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A method of operating a mill and a mill operated in accordance with the method.

The invention relates to a method of operating a mill of the kind having a mill body provided with end-walls, and including a mill burden discharge trunnion arranged externally of one end-wall. The mill is rotated about a generally horizontal rotational axle which is common to the mill body and the discharge trunnion. The inventive method is characterized by resting the mill body on at least two supports so arranged as to support the whole of the mill, and by rotating the mill body, while supported by these supports, by means of a hydraulic motor which is connected mechanically to the discharge trunnion and the rotational axle of which is common to the rotational axle of the discharge trunnion and the mill.

The invention also relates to a mill which includes two end-walls which extend generally perpendicular to their respective rotational axes and through which mill burden is introduced into and discharged from the mill respectively, a cylindrical mill casing which is supported between the end-walls and connected mechanically thereto, and a mill burden discharge trunnion which is connected to the discharge end-wall and faces outwardly therefrom. The mill is characterized in that each end-wall includes a support ring having an outwardly-facing contact surface and being generally parallel with the rotational axle; in that the discharge end-wall and the discharge trunnion are intended to transmit requisite torque from the discharge trunnion; and in that the discharge trunnion is intended for connection to the hydraulic motor by means of which the mill is rotated.

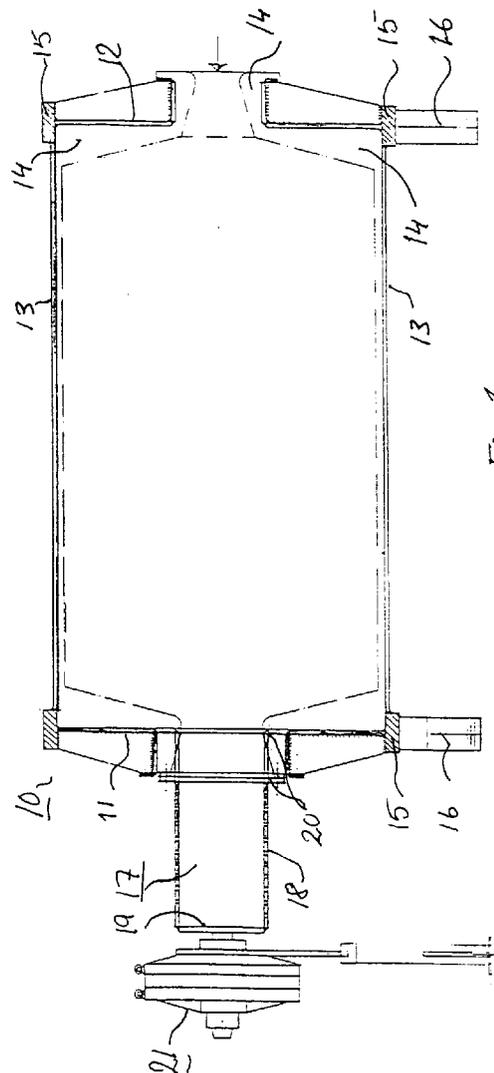


Fig. 1

The present invention relates to a method of operating a mill of the kind comprising a mill body having side walls and a hollow discharge trunnion arranged externally of one side wall, and in which the mill body is rotated by means of a substantially horizontal shaft which is common to both the mill body and the discharge trunnion.

The invention also relates to a mill which includes two end walls which extend generally perpendicular to their rotational axes and through which material to be ground, i.e. the mill burden, is introduced to and discharged from the mill respectively, a cylindrical mill casing which is supported between said end walls and mechanically connected thereto, and a mill burden discharge trunnion which is connected to and faces outwardly from the end-wall through which the mill burden is discharged.

Mills are used for grinding material that has an initial particle or lump size of from 5-40 mm, down to varying product sizes. Such mills are used at present within different fields, such as within the mining, cement, lime and porcelain industry, and also within the chemical industry.

