Feb. 24, 1970 J. E. NELSON 3,497,142

AUTOGENOUS GRINDING PROCESS AND MILL SYSTEMS

Original Filed Sept. 20, 1963 4 Sheets-Sheet 1

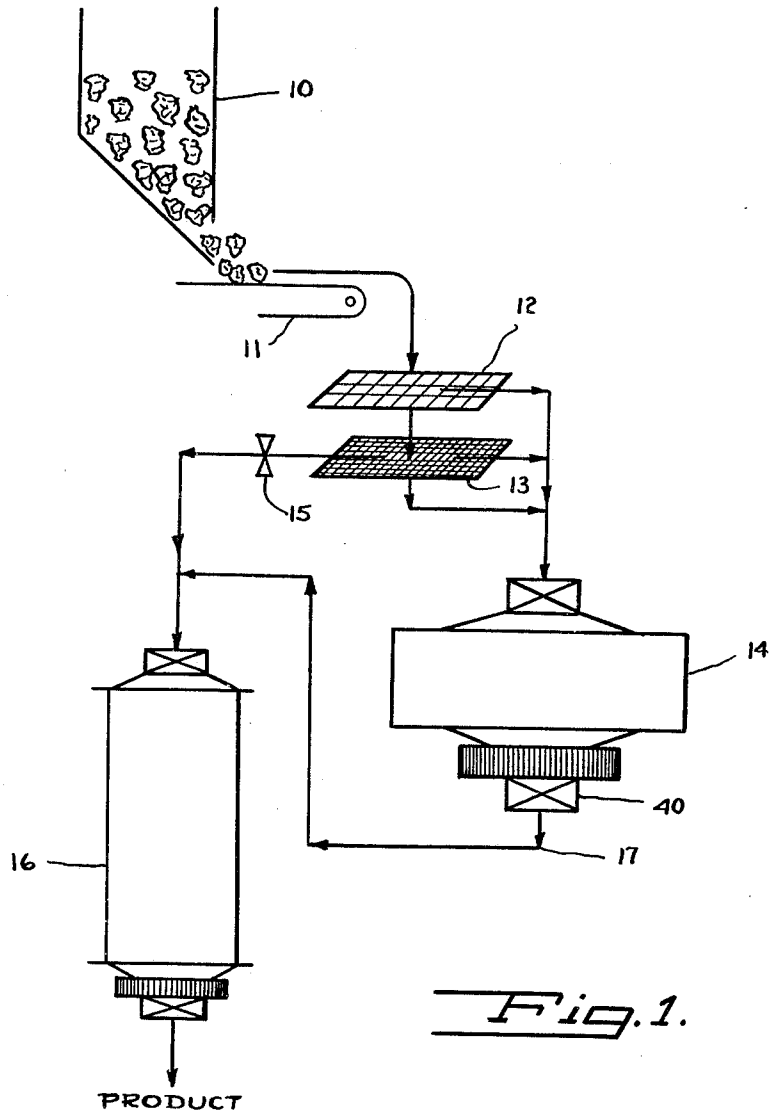

Fig. 1.

