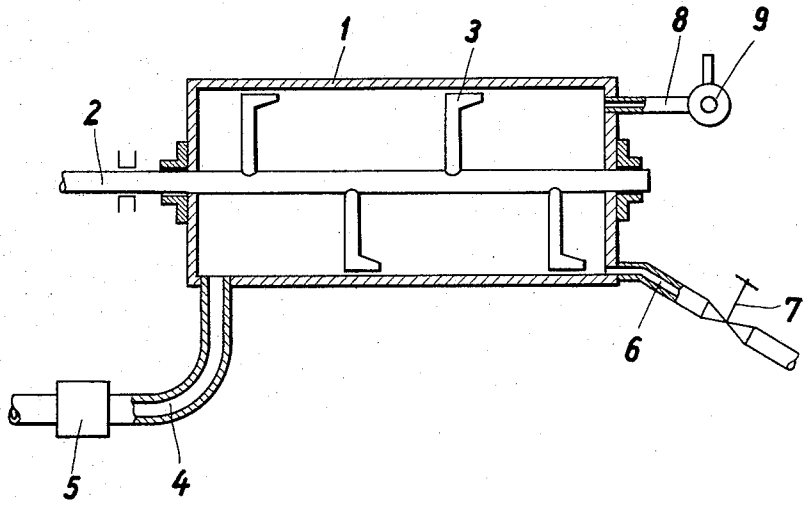
Nov. 2, 1965 P. A. GOESER 3,215,353

GRINDING METHOD FOR INTERRUPTEDLY AND CONTINUOUSLY WORKING MILLS AND APPARATUS FOR PRACTICING SAID METHOD

Filed May 20, 1963 3 Sheets-Sheet 1

Fig. 1



Inventor
PAUL A. GOESER
BY Robert K. Jacob.
AGT.

