Nov. 26, 1935. T. J. VOLLKOMMER 2,022,552

BALL MILL

Filed Jan. 9, 1933 2 Sheets-Sheet 1

Fig. 1.

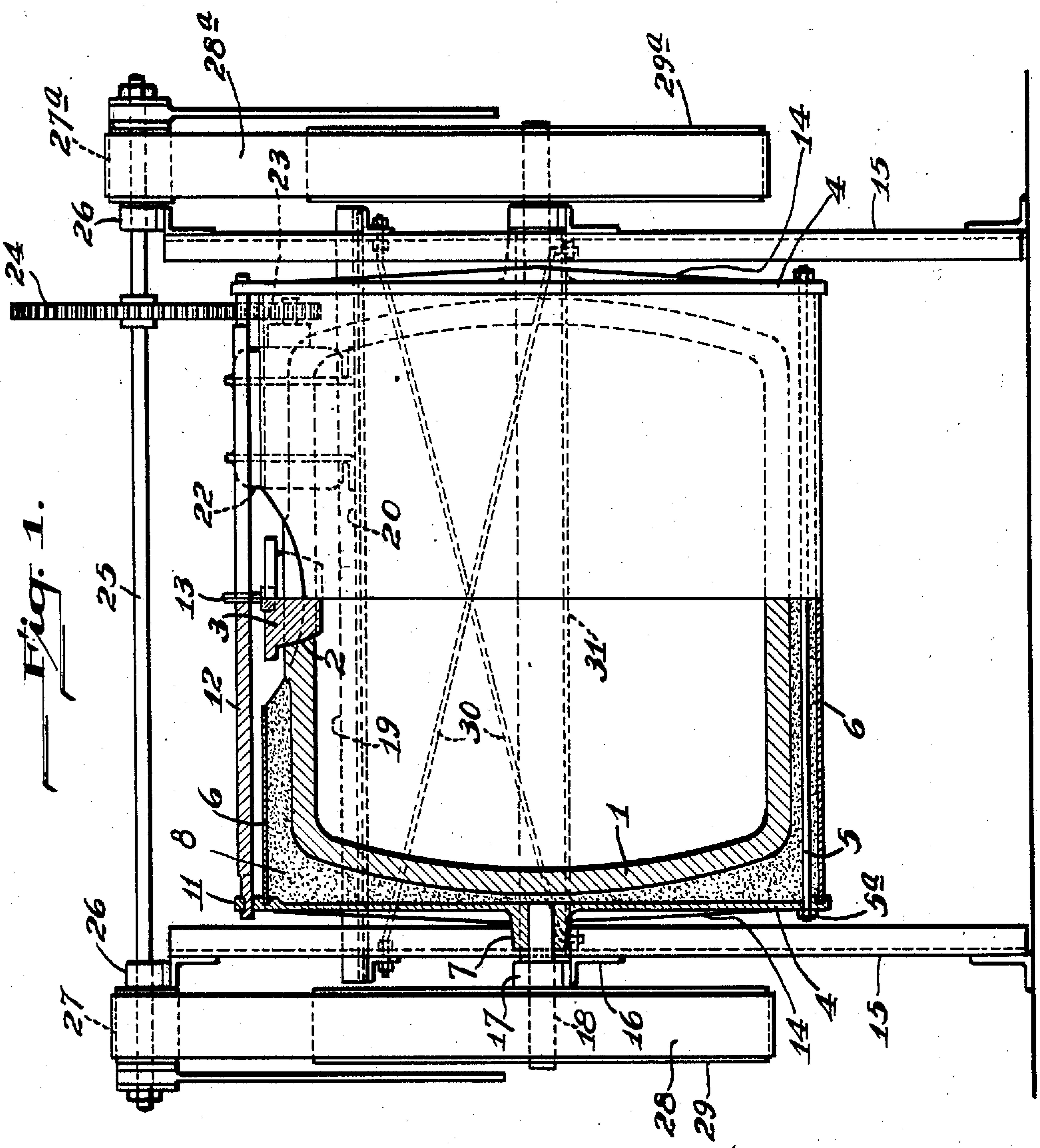
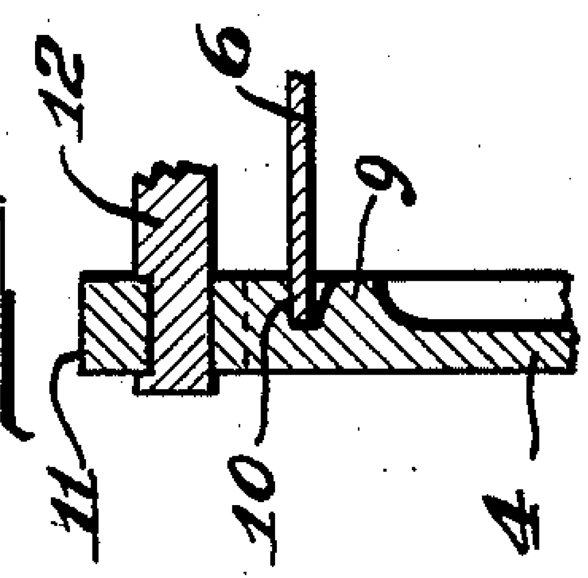


