

(19)



(11)

**EP 4 559 578 A1**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**28.05.2025 Bulletin 2025/22**

(51) International Patent Classification (IPC):  
**B02C 13/20** <sup>(2006.01)</sup> **B02C 13/288** <sup>(2006.01)</sup>  
**B02C 23/06** <sup>(2006.01)</sup>

(21) Application number: **24214780.9**

(52) Cooperative Patent Classification (CPC):  
**B02C 13/20; B02C 13/205; B02C 13/288;**  
**B02C 23/06**

(22) Date of filing: **22.11.2024**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB**  
**GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL**  
**NO PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA**  
Designated Validation States:  
**GE KH MA MD TN**

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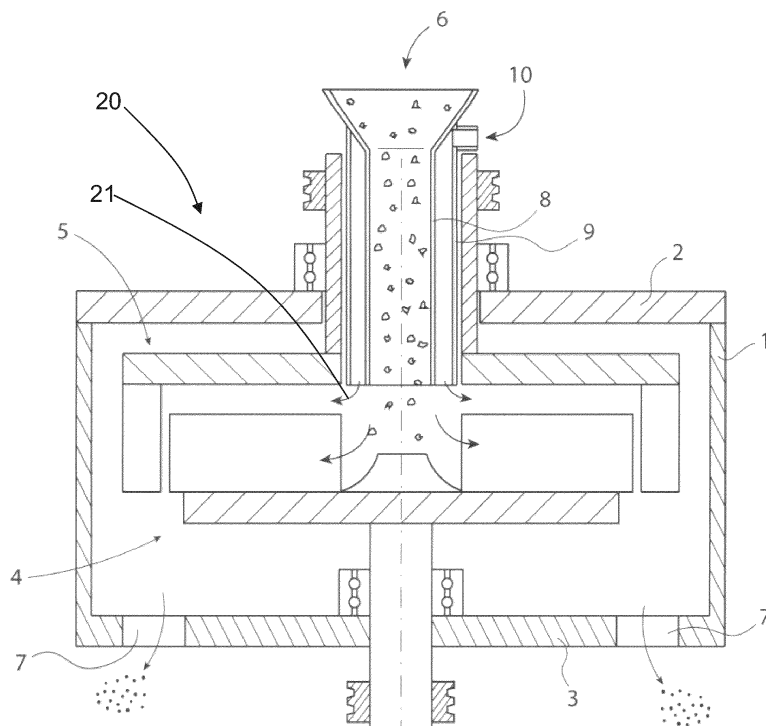
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(30) Priority: **24.11.2023 FI 20230107 U**

(54) **MILL**

(57) The object of the invention is a mill (20) comprising a housing (1), a lid (2) and a base (3) and inside which mill (20) are two rotors, an inner rotor (4) and an outer rotor (5), rotating in opposite directions, forming a crushing means, in which case material (6) to be crushed is feedable by means of an input pipe (8) to the center of the inner rotor (4), from where, owing to centrifugal force, the

material (6) to be crushed moves to the outer rotor (5) and onwards out of the mill (20) via the apertures (7), and in that around the input pipe (8) is another parallel guide pipe (9), in which case the pipes (8, 9) together form an air channel and nozzle for air coming via the aperture (10) to inside the mill (20).



**Fig. 1**

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## Description

**[0001]** The object of the present invention is a mill according to the independent claim. Other preferred embodiments of the invention are presented in the dependent claims.

**[0002]** The mill according to the invention is well suited for e.g. crushing crushed steel slag, combustion ash, bottom ash (IPA) or other industrial side streams, such as e.g. lime. The mill comprises a housing, a lid and a base, and inside the mill is a crushing means by the aid of which the material to be crushed is broken down. The crushing means comprises two rotors rotating in opposite directions, an inner rotor and an outer rotor, allowing material to be fed to the center of the inner rotor. From here, owing to centrifugal force, the material is ejected to the outer rotor and from there onwards, through the output apertures in the base at the bottom, out of the mill.

