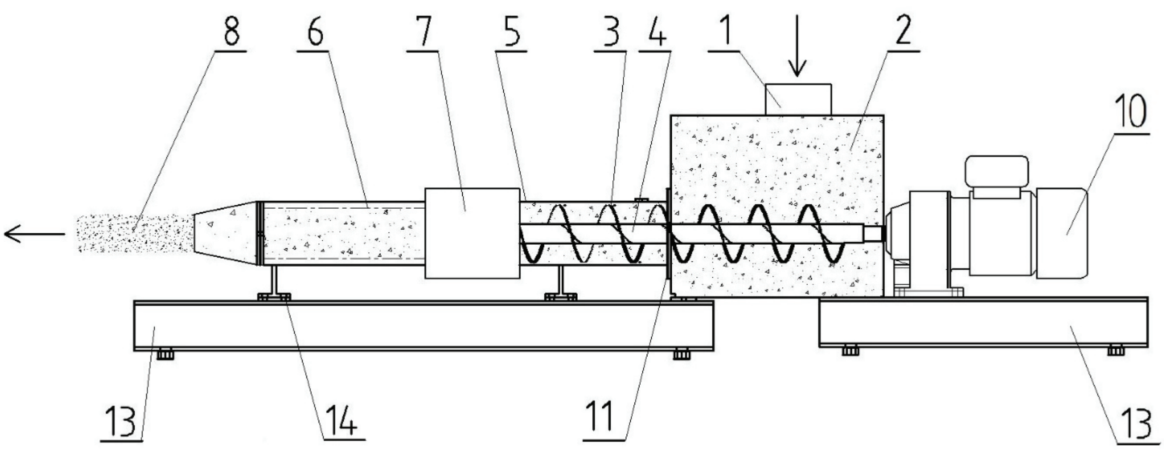

Figure 3 The front view of the equipment

Utility model source [10]:
https://worldwide.espacenet.com/publicationDetails/biblio?DB=EPODOC&II=3&ND=3&adjacent=true&locale=en_EP&FT=D&date=20150429&CC=CZ&NR=28113U1&KC=U1

2.3. An example of technical solution embodiment

The layout of the embodiment of the bulk metal treatment equipment liable to air oxidation, especially alkali-earth metals, will be explained on an exemplary embodiment with a reference to the relevant drawings. It shall be understood that the below-given descriptions are an illustrative expression of the application of principles of this technical solution.

In general, the equipment for treatment of bulk metals **6** liable to air oxidation, the treatment equipment especially for alkali-earth metals, is shown in **Figure 1** through 3. The equipment of this embodiment consists of a load-bearing structure **13**, on which there is a storage tank **2** with a hopper **1**, which is equipped with a protective gas inlet **9**. A shaft **4** with a worm **3** goes through the storage tank, which reaches into a heated tube **5** with a flange **11**, by which the heating tube **5** is connected to the storage tank **2**, where the other end of the shaft **4** is connected with a drive **10**. Furthermore, on the heating tube **5** there is a heating system **7** that sintered the bulk metals **6** to the continuum of metal materials **8** and the tube is connected with a load-bearing structure **13** by means of supports **14**.

3. CONCLUSION

In this paper, the methodology of innovation of equipment for treatment of bulk metals liable to air oxidation, especially rare-earth metals in the form of utility model in cooperation with the commercial sector under the auspices of the university. The main objective was the equipment innovation from the draft idea through the cooperation with the patent representative and the university as far as to finding of a commercial partner for the registered utility model.

There is described, an exact way for finding a solution, including the steps necessary to be adopted for the utility model registration [23]. A significant part of these procedures is an exact description of the concrete work - utility model: Apparatus for processing metals of loose nature tending to air oxidation, especially alkaline earth metals starting from the state of the art in the form and findings of concrete similar constructions, over the publication of the invention subject matter, including its description of functions and drawings, and ending with the composition of utility model claims necessary for filing the utility model application and the utility model implementation into the commercial sector.

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