In principle, such mills are operated in accordance with two different systems. In the case of so-called journal mills in which the mill body is supported on journal bearings consisting of roller or plain journal bearings, the mill is rotated by motors which, via gears and couplings, transmit the requisite power to the mill body through the medium of gear drives and gear rings arranged externally of the mill body. In the case of so-called rolling mills, the mill is rotated by motors which drive rollers that transmit the requisite power to the mill body by frictional drive means. In this latter case, the rollers function both as mill support means and mill drive means. Rolling mills are preferred in many instances, because they can be readily installed and because the investment and maintenance costs involved are low and because the mills can be easily used.

Hybrid forms of the two main groups of mill are also available, for instance mills which are driven by gear drives and which rest on non-driven rollers, and tube mills which, as described in EP-A-184 326, comprise non-driven rollers and a drive shaft.

Also available are mills which are based on grinding or attrition of the burden by vibration instead of rotation, these mills being emptied by means of non-driven rollers, as described in CH-A-383 735.

There is desired commercially a type of mill and a mill operating method which will afford further technical advances, as compared with those mills and mill-operating methods known to the art at present. These additional technical advances may, for instance, involve simpler control of mill operation, additionally reduced maintenance costs and a simpler, less expensive mill construction. Neither roller operated mills nor mills that are operated through the

medium of gear rings are sufficiently flexible to handle all situations, for instance those situations which require the mill body to be rotated slowly and through small angles of rotation when carrying out certain kinds of maintenance work on and within the mill. Consequently, it is necessary in many cases, to provide additional drive means for this type of mill operation, which results in unnecessary costs. In the case of roller mills, the problem is manifested in wear on the rubber rollers and in the relatively low permissible loads on each wheel, which necessitates the use of many drive wheels. Furthermore, the utility of the mill is limited by the necessity of avoiding high temperatures during a grinding or attrition process, i.e. the burden being ground must not be heated appreciably by the grinding effect, since this heat would spread out through the mill casing and to the rollers. The rubber rollers are unable to tolerate temperatures much in excess of 75-80°C without fracturing and being quickly destroyed. In principle, this renders it impossible to dry-grind material in such roller mills. A switch to metal wheels, for instance wheels made of nodular iron, would permit the permitted load on each wheel to be increased by 30-50 times, while simultaneously providing a roller resistance which is about 15% lower. In such cases, however, a problem resides in the greatly impaired possibility of driving the mill via the wheels, and consequently such wheels or rollers can only be used to support the mill body while rotation of said body must be effected in a conventional manner with the aid of a gear drive and gear rings.

The object of the present invention is to provide a novel mill operating method and also to provide novel mills in which the drawbacks mentioned in the introduction are substantially eliminated and which will fulfil to a great extent the majority of the desiderata expressed commercially with respect to technical development of such mills and the manner in which they are operated.

Accordingly, the inventive method is characterized by the steps set forth in the following Claim 1, and the inventive mill is characterized by the features set forth in the following Claims 2-5.

Thus, the inventive method involves causing the mill body to rest on at least two supports which are arranged in a manner such as to support the entire mill. The mill is rotated by means of a hydraulic motor which is connected mechanically to the burden discharge trunnion and the rotational axle of which is common with the axle of the discharge trunnion and the mill axle.

The drive means used is a hydraulic motor, which is mounted either directly on the discharge trunnion or on a shaft or the like which is connected axially to the trunnion, optionally via a gear arrangement. Such hydraulic motors are commercially available in sizes and in power outputs which are sufficient to drive mills of the size necessary for industrial use. Hydraulic

power is obtained by oil or an oil-water mixture under pressure, this pressure being maintained by rotary pumps. Hydraulic power has the advantage that the space required for power transmission is much smaller than the space required for conventional drive systems. Consequently, a hydraulic motor which is sufficiently strong to operate large and heavy mills with a full load of burden is much easier to control and to handle than corresponding electric motors. The speed of a hydraulic motor can be readily controlled and the rotational direction of such motors can be easily reversed. Small and slow movements and stationary conditions can be achieved readily without the need for additional equipment. Hydraulic motors suitable for such mill operating conditions are retailed under the trade name Marathon by Hägglunds Denison Drives AB, Mellansel, Sweden.