Fig. 2.



WITNESSES

A.B. Wallace

F.B. Flick

INVENTOR

Theodore J. Vollkommer

by Brown, Critchlow & Flick

his attorneys.

Nov. 26, 1935. T. J. VOLLKOMMER 2,022,552

BALL MILL

Filed Jan. 9, 1933 2 Sheets-Sheet 2

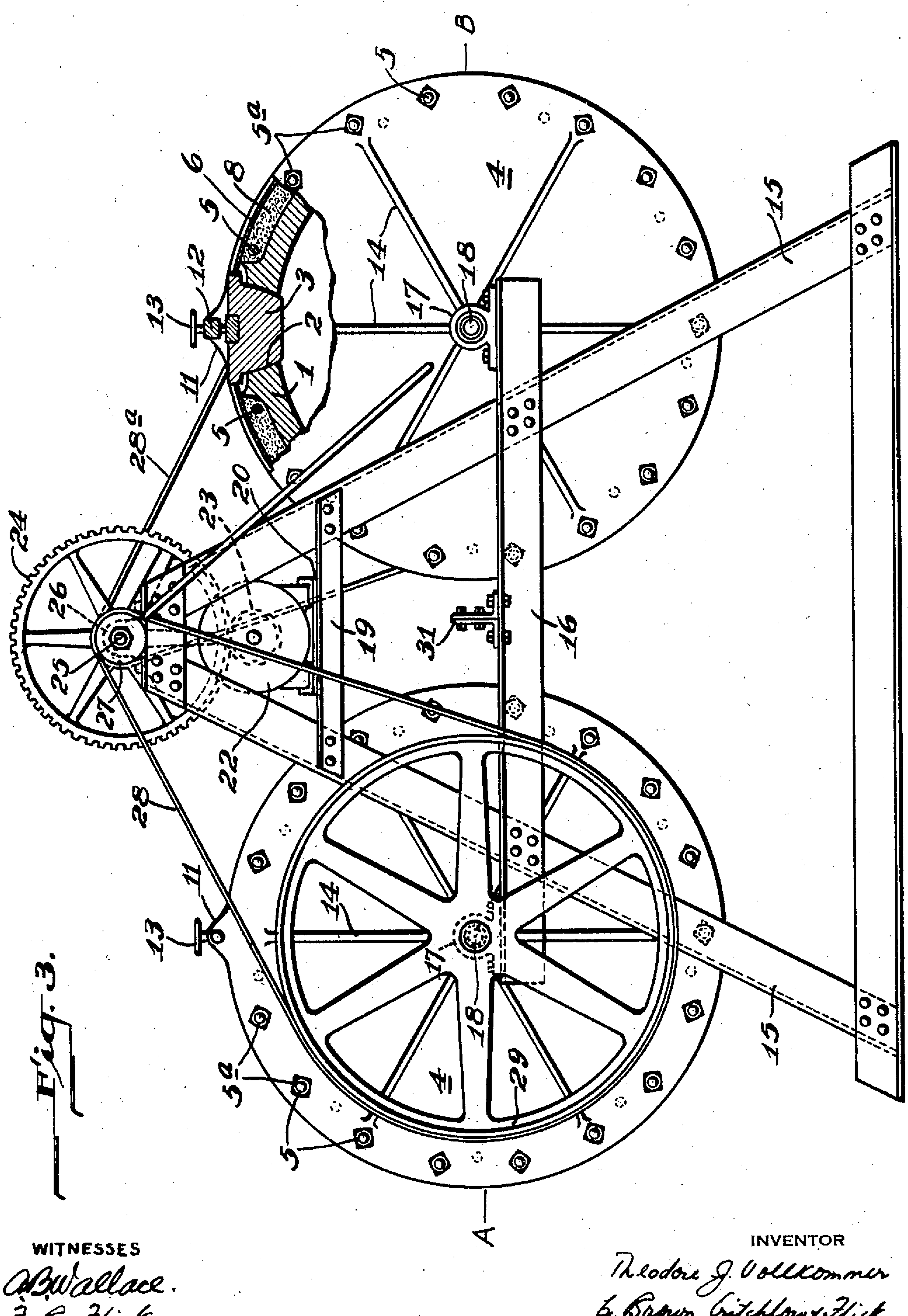


Fig. 3.

WITNESSES

A.B. Wallace.

F. B. Flick.

INVENTOR

Theodore J. Vollkommer

by Brown, Critchlow & Flick

his attorneys.

Patented Nov. 26, 1935

2,022,552

UNITED STATES PATENT OFFICE

2,022,552

BALL MILL

Theodore J. Vollkommer, Pittsburgh, Pa., assignor to The Vitro Manufacturing Company, Pittsburgh, Pa., a corporation of Pennsylvania

Application January 9, 1933, Serial No. 650,816

4 Claims. (Cl. 83—9)

This invention relates to ball mills.

Enamels, glazes, and the like materials must be finely ground to prepare them for use, and this is usually done in ball or pebble mills. These materials may be adversely affected by foreign agents, even in very minute amounts, so the prevailing practice is to grind against ceramic surfaces. In one type of ball mill the lining is composed of plates or blocks of suitable ceramic material laid with an appropriate mortar. Such jointed structures are subject to various serious disadvantages. For example, strains set up in the mill may weaken the joints, causing the lining elements to become loosened or dislodged. This entails the cost of repairing the lining and the temporary uselessness of the mill. A more serious consequence of the use of jointed linings arises from the practically inevitable contamination of the glaze or the like by the cement in which the lining is laid. Also, iron, e. g. in the form of rust, may gain access to the glaze or enamel through the joints. Such contamination is highly undesirable, not only because it causes specks or spots in the glazed or enamelled products, but also because the ground product may be off color. In both instances the loss may be great, both to user and producer of the color. These disadvantages accrue whether the lining is laid wet or dry, but particularly in the case of the latter.

It has been proposed to use continuous, or seamless, linings in order to overcome the foregoing disadvantages. These commonly take the form of ceramic ware jars of the general type used in the familiar laboratory ball mills. But these also are attended by economic disadvantages which are so serious as to entirely prevent their use in the large sizes desired in commercial practice. Being of ceramic material these jars are brittle, and while their strength is satisfactory in small sizes the fragility increases rapidly as the capacity of the jars increases. In the capacities needed for commercial operations the jars are particularly subject to cracking or complete breakage with consequent losses. These losses embody the replacement cost of the jar which may be substantial in the larger sizes, and the batch of material being ground may be lost, because of contamination by dirt, etc. Frequently the glazes, etc. are quite valuable, so that this danger is of substantial importance.