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Fig. 2

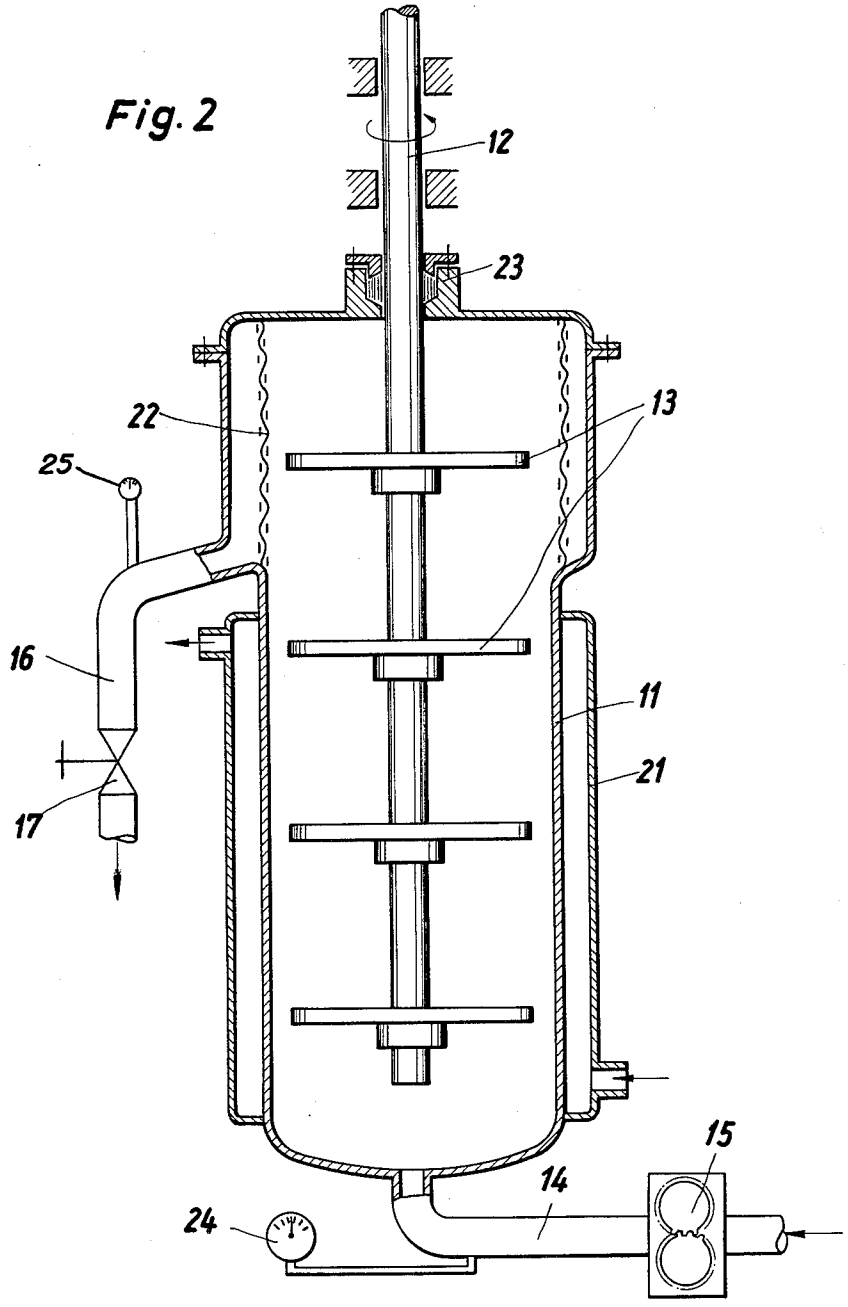

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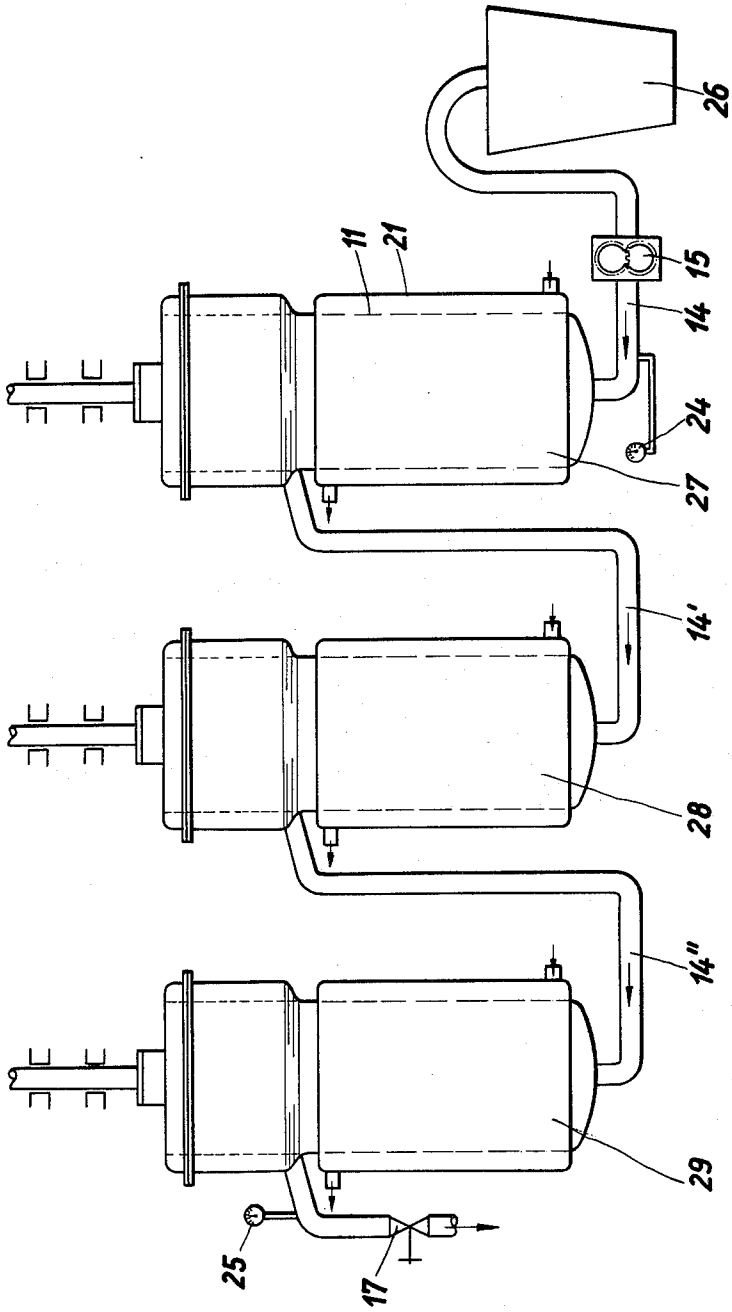
Fig. 3



Inventor:
PAUL A. GOESER
BY Robert K. Jacob
AGT.

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GRINDING METHOD FOR INTERRUPTEDLY AND CONTINUOUSLY WORKING MILLS AND APPARATUS FOR PRACTICING SAID METHOD

Paul A. Goeser, Mannheim-Feudenheim, Germany, assignor to Draiswerke G.m.b.H., Mannheim-Waldhof, Germany

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5 Claims. (Cl. 241—15)

The invention relates to a grinding method for use with interruptedly and continuously operating mills of all types where the auxiliary grinding means and the material being ground are moved by stirring mechanisms and where the material being ground and the auxiliary grinding bodies are subjected to pressure, as well as to apparatus for carrying out this method.