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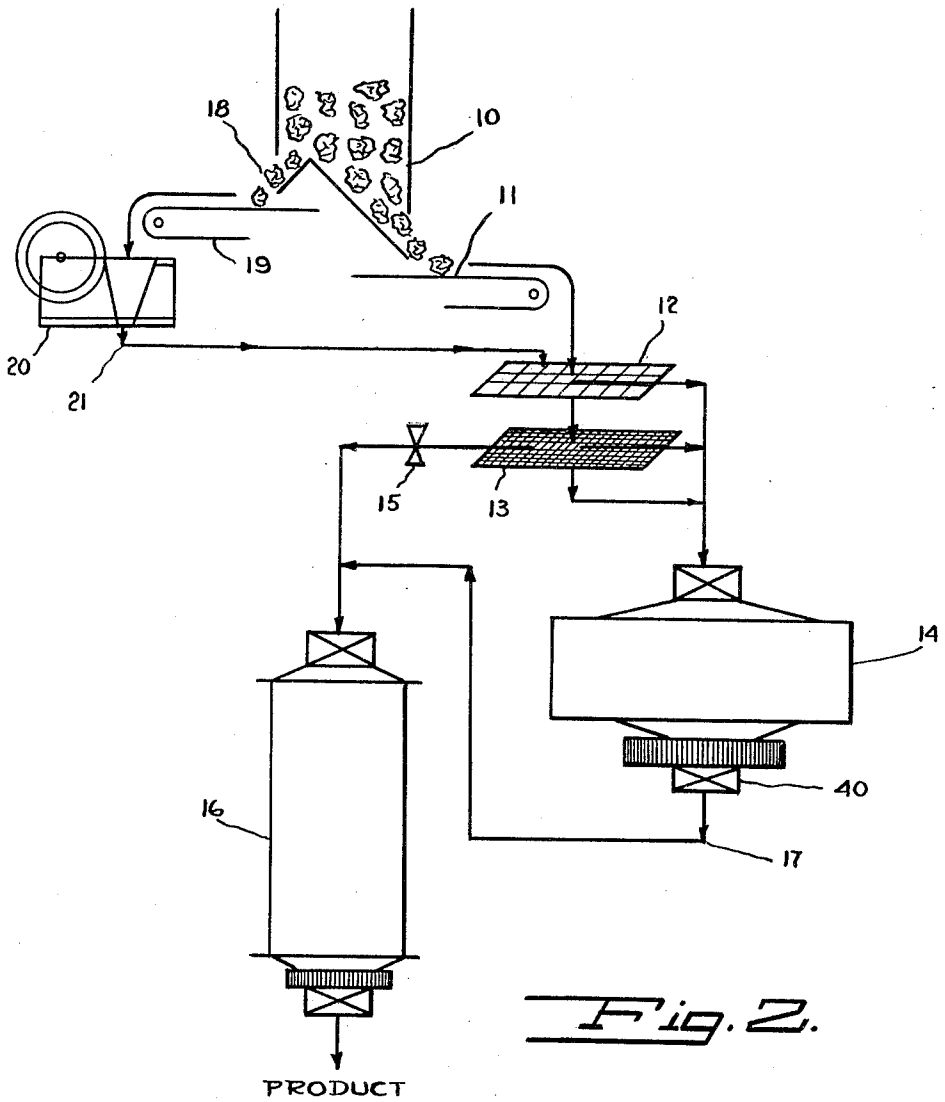

Fig. 2.

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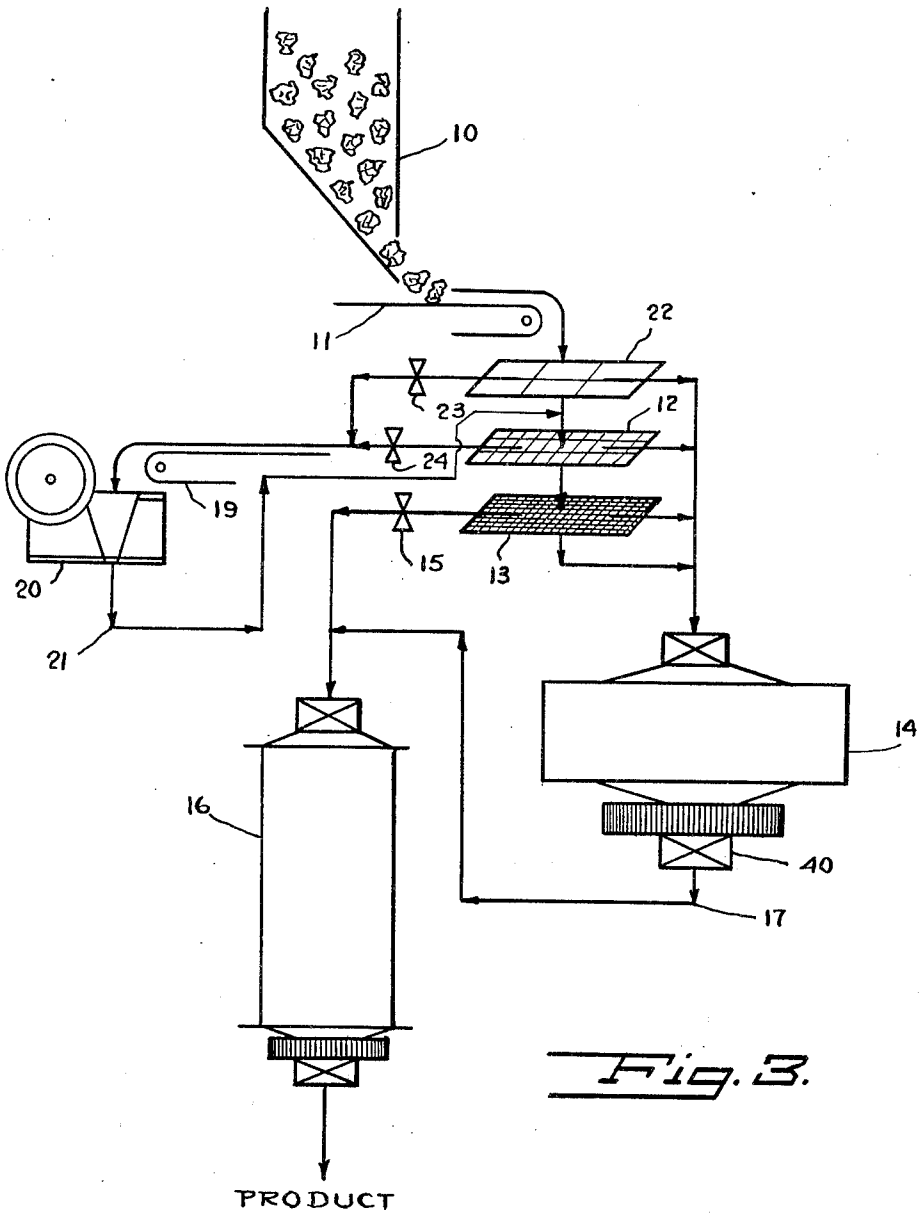