According to the present invention, the mill body rests on at least two supports. It is proposed in this respect that the mill is supported on supports in the form of metal rollers or wheels, for instance made of nodular iron. When the supports have the form of rollers or wheels, each support will preferably comprise two rollers or two wheels. When two rollers or two wheels are used, the rollers or wheels are preferably spaced apart at a distance which is smaller than the diameter of the mill and greater than their own diameters. A suitable roller spacing can be calculated on the basis of the rollers and on that part of the mill which rolls on said rollers, so as to obtain a desired pressure between rollers and mill. It may, of course, sometimes be appropriate for each support to comprise more than two rollers or wheels, for instance in the case of extremely heavy or large mills. The inventive method prefers that the friction generated between supports and mill is as low as possible, and consequently the rollers or wheels are chosen with an appropriate surface to this end and with the smallest possible intrinsic roller resistance.

Alternatively, the supports may have the form of static slide surfaces against which corresponding slide surfaces on the mill move. These slide surfaces may be lubricated so as to reduce the frictional forces generated therebetween, or may have the form of hydrostatic plain bearings.

The inventive mill has provided at each end-wall thereof a support ring which has an outwardly-facing contact surface and which is essentially parallel with the rotational axis. This support ring is either an integral part of the actual end-wall itself or is fixedly mounted thereto. The contact surface of said ring is intended to rest against the support, so that the mill will be carried by the support and so that the smallest possible frictional forces are generated between support and support ring as the mill rotates. Thus, the contact surface is chosen either for use in combination with metal support rollers or wheels, or in combination with supports in the form of slide surfaces.

The discharge end-wall and burden discharge trunnion of the mill are constructed to transmit the necessary torque from the discharge trunnion. The discharge trunnion is arranged for connection to the hydraulic motor by means of which the mill is rotated. The free end of the discharge trunnion is suitable provided with means for connecting said trunnion to the hydraulic motor which functions to rotate the mill, said means having the form of a shaft whose rotational axle is common with the trunnion axle, for instance.

The invention will now be described in more detail with reference to an exemplifying embodiment of thereof illustrated in the accompanying drawing, in which Figure 1 is a longitudinal section view of a mill according to a preferred embodiment, illustrating drive means and supports for mill operation in accordance with the inventive method; and Figure 2 shows the same mill from the infeed end thereof.

Figure 1 illustrates a mill, generally referenced 10, having two end-walls 11, 12 and a cylindrical mill casing 13 arranged between said end-walls. The inner surface of the mill casing 13 is lined with a lining 14, which protrudes out through the end-walls 11, 12 such as to afford protection to the infeed and outfeed openings provided in respective end-walls. Mounted in each of the end-walls 11, 12 is a respective support ring 15 which extends around the full periphery of its respective end-wall. The support rings 15 rest against supports 16, which may have the form of rotating wheels or rollers or static slide surfaces, although in the case of the Figure 2 embodiment said supports have the form of wheels 16a. The left end-wall 11 of the illustrated embodiment is assumed to be the burden outfeed end-wall, and arranged externally of said wall is a cylindrical burden discharge trunnion 17 which comprises a casing 18 and an end-wall 19. The casing 18 is fixedly connected to the outfeed end-wall 11, as shown at 20. Mounted externally of the end-wall 19 of the trunnion 17 is a hydraulic motor which functions as a drive means 21 and which is connected directly to said trunnion end-wall 19 for transmission of the torque required to rotate the mill.

Figure 2 shows the manner in which the mill 10 may be supported when the supports have the form of wheels 16a. The wheels 16a are positioned so that the angle $\alpha + \beta$ illustrated in the Figure is the most suitable for operation of the mill concerned, partly with respect to the friction generated between the mill support rings 16 and the wheels 16a, and partly with respect to those forces or loads to which the wheels 16a are subjected by the weight of the mill and by rotation of the mill.