**[0003]** The solution according to specification FI 128329 B represents the state of the art. In this solution, air is supplied to inside the mill through the gap between the rotating pipe shaft of the upper rotor and the stationary input pipe for the material to be crushed. The purpose of the solution is to supply compressed air, or compressed air and water, into the mill from the air gap. The aim is to reduce the dispersion of toxic dust particles into the environment while at the same time cooling the material to be crushed. A drawback of the solution is the poor dispersion inside the mill of the compressed air supplied into the mill. The air flow enters the mill only parallel to the shaft of the mill, which means that its dispersion inside the mill is not optimal. At the same time, it should be noted that this solution specifically attempts to moisten the material to be crushed, which is the opposite of the solution according to the present invention.

**[0004]** The solution according to the invention aims to reduce the problems caused by moisture inside the mill. The solution ensures that the air supplied to inside the mill is efficiently dispersed into the material to be crushed, in which case moisture is removed from the material and moisture causes fewer problems for the operation of the mill. Moisture in the material to be crushed causes the material to adhere to the surfaces of the crushing means and to the inner surface of the mill. Likewise, moisture inside the mill causes the material to clump together again. When the air supplied to inside the mill can be efficiently mixed with the material to be crushed, the need to clean the internal parts of the mill from the material adhering to them is reduced.

**[0005]** The purpose of the present invention is to further improve the operating efficiency of the air supplied to inside the mill. This is achieved with a solution in which there is another parallel guide pipe for air around the input pipe for material, which pipes together form an elongated, tubular nozzle for the air to be supplied into the mill, in which case air is supplied from the top downwards between the inner rotor and the outer rotor. The different

embodiments of such a solution allow air to spread efficiently inside the mill, thereby reducing the caking of material and its adhesion to the mill structures. One preferred embodiment according to the invention is characterized in that there are holes in the guide pipe at the lower end of the air nozzle, from which holes air is able to discharge in the radial direction of the shaft of the mill.

**[0006]** In the following the invention will be described in more detail with the aid of some examples of its embodiment with reference to the attached simplified drawings, wherein

Fig. 1 presents a cross-section of a preferred embodiment of the mill, and

Fig. 2 presents a solution for the lower part of the air nozzle according to one preferred embodiment.

**[0007]** The mill 20 comprises a housing 1, a lid 2, and a base 3. Inside the mill is a crushing means, by means of which the material 6 can be crushed. The crushing means is formed from two rotors rotating in opposite directions, i.e. an inner rotor 4 and an outer rotor 5. The material 6 is feedable to the center of the inner rotor 4, from here, owing to centrifugal force, it is ejected to the outer rotor 5 and onwards out of the mill 20 through the output apertures 7 in the base 3 at the bottom. Around the input pipe 8 for material 6 is another parallel guide pipe 9, which pipes together form an elongated, tubular channel and a nozzle for air, which air is feedable through the input aperture 10 down between the inner rotor 4 and the outer rotor 5, according to the arrows 21, from the ring-shaped aperture formed by the pipes. The air supplied is preferably compressed air, which can be supplied with a steady flow or in pressure pulses to inside the mill 20. A steady input of compressed air enhances the milling of the material. Pressure pulses, on the other hand, effectively remove the material 6 attached to the structures inside the mill 20, thereby reducing the need to stop and open the mill for mechanical cleaning. From the viewpoint of the sealing of the mill 20 it is advantageous to bring air to inside the mill with a separate pipe solution according to the invention, compared to a state-of-the-art solution where air is brought inside the mill through the gap between the input pipes of the material 6 and the shaft of upper rotor.

**[0008]** Moisture inside the mill 20, possibly supplied along with the material, causes problems in the operation of the mill. Moisture binds the small particles of crushed material to each other, to the walls of the mill 20, and also to parts of the crushing means. In the solution according to the invention, the air supplied to inside the mill 20 is distributed more evenly and more efficiently inside the crushing means and the mill, and prevents the material from adhering to the walls and rotors. Air also assists transportation of material 6 out of the mill through the mill 20 and the output apertures 7.

