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ELECTROMAGNETIC BALL MILL

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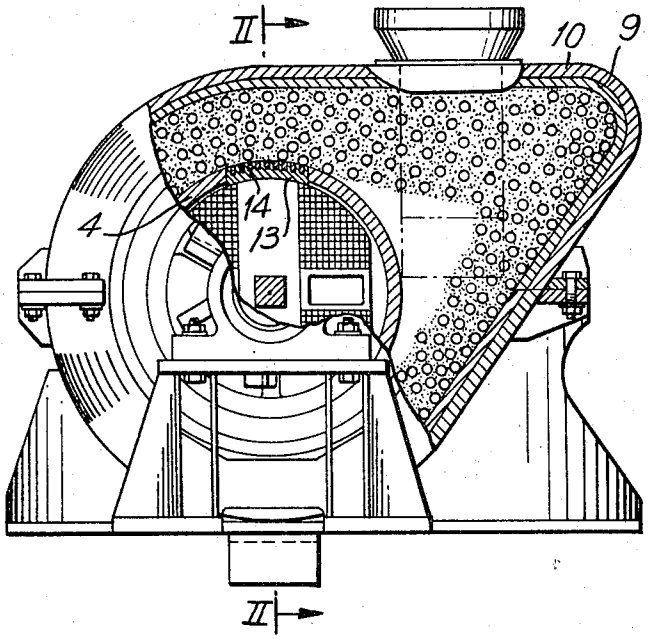
FIG. 1



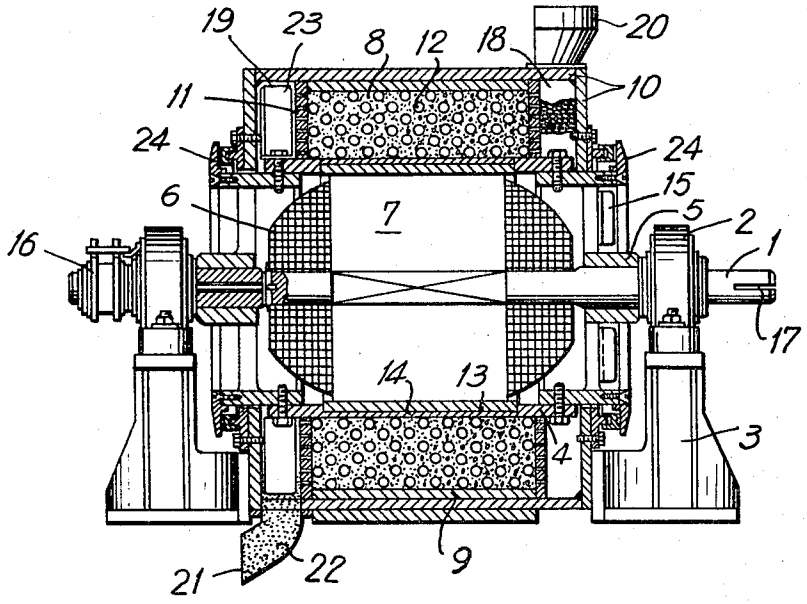


FIG. 2

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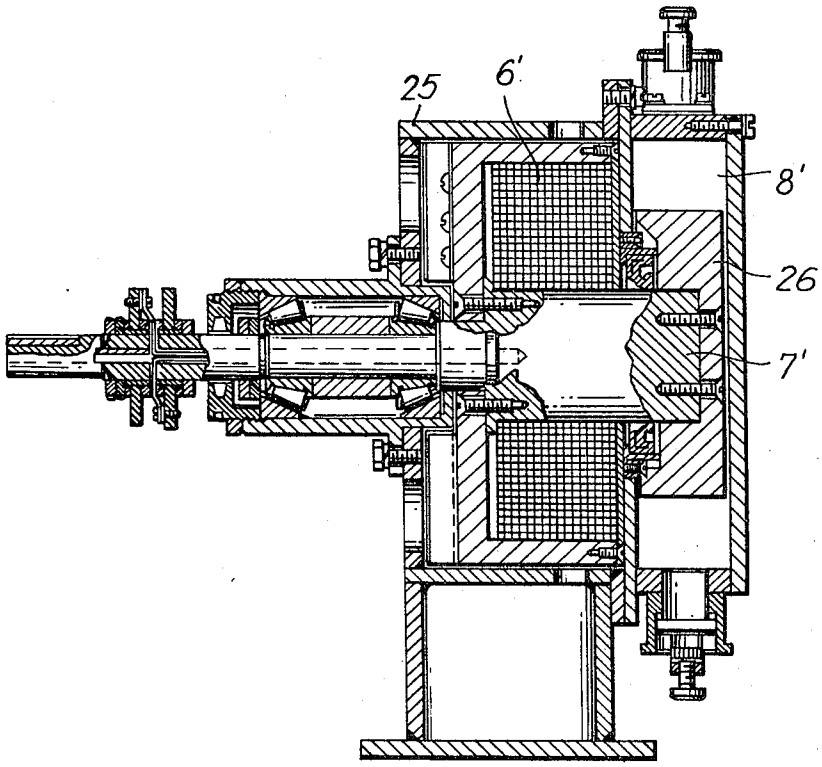
FIG. 3