The combination of inventive method steps enable a mill and a mill drive to be constructed which has important advantages over known techniques. Some of these advantages have already been indicated in the introductory paragraphs above, for instance easier control of mill operation, reduced

maintenance costs, simplified mill constructions, and the possibility of effecting slow and small rotational movements of the mill, for instance when carrying out maintenance work, since no additional drive means are required, with the exception of the hydraulic motor. In addition to these advantages, the following advantages are also afforded by the invention:

* The mill can be used without needing to place special demands on the ambient surroundings, since the hydraulic motor is able to withstand dust and other environment influencing factors. The drive unit of the motor which produces the hydraulic power can be positioned far from the actual motor itself with no disadvantage, so as to be protected from a possibly dirty environment.

* When practicing the present invention, the torque applied during a grinding operation can be measured readily and precisely, a facility which is not found in known mills, since the torque generated by electric motors cannot be accurately determined due to prevailing phase shifts and the uncertainty in the efficiency of the motor concerned. A facility in which torque can be measured exactly can be used to control the mill and the grinding process with high precision. The facility also enables the torque generated to be recorded.

* The invention enables existing enrichment plants and the like to be reconstructed and expanded more easily, since the space required to practice the inventive method and to install and operate the inventive mill is considerably smaller than the space required by the known technique. The mill, mill foundation and mill drive means occupy only a small space, particularly in the width direction of the mill, compared with possible alternative solutions.

Claims

1. A method of operating a mill of the kind which comprises a mill body having end-walls and a mill burden discharge trunnion mounted externally of one end-wall, and in which method the mill is rotated around a substantially horizontal rotational axle which is common to the mill body and the discharge trunnion, **characterized** by the combination of causing the mill body to rest on at least two supports which are arranged so as to support the whole of said mill; and by rotating the mill body supported on said supports with the aid of a hydraulic motor which is connected mechanically to the discharge trunnion and the rotational axle of which motor is common with the rotational axle of the discharge trunnion and the mill.

2. A mill for carrying out the method according to

Claim 1, comprising two-end walls which extend generally perpendicular to their rotational axle and through which the mill burden is fed into and discharged from the mill respectively, a cylindrical mill casing which is supported between the end-walls and connected mechanically thereto, and a mill burden discharge trunnion which is connected to the discharge end-wall and faces outwardly therefrom, **characterized** in that each end-wall includes a support ring which has an outwardly-facing contact surface and which is essentially parallel with said rotational axle; in that the discharge end-wall and the discharge trunnion are intended to transmit requisite torque from the discharge trunnion; and in that the discharge trunnion is intended for connection to a hydraulic motor which functions to rotate the mill.

3. A mill according to Claim 2, **characterized** in that the contact surfaces of the support rings are adapted for contact with mill supports in the form of metal rollers or wheels.

4. A mill according to Claim 2, **characterized** in that the contact surfaces of the support rings are adapted for contact with supports in the form of slide surfaces.

5. A mill according to any one of Claims 2-4, **characterized** in that the free end of the discharge trunnion is provided with means for connecting the trunnion to the hydraulic motor functioning to rotate the mill.