If the walls of these jars are increased in proportion to the increase in capacity, or volume, the walls became so thick in the larger sizes that they cannot be dried and burned, i. e. the thickness of wall becomes so great that it is not possible to manufacture the jars. Consequently where such mills are used the trade has been confined to jars less than about three feet in diameter, although it would be desirable to use larger sizes, for obvious reasons of operating economy.

Moreover, in the use of these ceramic jars the wall thickness is reduced by abrasion by the pebbles or balls used for grinding. Manifestly this further weakens the jars and such progressive erosion of the wall greatly enhances the danger of breakage and consequent loss of the charge. Therefore, as a precautionary measure it is necessary to discard the jars prior to the time when they are actually worn out. In customary practice safety demands that they be discarded when the wall thickness has been decreased to about half its original magnitude. Actually, however, many jars when discarded are inherently capable of much longer life, so that this practice involves a substantial economic loss.

In addition, the means heretofore used for mounting the jars for rotation have been unsatisfactory, because it has been necessary to apply substantial clamping pressure to the jars, which may set up strains inducing cracking and breakage. Also, the jars are liable to shift out of center, which throws undue strains on the supporting means and the jars themselves. Moreover, the supporting means used heretofore render it difficult to clean the outside of the jars and maintain them clean. This is an important feature in the manufacture of glazes and enamels, particularly those of delicate tints, since the access of small amounts of impurities may markedly alter the hue of the fired glaze or enamel.

It is among the objects of this invention to provide ball mills having continuous, or seamless, ceramic ware linings, whereby the materials being ground are nowhere exposed to contamination, which are reinforced to prevent or minimize cracking and breakage, may be used until the wall has been worn through by abrasion in use, may be made of substantially any desired size without undue increase in wall thickness, are easily cleaned and kept clean, are relatively inexpensive and of rugged construction, and which in their preferred embodiment are positively held and maintained in fixed position relative to the axis of rotation.

The invention may be described in connection with the accompanying drawings, in which Fig. 1 is a side view, partly in section, of a ball mill showing the preferred embodiment of the invention; Fig. 2 a fragmentary enlarged view of a portion of mill casing shown in Fig. 1; and Fig. 3 an end view of the mill showing also the preferred manner of mounting it for use.

In accordance with the invention a monolithic, or seamless, ceramic ware lining is wholly embedded in a body of hardened cementitious material of such thickness as to reinforce the lining against breakage. This overcomes the numerous disadvantages of prior ball mills. Thus decrease in wall thickness of the lining due to abrasion in use is compensated for so that the useful life of the lining is at least doubled, since breakage at any stage is substantially eliminated and because the mill may be used until the lining has been worn through, the cement acting, in effect, as additional wall. Being monolithic there are no joints through which the material being ground is exposed to contamination, and since the cementitious embedding material is wholly outside of the lining the material being ground has no access to it.

Most suitably such seamless linings take the form of monolithic ceramic ware jars of the usual type, and preferably the cementitious body is of reinforced construction.

The jars may be mounted in a variety of ways for use as ball mills, for example by supporting the jar in its embedding cement body between a pair of end plates provided with outwardly extending trunnions, the end plates being held together by tie rods which extend longitudinally of the jar and which preferably are embedded in the cementitious material to provide a reinforced cement structure. In the preferred embodiment the jar is supported in and spaced from a casing formed of such end plates connected by tie rods disposed about the jar, and an outer side wall, or shell, extending between the end plates outside of the tie rods. The space between the jar and the casing is then filled with suitable hydraulically setting material to wholly embed the jar and tie rods.

Any suitable cementitious material may be used for this purpose, such as Portland or other cement, concrete, gypsum, and the like. Means are also provided for keying the embedded structure in the casing with respect to the end plates, so that the jar is prevented from shifting laterally, i. e., away from the axis of rotation.