**[0009]** Fig. 2 presents a preferred embodiment of the lower part of the air nozzle. The input pipe 8 for material 6 and the guide pipe 9 for air protrude from the underside of

the outer rotor 5. Preferably these pipes 8 and 9 extend 10-70 mm, and very preferably 10-40 mm, downwards from the underside of the outer rotor 5. As shown in Figure 2, in the guide pipe 9 are holes 11, from which air can also be discharged to the side, i.e. in the radial direction of mill 20 as shown by the arrows 21. Such radial flow, steady or pulsed, provides efficient mixing of air with the material 6 to be crushed and, in particular, keeps the underside of the upper rotor, i.e. the outer rotor 5, and the crushing means clean of the material. The fabrication of these sort of air holes in a solution that complies with the state of the art is impossible because the outer wall of the air channel is the shaft of the rotor.

**[0010]** The holes 11 in the guide pipe 9 can be made directly parallel to the radius of the mill 20, as is presented in Fig. 2, or preferably also at an oblique angle, facilitating flow through the holes and allowing more air to flow radially through the wall of the guide pipe. In such a case, the aperture of the hole 11 inside the guide pipe is higher than the aperture of the hole on the outer surface of the guide pipe. The angle of inclination can be freely chosen between the flow coming straight through the axial guide pipe 9 of the mill 20 and holes in the radial direction. Preferably the angle is 20-70 degrees moving from the radial direction to the axial direction and very preferably 35-55 degrees. The holes 11 in the guide pipe 9 can be at one or more different distances from the bottom end of the guide pipe. Also, the aperture of the hole 11 on the inner surface of the guide pipe 9 may be at a different point on the circumference of the guide pipe in a lateral direction from the outlet aperture of the hole on the outer surface of the guide pipe, thereby causing the airflow to be turned in the direction of the circumference of the guide pipe and causing eddies inside the mill.

**[0011]** The radial airflow of the mill 20 can also be enhanced by making the input pipe 8 slightly longer than the guide pipe 9 and by expanding the inlet aperture of the input pipe inside the mill by bending the input pipe to be horn-like in shape. This allows the flow to be turned in the radial direction and the flow inside the mill to be enhanced.

**[0012]** In addition to the guide pipe 9, there can also be holes 11 in the input pipe 8, allowing air to be mixed directly into the material 6 to be crushed as soon as the material arrives between the rotors. Such holes 11 in the input pipe, 8, may also be located higher in the structure of the input pipe and their location is not limited to the section of the input pipe below the bottom surface of the outer rotor 5. The holes in both the pipes 8 and 9 do not all need to be at the same angle, but instead the pipes can comprise holes at different angles. In addition, the apertures (inlet and outlet) of the holes 11 of the guide pipe 9 and/or of the input pipe 8 on the surfaces of the aforementioned pipes may be at a different point in the direction of the circumference of the pipes, in which case air is made to eddy inside the mill 20. Likewise, part of the ring-shaped air gap between the input pipe 8 and the guide pipe 9 in the space between the rotors 4 and 5 can be

covered, in which case the air flow through the holes 11 in the radial direction of the mill 20 is enhanced. This covering can be done e.g. by welding shut-off blocks to part of the air gap.

**[0013]** It is obvious to the person skilled in the art that the invention is not limited to the examples described above, but that it may be varied within the scope of the claims presented below. Apart from steel slag, the mill is suited for crushing combustion ash, bottom ash (IPA) or other industrial side streams, such as e.g. lime. The invention is extremely advantageous in processing material masses containing moisture. The separation of metals from the crushed mass is performed with apparatus and methods that are *per se* known in the art. Iron particles, for example, can be separated by means of a magnetic separator and other, non-magnetic, metals e.g. with chemical methods known in the art. The apparatus can also be used for adding water to material for crushing that is dry or for adding various chemicals to the material.