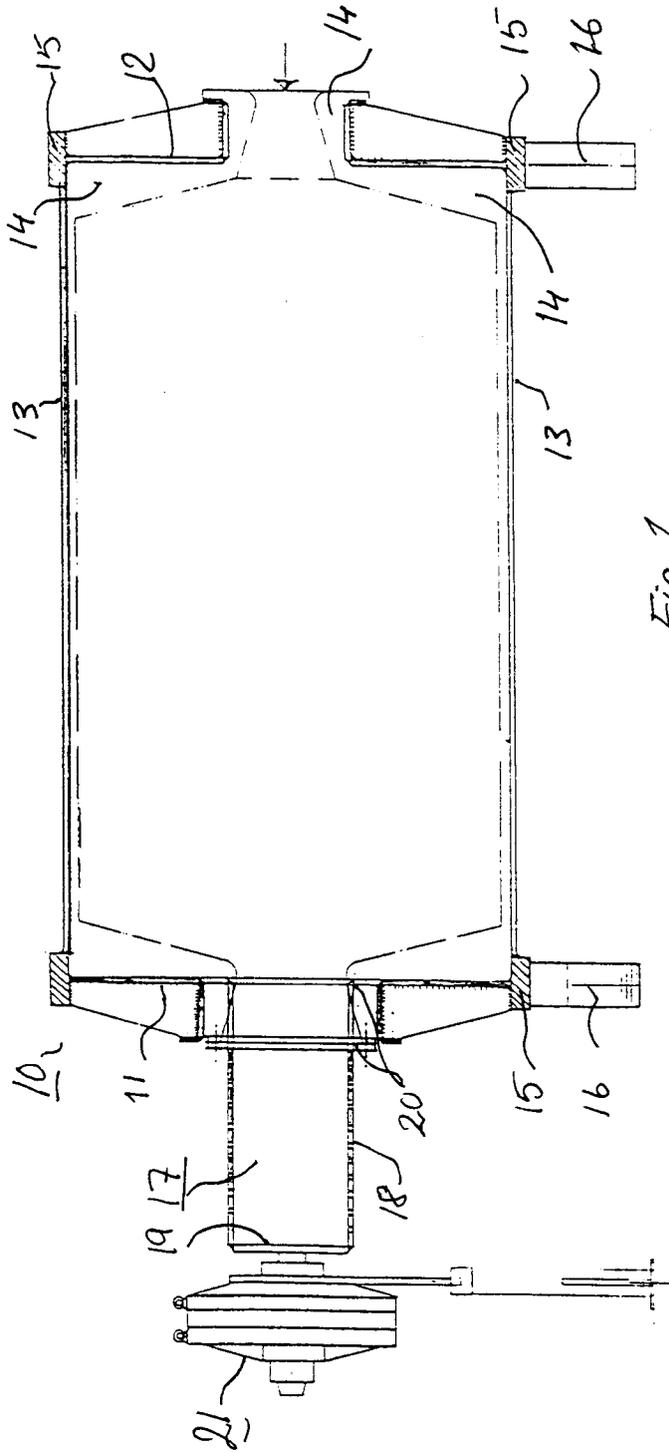


Fig. 1

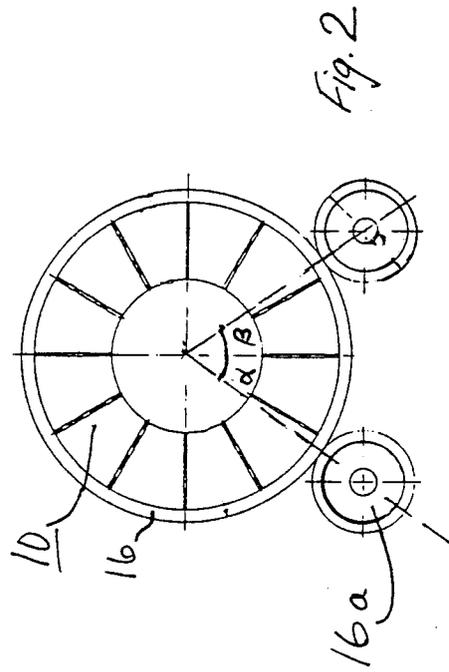


Fig. 2



European Patent
Office

EUROPEAN SEARCH REPORT

Application number
EP 92 85 0020.6

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.)
A	EP-A-0 184 326 (F.L. SMIDTH & CO. A/S) * the whole document * ---	1-5	B 02 C 17/24
A	CH-A-383 735 (U. AMMANN MASCHINENFABRIK AG) * the whole document * -----	1-5	
			TECHNICAL FIELDS SEARCHED (Int. Cl.)
			B 02 C
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
STOCKHOLM		12-05-1992	ASPLUND W.
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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