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ELECTROMAGNETIC BALL MILL

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ABSTRACT OF THE DISCLOSURE

An electromagnetic ball mill having a vertical working chamber containing grinding metal bodies which undergo rotational movement in a vertical plane under the action of a rotating magnetic field in the chamber. The chamber widens upwardly in a horizontal direction in the vertical plane of rotational motion of the bodies.

The present invention relates to electromagnetic ball mills for fine grinding, both by dry and wet methods, of various hard materials, such as diamond, cement, coal, etc.

There are known electromagnetic ball mills for fine grinding of cement, ore and the like materials, said mills having a cylindrical working chamber in which the grinding balls are disposed in a trough, arranged concentrically with the cylindrical wall of the chamber, the balls being driven by means of an electromagnet rotating about the working chamber.

The grinding of material in such mills is effected by grinding it between the cylindrical wall of the chamber and the balls.

The disadvantages of said mills are their low specific production and considerable consumption of electric power.

Said disadvantages are caused by the fact that the design and principle of operation of the mill of such type do not provide for a fine grinding of the hard materials in one pass of said materials through the mill.

Therefore, the ground material must be subjected to separation, while the fractions insufficiently ground must be returned for a secondary grinding.

There are also known electromagnetic ball mills, in which the working chamber is made in the form of a ring disposed between two stationary exicitation windings enclosed in armour-plated casings and energized with A.C.

The grinding metal balls, charged in the working chamber, are set in motion by the magnetic field generated by said excitation windings.

Said mills, being of considerable dimensions and having a great specific consumption of electric power, possess a low productivity.

This is explained by the fact that in such mills the grinding of material is effected mainly due to the friction between the particles of material and the steel balls, moving under the effect of the rotating magnetic field. The steel balls are at the same time subjected to the action not only of the magnetic forces of the field, but also of centrifugal force, pressing said balls against the upper portion of the circular chamber and against each other, which results in a waste of the kinetic energy of the balls.

In addition, the above-said electromagnetic ball mills have an increased specific consumption of electric power

on account of harmful currents, resulting from the interaction of magnetic fields of the excitation windings, energized by A.C., as well as due to considerable resistance against the passage of magnetic lines of force through the armour-plated casings.

A further serious disadvantage of the conventional electromagnetic ball mills is the complexity of their repairs when the excitation windings are burnt (especially in case it is the external primary winding), since this means a long-term interruption of the plant operation. It should be noted that both of the above-said types of mills are not practical for grinding small amounts of material, which is the case when grinding diamonds.

It is an object of the present invention to provide an electromagnetic ball mill, allowing the grinding of materials of various degrees of hardness, and providing a high productivity and good operational characteristics with relatively small overall dimensions of the plant and low specific consumption of electric energy.

These objects are achieved by the full utilization of the kinetic energy of the steel balls and by a drastic increase in the number of their collisions. This is achieved by widening the working chamber on one side in the direction of the inertial motion of balls in the upper portion of the chamber, while the electromagnet is arranged in such a manner that it sets up a magnetic field mainly in that part of the chamber which is opposite the widening portion.