## Claims

1. Mill (20) comprising a housing (1), a lid (2) and a base (3) and inside which mill (20) are two rotors, an inner rotor (4) and an outer rotor (5), rotating in opposite directions, forming a crushing means, in which case material (6) to be crushed is feedable by means of an input pipe (8) to the center of the inner rotor (4), from where, owing to centrifugal force, the material (6) to be crushed moves to the outer rotor (5) and onwards, via the apertures (7) out of the mill (20), **characterized in that** around the input pipe (8) is another parallel guide pipe (9), in which case the pipes (8, 9) together form an air channel and nozzle for air coming via the aperture (10) to inside the mill (20).
2. Mill (20) according to claim 1, **characterized in that** the guide pipe (9) and input pipe (8) preferably extend 10-70 mm, and very preferably 10-40 mm, outwards from the bottom surface of the outer rotor (5).
3. Mill (20) according to claim 2, **characterized in that** in the guide pipe (9) are holes (11) in the section of it protruding outwards from the bottom surface of the outer rotor (5).
4. Mill (20) according to claim 2 or 3, **characterized in that** in the input pipe (8) are holes (11).
5. Mill (20) according to claim 3 or 4, **characterized in that** the holes (11) of the guide pipe (9) and/or of the input pipe (8) are in the radial direction of the mill (20) or at an angle between the radial direction and the direction of flow between the pipes (8, 9), preferably at an angle of 10-70 degrees and very preferably 35-55 degrees moving from the radial direction to the direction of flow.

6. Mill (20) according to claim 3 or 4, **characterized in that** the apertures of the holes (11) of the guide pipe (9) and/or of the input pipe (8) on the surfaces of the aforementioned pipes (8, 9) are at a different point in the direction of the circumference of the pipes (8, 9), in which case air is made to eddy inside the mill (20). 5
7. Mill (20) according to any of claims 3-6, **characterized in that** the ring-shaped aperture inside the mill (20) formed by the input pipe (8) and the guide pipe (9) is partially blocked to enhance radial flow. 10
8. Mill (20) according to any of claims 2-7, **characterized in that** the input pipe (8) extends farther from the bottom surface of the outer rotor (5) of the mill (20) than the guide pipe (9), and **in that** the end of the input pipe (8) is horn-like in shape. 15