Fig. 3.

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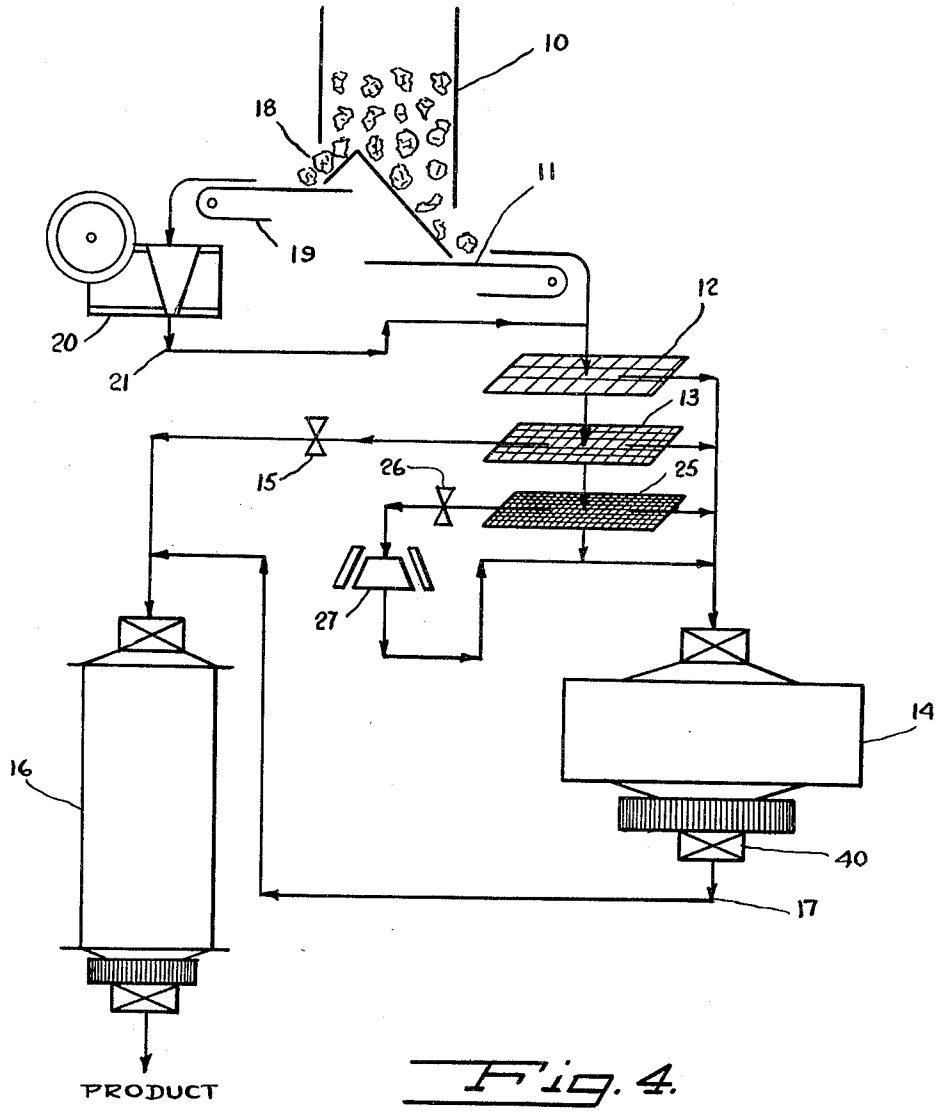