Where a side wall shell is not used the body of cement should be thick enough to permit the jar to be safely worn through in use. Such shells, however, back up the cementitious material in which the jar is embedded, and their use is advantageous for this reason.

The invention may be described in greater detail with reference to the drawings. The embodiment shown comprises a hollow ceramic ware jar 1 of the type customarily used in ball mills. This is formed in one piece, so that it is a seamless, essentially monolithic structure. The jar is provided with a side port 2 provided with a removable closure 3. The casing shown for purposes of illustration comprises end plates 4 positioned at the ends of the jar and connected by tie rods 5 threaded at their ends to receive nuts *5a*. Surrounding the tie rods is a shell 6 which extends between the end plates and which may be formed of any suitable rigid formable material, such as sheet metal, fiber, or the like. The end plates are provided with centrally disposed outwardly extending trunnions 7 for supporting the mill for rotation.

The jar is mounted in the casing in spaced relation thereto and the space between the jar and the casing is entirely filled with a cementitious material 8, as seen in Fig. 1. A suitable opening is provided in the shell for port 2 and its closure 3, so that the mill can be charged and discharged, as shown in Fig. 1.

Means are also provided for retaining the shell and jar in fixed position, as by keying the cement body to the end plates. This may be done in any of a number of ways, one of which is illustrated in Figs. 1 and 2. End plates 4 are provided with a peripheral inwardly extending flange 9 having a groove 10 formed therein on the inside face of the flange. Shell 6 is cut with its edges exactly parallel so that when inserted in groove 10 permanent exact axial alignment is obtained. Flange 9 acts as a peripheral stop, as seen in Figs. 1 and 2, which keys the cement body in place. Thus the cement body with its embedded jar is permanently retained in position, and lateral slippage cannot occur.

Closure 3 may be held removably in position in any suitable manner, as by means associated with the casing structure. In the embodiment shown in the drawings end plates 4 are provided with lugs 11 for reception of a cross bar 12 provided with screw means indicated conventionally at 13 for applying pressure to closure 3. The end plates may be provided with radial strengthening ribs 14, if desired.

As appears from the drawings, the material ground within the jar is nowhere exposed to cement or other contaminating agency, the construction providing, in effect, a reinforced monolithic body of which the reinforcing material can not contact anywhere with the glaze or enamel, either in grinding or in passing through port 2. The cement body being of substantial thickness and being itself reinforced by tie rods 5, reinforces the jar adequately against cracking and breakage. Also, by virtue of this strengthening action the jar may be used until its wall has been worn through the abrasion of the grinding elements, the danger of cracking during the later stages of wear being wholly, or largely, eliminated. This action is enhanced by outer shell 6 which cooperates to strengthen the reinforcing cement body. It will be clear that as a result jars of any desired capacity, however large, may be used in the practice of the invention, so that the invention not only represses structural disadvantages of prior art mills of both types, but also greatly extends the usefulness of the seamless jar type. Also, the construction described and shown is easily cleaned, inside and out.

The mill provided by the invention may be arranged in any suitable manner for rotation. A particularly desirable mode of mounting is shown in the drawings, in which the mills are mounted in tandem to be driven by a single motor. The construction shown comprises a pair of spaced A-frames 15 having cross bars 16 which are provided with bearings 17 for stub shafts 18 keyed in trunnions 7. The A-frames are also provided with cross bars 19 which carry a longitudinally disposed stiffening plate 20 upon which is mounted a motor 22 to the shaft of which is keyed a pinion 23 meshing with a gear 24 mounted on a drive shaft 25 rotatably carried in bearings 26 connected to the top of the frame.

Shaft 25 is provided at opposite ends with drive pulleys 27 and *27a*. Pulley 27 drives one of the mills, for example mill A, Fig. 3, through a belt 28 and pulley wheel 29 keyed on shaft 18 at the corresponding end of mill A. The other mill, B, is driven similarly, but at the opposite end, through pulley 27a, belt 28a and pulley wheel 29a.