According to the present invention, it is proposed to make the working chamber in the form of an incomplete circular cylinder extending into the widening portion, which coincides with the direction of the inertial motion of the balls in the upper portion of the chamber, said widening portion being formed by two intersecting walls, tangent to the circular cylindrical surface.

The steel balls in such a chamber move under the effect of the rotating magnetic field, first in a circular path in the circular portion of the working chamber, then in a rectilinear path under the action of the centrifugal force, exceeding the attraction force of the magnetic field, in the widening portion of the chamber and strike the material being ground, thereby completely utilizing the stored kinetic energy.

With such an elongated shape of the chamber, it is preferred to place the electromagnet inside the chamber in such a way that its axis of rotation preferably coincides with the axis of the circular cylindrical surface of the chamber.

To protect the electromagnet from the collisions of the grinding balls, it is enclosed in an armour-plated casing.

To diminish the resistance to the passage of magnetic lines of force through the armour-plated casing, the casing is provided with slots over the poles of the electromagnet, which slots accommodate inserts of a magnetizable material, reinforced with a wear-resisting material.

In case the ball mill is employed mainly for grinding diamonds or other very hard materials, it is recommended to provide the electromagnet with an elongated armature, the portion of which, free from the excitation winding, is accommodated inside the working chamber, while the remaining or greater portion of the electromagnet with the excitation winding is disposed outside the working cham-

ber, which allows to drastically reduce the chamber dimensions.

These and other objects of the present invention will become more fully apparent from a consideration of the following detailed description of two embodiments of the invention, taken in conjunction with the appended drawings, in which:

FIG. 1 is a longitudinal section of one embodiment of electromagnetic ball mill, in which the electromagnet is disposed inside the working chamber in such a manner that the axis of rotation of said electromagnet coincides with the axis of the circular cylindrical surface of the chamber;

FIG. 2 is a cross-sectional view of the electromagnetic ball mill of FIG. 1 taken along lines II—II; and

FIG. 3 is a cross-sectional view of another embodiment of the electromagnetic ball mill, in which but one portion of the electromagnet is disposed inside the working chamber, namely, the elongated portion of the armature of the electromagnet, which is free from the excitation winding.

The electromagnetic ball mill, represented in FIGS. 1 and 2, is provided with a shaft **1**, rotating in bearings **2**, fixed on supports **3**.

An armour-plated casing **4** is rigidly connected with the shaft **1** by means of hubs **5**.

The armour-plated casing **4** accommodates an electromagnet comprising an excitation winding **6** wound on an armature **7**, which is also rigidly mounted on the shaft **1**.

A working chamber **8** is formed by a space defined by the casing **4**, armour plates **9** of a body **10** and lateral lattice plates **11**. The working chamber is charged with steel balls **12**. The casing **4** and plates **9** and **11** are manufactured of a non-magnetic, wear-resistant material.

In the region above the poles of the electromagnet in the casing **4** there are provided inserts **13** manufactured of a magnetizable material which is protected from wear by high-strength inserts **14**.

To cool the excitation windings, blades **15** are mounted on spokes of the hubs **5**. On one end of the shaft **1** contact rings **16** are mounted to supply the excitation current, while on the other end a splined groove **17** is provided for connecting the shaft **1** to an electric motor (not shown in the figures).

Formed between the lateral walls of the body **10** and the lattice plates **11** of the chamber **8** are spaces **18, 19** for respectively charging material to be ground and for discharging ground material. A receiving funnel **20** is provided over the charging space **18**, while under the discharging space there is provided a discharge aperture **21** for delivering the ground material **22**. To provide for the aspiration of the ball mill, the mill is provided with an impeller **23** mounted in the discharging space **19**. Provided on the sides of the mill body are packings **24**.

The described embodiment of the electromagnetic ball mill is in the main expedient to be employed in those cases where it is required to grind large amounts of material.

In case of grinding small amounts of material, which is usual when grinding diamonds or other precious stones, the mill is recommended to be made according to the embodiment, as shown in FIG. 3.

This embodiment is characterized by the fact that the armature **7'** (FIG. 3) is elongated, with a portion of the armature being left free from the excitation winding. The electromagnet is mounted in such a manner as to enable the portion of the armature free from the winding **6'** to be accommodated inside the working chamber **8'**, while the remaining portion of the electromagnet is disposed outside the chamber in a separate body **25** adjacent to the working chamber **8'**.

