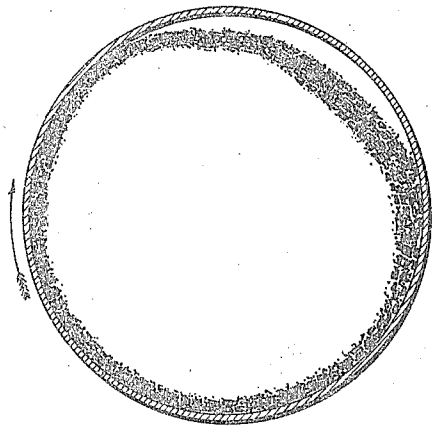
M. J. DAVIDSEN.

METHOD OF GRINDING IN TUBE MILLS.

APPLICATION FILED AUG. 7, 1913.

1,164,264. Patented Dec. 14, 1915.



WITNESSES

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METHOD OF GRINDING IN TUBE-MILLS.

1,164,264. Specification of Letters Patent. Patented Dec. 14, 1915.

Application filed August 7, 1913. Serial No. 783,470.

To all whom it may concern:

Be it known that I, MEYER JOSEPH DAVIDSEN, a subject of the King of Denmark, residing in Paris, France, have invented certain new and useful Improvements in Methods of Grinding in Tube-Mills, of which the following is a specification, reference being had to the accompanying drawing, which forms a part hereof.

This invention relates to the fine grinding of various substances, such as cement clinker, coal for use in rotary kilns, etc., in drums rotating on horizontal axes which are charged with relatively small grinding bodies such as flint pebbles or metallic grinding bodies, which are free within the drums and have motion only in vertical planes at right angles to the axis of rotation. The object of the invention is to increase the efficiency of such grinding mills, that is, to increase the output per horse power required to drive the mills.

In accordance with the present invention the charge of grinding bodies is reduced to about one-half, by weight per cubic foot, of the charge which has been employed heretofore, the weight of the material being ground and in the drum at any one time is also preferably reduced somewhat as compared with ordinary practice, say to about ten per cent. of the weight of the grinding bodies, and the speed of rotation of the drum is considerably increased, so that the grinding bodies fall through a greater or less distance within the drum and the rolling and rubbing action of the grinding bodies which is characteristic of the old practice is replaced by a beating or hammering action under the new practice, which is found to be much more effective in pulverizing the material in the drum.

The invention will be understood more readily by reference to the accompanying drawing which illustrates the action of the grinding bodies under the present invention.

The drum a, in which the grinding is carried on, may be of any suitable dimensions, made of any suitable material, supported in any suitable manner and rotated by any suitable means. The drum is of course provided, as usual, with suitable inlet and discharge openings. In the drum is placed the charge of grinding bodies. In the figure the grinding bodies c are indicated as metallic grinding bodies. Flint pebbles might be used in the new method, but as they would be quickly broken up by the hammering action it is preferable to use metallic grinding bodies in the practice of the new method.

The volume of metallic grinding bodies employed in the new method is much smaller than the volume of flint pebbles employed in the old method, but it will be understood that in the new method there is employed about half the quantity by weight of grinding bodies of the same kind that is employed in the practice of the old method, although the proportions may differ more or less. The quantity of material being ground which is permitted to be in the drum at any one time is preferably somewhat less under the new method than under the old method, being preferably about ten per cent. of the weight of the grinding bodies. No attempt is made to represent in the drawing the material being ground.

In the practice of the new method, with a considerably lighter charge of grinding bodies, the drum is driven at a considerably higher rate of speed than under the old method. The speed of rotation is not precisely limited, but in general, it may be stated as approximately equal, in revolutions per minute, to the quotient of 45 divided by the square root of the diameter expressed in meters. The speed may be expressed in the formula as follows:

$$\text{R. P. M.} = \frac{45}{\sqrt{D}},$$

in which D is the diameter of the drum in meters. The speed of rotation of the drum under the new method is not determined arbitrarily but is dependent upon certain known factors.

The speed at which the mass will begin to be carried around with the drum is that at which the centrifugal force becomes so great that the resultants of the centrifugal force and the force of gravity which act upon any particle of the mass fall wholly outside the circumference of the drum, so that a particle, for example, at the zenith point of its path is acted upon by a centrifugal force which is both equal and opposite to the force of gravity, whereby the particle is carried from the zenith point without relative motion and descends on the other side of the zenith point in contact with the shell of the drum. This speed at which the particles of the mass begin to move en-

tirely around with the drum may be called the critical speed. It can be demonstrated that at the increased speed indicated by the formula

$$R.\ P.\ M. = \frac{45}{\sqrt{D}}$$

the centrifugal force is 113.2 per centum of the unit weight of the combined mass of grinding bodies and material. It might be expected that if the centrifugal force exceeds the force of gravity the entire charge of grinding bodies and material would be carried around with the drum. Because of minor factors which have not been taken into account, particularly the slipping of the grinding bodies and material on the shell or lining of the drum, this is not the case, but at this point, when the relative weight of the charge is reduced as before described, the grinding bodies and material are carried to a point near the zenith and considerably above the point where the components cease to receive mechanical support from the components below them. As they approach the zenith point the components of the mass leave the shell of the drum and, under the influence of their own momentum as well as of the force of gravity and the centrifugal force move in parabolas toward the opposite and lower side of the drum so that their action is changed from the rolling and rubbing action under the old method to a beating or hammering action which is much more effective in pulverizing the material.

It is found in practice that with the increase in speed and the decrease in weight of the charge of grinding bodies, the horse power required to drive a grinding mill is reduced about sixty per centum while the capacity of the mill is at the same time reduced only about twenty per centum so that the efficiency is greatly increased.

It will be understood that particular reference has been had in this specification to dry grinding and that, by reason of the greater slippage, in wet grinding, between the combined mass of grinding bodies and material and the wall of the mill, it may be necessary, in wet grinding, to vary somewhat the speed of rotation in order to secure the results herein set forth. It will also be understood that although particular reference has been had herein to the preferred weight of grinding bodies per cubic foot, it is necessary that the bulk of the combined mass of grinding bodies and material shall not be so great as to furnish mechanical support for the grinding bodies to a point where they may be carried beyond the zenith in contact with the shell.

I claim as my invention:—

The method of grinding material that consists in producing by centrifugal force only a practically continuous, thin whirling layer of combined material and grinding bodies about a horizontal axis in an uninterrupted endless path and at such a speed as to both substantially confine such material and bodies to such endless path and also to permit a forward portion of the said bodies and material to fall upon a rear portion of the same.

This specification signed and witnessed this 25th day of July, A. D., 1913.

MEYER JOSEPH DAVIDSEN.

Signed in the presence of—

HALZER E. STENBJORN.

AXEL SCHÄFFER.