For the new method all types of mills are suitable as long as the auxiliary grinding bodies, for example balls, move in closed spaces. Heretofore these mills were operated under normal atmospheric pressure. It is also known to operate such mills under a vacuum and furthermore the use of protective gas is known that is under normal atmospheric pressure. In a ball mill for separating precious metals from minerals by the use of chemicals air is introduced prior to the beginning of the grinding process for increasing the internal pressure.

At balanced atmospheric pressure no effect of the atmosphere or of the pressure is obtained on the gravity forces responsible for dispersing the solid bodies in the liquids. By using vacuum the adsorption of gas that decreases or prevents moistening and breaking up of agglomerations of kernels of solid powder is to be eliminated. The use of protective gas serves for accelerating or slowing down reactions within the material being ground and is intended to decrease hazards resulting in accidents. For the most part, there is no connection between the degree of grinding or sub-dividing of agglomerates and dispersion. It has been found that with these known methods the desired grinding effect is not obtained in many instances. Accordingly it is an object of the invention to produce with interruptedly or continuously operating mills of the aforementioned type a pressure for the material being ground by means of a pumping operation. Instead of operating at atmospheric pressure or at sub-atmospheric pressure, the invention provides for employing an over-pressure in the mill. The magnitude of the pressure can be varied within optimal limits depending on the material being worked and on the desired end result.

The pressure exerted upon the material being ground develops an increase in the gravity forces that arise in the material being ground. This increase of the gravitational forces is essentially more important than, for example, the decrease of the gas adsorption by using a vacuum. The pressure itself may or must be exerted in different ways depending on the particular grinding purpose.

The greatest advantage of the new method is obtained with stirring mills because with these the movement impulses of the auxiliary grinding bodies are obtained by the stirring mechanisms independently of the fact whether the auxiliary grinding bodies still have the prescribed ball size or whether they are in the form of more or less fine sand. This means that the viscosity can be varied within wide limits without basically affecting the manner of operation. With stirring mechanism mills of this type the pressure is produced by compressing the batch being worked.

In interruptedly operating stirring mechanism mills the grinding container is placed under pressure by means of a grinding material pump. With continuously operating mills the material being ground is pumped in under pressure and the discharge is so controlled by means of a choke or a pressure relief valve that the desired pressure is maintained inside of the grinding space.

For carrying out the method in mills known per se, such as the types mentioned above, it is only necessary to employ suitable means for producing a pressure on the material being ground and on the auxiliary grinding bodies. Particularly with interruptedly operating mills a pump for the material being ground serves for this purpose. With continuously operating mills it is necessary to provide besides the pump for the material being ground also a choke or a pressure reducing valve at the outlet whereby the pressure can be controlled inside the grinding space in a suitable manner.

If the pressure is not effected by the material being ground but by additional pressure means such as pressure gas or the like, then it is necessary to provide in a suitable location of the grinding space an inlet for pressure gas supplied by a compressor or the like.

Further advantages and features of the invention will become apparent from the following specification with reference to the drawings which schematically illustrate embodiments of the invention and in which:

FIG. 1 illustrates a drum mill or stirring mechanism ball mill with the different possible types of means for producing pressure;

FIG. 2 shows a stirring pot mill; and

FIG. 3 a multiple ball mill.

In a mixing drum **1** a shaft **2** moves the stirring tools **3**. The drive for the stirring mechanism shaft **2** is not illustrated. In the supply conduit **4** for the material to be ground a pump **5** is connected, the capacity of which may be changed. At the outlet **6** a choke **7** is provided or a pressure release valve. During the grinding operation this choke is closed for interrupting working conditions while with continuously operating mills it permits the continuous passage of the material being ground while maintaining a corresponding pressure in the grinding space.

In the mill illustrated it is also possible to supply air under pressure or a pressure gas from a compressor or the like into the grinding space by way of a connection **8**.

It is quite possible with the mill illustrated in FIG. 1 as well as in connection with the other embodiments shown to provide only one or the other means for producing pressure depending on the use or operation. FIG. 2 shows a stirring pot mill known per se, where the stirring pot **11** comprises a lower part that is preferably provided with a cooling mantle **21** and an upper part which is equipped with a screen **22**. The vertically journalled shaft **12** is provided with stirring disks **13** for moving the grinding material and the auxiliary grinding bodies, for example, balls. The material being ground is supplied by way of a conduit **14** arranged and entering centrally of the bottom of the stirring pot **11**. The ground material leaves the mill by way of outlet **16**. For sealing the inside of the stirring pot a sealing bushing **23** is provided for the shaft **12**. The conduit **14** has a pump connected thereto which forces the material being ground into the stirring pot **11** under suitable pressure which may be checked, for example, by a manometer **24**. At the outlet **16** a choke **17** or a pressure reducing valve may be provided. If desired it is also possible to provide at this location a checking manometer **25**.