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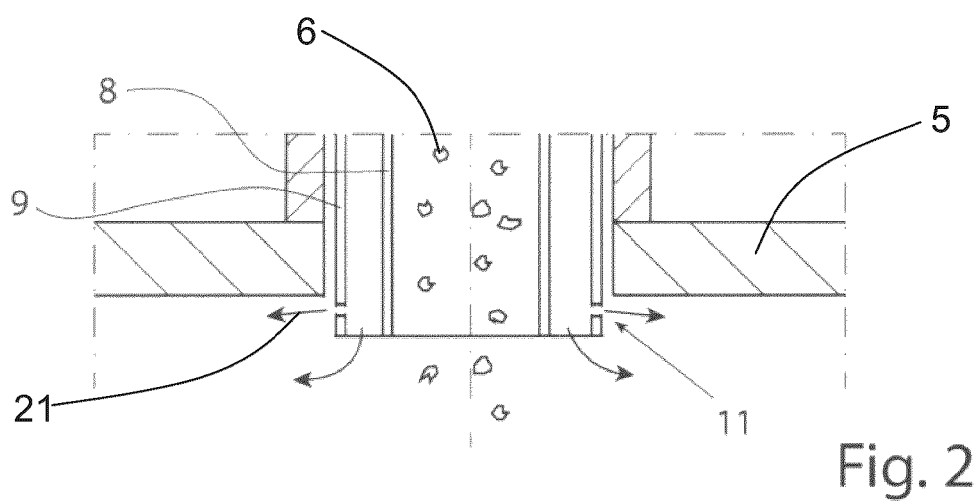
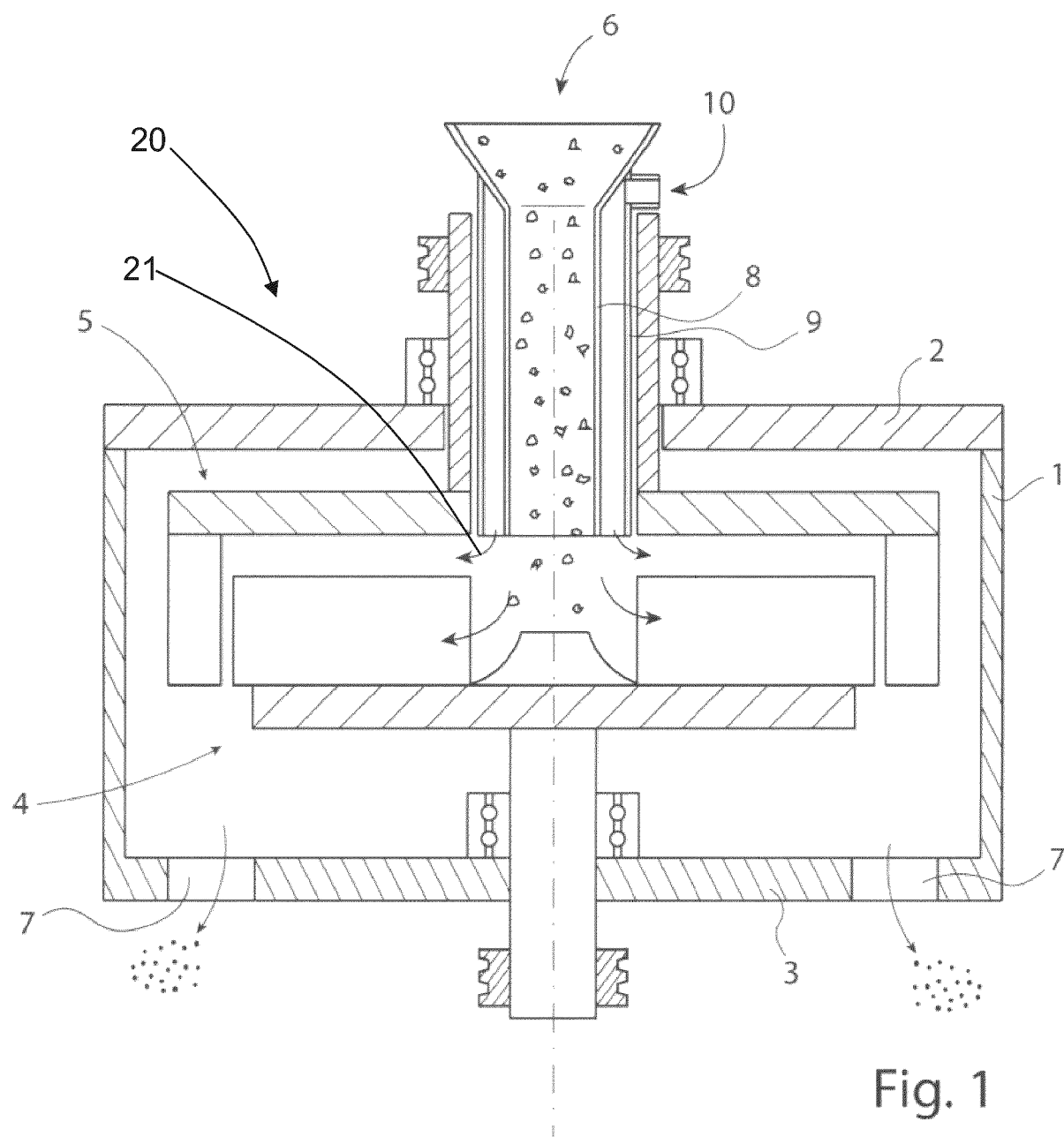
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## EUROPEAN SEARCH REPORT

Application Number

EP 24 21 4780

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