An armoured disk **26** manufactured of a non-magnetic material is mounted on the portion of the electromagnet which is disposed in the chamber **8'**.

With such a design, it is possible to make the working chamber of smaller dimensions.

The principle of operation of the electromagnetic ball mill of FIGS. 1–3 is given below.

Direct or alternating current is supplied via current tap **16** to the excitation winding **6** or **6'** thus setting up a permanent magnetic field, which rotates together with the electromagnet and entrains the steel balls **12**, which travel at a speed almost equal to the speed of rotation of the electromagnet. The balls pass into the elongated portion of the working chamber where the balls travel with rectilinear movement and grind the material, supplied into the chamber **8** via receiving hopper **20**.

Having consumed the kinetic energy by striking the material found in the elongated portion of the chamber, the steel balls are entrained under the influence of the rotating electromagnet together with the material being ground into the circular portion of the chamber where the material is subjected to the attrition action of the balls; further, the grinding cycle is repeated.

Though the present invention has been described in connection with the preferred embodiments thereof, various modifications may be resorted to without departing from the true idea and scope of the invention.

What I claim is:

1. An electromagnetic ball mill comprising a working chamber containing grinding metal bodies, a rotatable electromagnet proximate said chamber for producing a rotating magnetic field in said chamber to impart rotational motion to said bodies in said chamber, said chamber including a first portion in which the rotational motion of the bodies is in a plane, and a second portion extending from the first portion in the plane of rotation of the bodies such that said bodies travel between said portions, said first portion having opposite ends from which the second portion extends in gradually increasing manner from one end to the other in a direction corresponding to the direction of rotational motion of said bodies at said other end, said electromagnet being mounted relative to said chamber to establish said magnetic field substantially in entirety in said first portion.

2. An electromagnetic ball mill comprising a working chamber containing grinding metal bodies; a rotating electromagnet for producing in said working chamber a rotating magnetic field to impart rotational motion to said bodies; said working chamber being constituted as an incomplete cylinder with a widening portion extending therefrom in the direction of rotational motion of the sleel balls in the upper portion of the chamber, said chamber having walls in said widening portion which are tangent to the surface of the incomplete cylinder; said electromagnet being mounted adjacent said chamber such that it establishes the electromagnetic field mainly in the incomplete cylinder portion of the chamber.

3. A ball mill according to claim **1**, wherein the electromagnet is mounted inside said working chamber.

4. A ball mill according to claim **1**, wherein the electromagnet is mounted inside said working chamber.

5. An electromagnetic ball mill comprising a working chamber containing grinding bodies; a rotating electromagnet for producing in said chamber a rotating magnetic field to impart motion to said bodies; said working chamber widening in one direction coinciding with the direction of inertia movement of said bodies in said working chamber at the upper portion of said chamber, a casing surrounding said electromagnet, said electromagnet including poles, said casing being provided with slots in the region of the poles of the electromagnet, and inserts of magnetizable material in said slots and reinforced with a wear-resistant material, said electromagnet being mounted inside said working chamber to establish the electromagnetic field mainly in the portion of the chamber outside the widening portion.

6. A ball mill according to claim **1** comprising means for rotating said electromagnet, said electromagnet comprising an elongated core including one portion which is

free of excitation winding and is disposed inside said working chamber.

7. A ball mill according to claim 2 comprising means for rotating said electromagnet, said electromagnet comprising an elongated core including one portion which is free of excitation winding and is disposed inside said working chamber.

8. A ball mill according to claim 1, wherein said chamber is disposed substantially vertically and the plane in which the bodies undergo rotational movement is also vertical, said chamber widening horizontally in an upwardly direction in the vertical plane of rotation of the bodies.

References Cited

UNITED STATES PATENTS

1,894,106	1/1933	Lehrack	241—172
2,292,275	8/1942	Kiesskalt	241—172
2,822,987	2/1958	Uhle	241—172
2,883,118	4/1959	Taylor	241—172

FOREIGN PATENTS

316,499	12/1919	Germany.
888,641	9/1953	Germany.

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