A continuously operating multiple compartment ball mill is illustrated in FIG. 3 which consists essentially of three or more stirring pot mills in accordance with FIG. 2 where the means for producing the pressure and maintaining the pressure are suitably not provided in each mill unit but only once for the entire group of mills. In all other respects the same grinding principle in accordance with the invention is employed with the multiple grinding

mill. The material being ground is brought out of a supply container **26** by means of the pump **15** into the first stirring pot mill **27**. Thence the ground material is conducted by way of a conduit **14'** to the second grinding pot mill **28** and from there by way of a second conduit **14''** into a third mill **29**. Thus there are actually three similar mills connected in series in a manner that the duration of treatment for the material to be ground can be extended as desired. The manner of operation and of producing pressure does not differ from that for a single mill.

The invention is not limited to the embodiments illustrated and described. It may be employed with other mills and other auxiliary grinding bodies and it is also possible to provide the means for producing pressure either by way of the material to be ground as it is supplied or by a separate pressure gas that may be supplied separately or at random.

Having thus described my invention with reference to the embodiments illustrated in the drawings, I do not wish to be limited thereto but what I desire to protect by Letters Patent of the United States of America is set forth in the appended claims.

I claim:

1. Grinding method employing a continuously operating grinding mill containing auxiliary grinding bodies such as balls, said method comprising the steps of supplying by means of a pump and under pressure material to be ground to the chamber of the mill containing the auxiliary grinding bodies, subjecting the material and the auxiliary grinding bodies to the action of stirring tools while maintaining greater than atmospheric pressure in the chamber, and controlling by valve means the quantity of material being treated and thereby the pressure in the chamber.

2. Grinding mill for a continuous grinding operation comprising a milling chamber, means sealing said chamber during the operation of the mill, stirring tools movably mounted in said chamber, auxiliary grinding bodies in said chamber movable by said stirring tools, and a pump connected to a material supply source operative to feed the material to be ground to said chamber and to place said material and said grinding bodies under atmospheric pressure, a discharge aperture in said chamber for discharging treated material from said chamber while retaining the grinding bodies therein and means for reducing and controlling the pressure comprising a choke or pressure reduction valve located proximate said discharge aperture.

3. Grinding mill for a continuous grinding operation comprising a plurality of milling chambers connected in series, means sealing said chambers during the operation of the mill, stirring tools movably mounted in said chambers, auxiliary grinding bodies in said chambers movable by said stirring tools, a pump connected to a material supply source operative to feed the material to be ground to one of said chambers and to place said material and said grinding bodies under atmospheric pressure, a discharge aperture in another said chamber for discharging treated material therefrom while retaining the grinding bodies therein and means for reducing and controlling the pressure comprising a choke or pressure reduction valve located proximate said discharge aperture.

4. Grinding mill for a continuous grinding operation comprising a plurality of milling chambers connected in series, means sealing said chambers during the operation of the mill, stirring tools movably mounted in said chambers, auxiliary grinding bodies in said chambers movable by said stirring tools, a pump connected to a material supply source operative to feed the material to be ground to one of said chambers and to place said material and said grinding bodies under atmospheric pressure, a discharge aperture in another said chamber for discharging treated material therefrom while retaining the grinding bodies therein and means for reducing and controlling the pressure comprising a choke or pressure reduction valve located proximate said discharge aperture, said pump for feeding material and placing it under atmospheric pressure being connected to the first in the series of chambers and said means for controlling the pressure being associated with the last of said chambers.

5. Grinding mill for a continuous grinding operation comprising a plurality of milling chambers connected in series, means sealing said chambers during the operation of the mill, stirring tools movably mounted in said chambers, auxiliary grinding bodies in said chambers movable by said stirring tools, a pump connected to a material supply source operative to feed the material to be ground to one of said chambers and to place said material and said grinding bodies under atmospheric pressure, a discharge aperture in another said chamber for discharging treated material therefrom while retaining the grinding bodies therein and means for reducing and controlling the pressure comprising a choke or pressure reduction valve located proximate said discharge aperture, said milling chambers being connected with one another in a pressure tight manner to maintain the same pressure in each chamber.

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ROBERT C. RIORDON, *Primary Examiner.*

J. SPENCER OVERHOLSER, WILLIAM W. DYER, JR, *Examiners.*