The A-frames are strengthened by diagonally transverse tension rods 30, and plate 20 cooperates therewith to render the frame strong and rigid. Additional rigidity is provided in the form shown by a transverse brace 31 connecting cross bars 16 between the two mills. Brace 31 may comprise two angle sections connected back to back to form an inverted tie, as shown in Fig. 3.

This construction is advantageous particularly because it reduces the power requirements. The power needed to start ball mills, at least in the larger sizes, is, roughly, about three to four times that needed for running the mill. By driving two mills from a single motor it is possible to use a motor no larger than that needed for starting and driving a single mill, because when one mill is running its inertia is available to assist in starting the second mill, so that the latter may be started without exceeding the peak load of the motor. Also, the tandem mounting in the A-frames shown affords a saving in floor space, provides simplicity of construction and permits running of either or both of the mills according to need.

It will be observed that the mills are mounted at a substantial distance above the floor so that collecting pans can be inserted readily beneath the mill for discharging the ground batch. In prior types of construction it has been necessary to reinforce the framework at the bottom, so that collecting means, such as pans, could not be run far enough under the mill to safely gather the ground product when the mill was dumped. With the construction shown collecting devices may be inserted from either side of the mill and be extended as far as need be for reception of the mill contents without spilling, and if desired such collecting means may take wheeled forms. These constitute substantial advantages over the prior structures.

According to the provisions of the Patent Statutes, I have explained the construction and mode of use of my invention, and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A ball mill comprising a seamless closed end ceramic ware jar positioned with its ends between a pair of metallic end plates provided with a recessed portion on their interior surfaces, tie rods connecting said end plates disposed about said jar, and a body of hardened cementitious material disposed about said jar embedding it and the tie rods therein and thereby providing a reinforced shell about the jar strengthening it against breakage and compensating for decrease in jar wall thickness in use, said recesses cooperating with said body to maintain axial alignment of said body and its embedded jar in the mill.

2. A ball mill comprising a seamless closed end ceramic ware jar disposed in spaced relation from the walls of an enclosing casing including end plates, a side wall of rigid formable material extending between the end plates, and tie rods connecting the end plates and arranged around the jar within the casing, the jar being provided with a side port extending through said casing, a removably retained closure for said port, and a body of hardened cementitious material filling the space between the jar and casing and embedding the jar and tie rods, said end plates being provided on their interior surfaces with recesses into which said cementitious material extends and cooperating therewith to key said cementitious body against shifting with respect to the longitudinal axis of the mill, and said casing and side wall cooperating to prevent breakage of the jar and to permit its use until the jar wall has been abraded substantially through in use.

3. A ball mill comprising a seamless closed end ceramic ware jar disposed in spaced relation to the walls of an enclosing casing including end plates each provided on its outside surface with a trunnion and provided with an inwardly extending grooved flange, a side wall of rigid formable material extending between the end plates and seated in the grooves in said flanges, and tie rods connecting the end plates and arranged around the jar within the casing, the jar being provided with a side port extending through said casing, a removably retained closure for said port, and a body of hardened cementitious material filling the space between the jar and casing and embedding the jar and tie rods, said casing and side wall cooperating to prevent breakage of the jar and to permit its use until the jar wall has been abraded substantially through in use, and said body being keyed by said flanges to maintain axial alignment of the body and its embedded jar.

4. A ball mill comprising a seamless closed-end ceramic ware jar positioned with its ends between a pair of metallic end-plates, tie rods connecting said end-plates disposed about said jar, and a body of hardened cementitious material disposed about said jar embedding it and the tie rods therein and thereby providing a reinforced shell about the jar strengthening it against breakage and compensating for decrease in jar wall thickness in use, the interior surfaces of said end-plates being provided with means cooperating with said body of cementitious material to key said body to the end-plates and thereby maintain axial alignment of the body and its embedded jar in the mill.

THEODORE J. VOLLKOMMER.