Fig. 4.

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3,497,142

AUTOGENOUS GRINDING PROCESS AND MILL SYSTEMS

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Continuation of application Ser. No. 310,271, Sept. 20, 1963. This application Oct. 10, 1968, Ser. No. 781,670
The portion of the term of the patent subsequent to Oct. 17, 1985, has been disclaimed
Int. Cl. B02c *17/02, 7/00;* B07b *13/00*
U.S. Cl. 241—24 4 Claims

ABSTRACT OF THE DISCLOSURE

Concentration of sizes of material in mill components of a grinding mill system for grinding run-of-mine material are controlled by extracting a portion of a predetermined size of pebble material from the run-of-mine material before it enters an autogenous mill (such that the size range of input to the autogenous mill is controlled) and passing a controlled amount of the extracted pebbles directly to a pebble mill which is in series with the autogenous mill to maintain satisfactory grinding in the pebble mill. To provide sufficient pebble size material for extraction, the run-of-mine material may be crushed prior to such extraction.

This is a continuation of application Ser. No. 310,271, filed Sept. 20, 1963, now abandoned.

This invention relates to autogenous grinding mill systems or apparatus or the like and has particular reference to the provision of a new and improved autogenous grinding mill system of the type in which coarse, friable, run-of-mine material is subjected to self-reduction, and of a process for the removal of material of desired size from the remainder of said coarse, friable material prior to the time that such is fed into the grinding mill.

As used herein, the term "autogenous" shall mean the use of a friable material undergoing reduction, either in whole or in part, as its own grinding media. The term "run-of-mine" material, as used herein, shall mean a mixture of friable material, which mixture normally includes coarse, intermediate, and fine sizes, the larger sizes being sufficient to effect self-reduction and reduction of the smaller sizes present in the mixture. The term "pebble milling," as used herein, shall mean the use of screened fractions of the friable material in the coarse range, as media, for the grinding of the finer sizes of the same material.

Conventionally, when a product much finer than about 10 mesh is required, it is, generally, not practical to produce such product in a single mill which is being fed with run-of-mine ore. Thus, conventionally, when a finer product than about 10 mesh is required, it is usually necessary to first produce an intermediate sized product from one grinding mill, and then to further grind this product in an additional mill, or additional mills as the specific case may require, using the pebble milling process.

Conventionally, the pebbles necessary for this pebble milling process are obtained either from the charge within the first or primary mill, through suitable ports, or from the discharge of said first mill by means of auxiliary apparatus.

Said conventional processes for the removal of the pebbles, however, possess certain severe inherent disadvantages and deficiencies.

In the first place, should the necessary pebbles be removed from the charge within the first mill by means of suitable ports, material of sizes other than that desired for use either as pebbles or as the primary mill product

is obtained; such making the provision of auxiliary apparatus necessary for the required separation of the unwanted fractions of said material and either the returning of such to the primary mill or the separate treatment of such elsewhere. Furthermore, in the use of the port process, a further disadvantage arises from the difficulty in adjusting the port size and area to match the, generally, constantly changing requirements of the pebble mills.

Should the necessary pebbles be obtained from the discharge of the first, or primary, mill, a range of size of material even greater than that obtained through the use of the port method is obtained; said greater range of size of material leading to even greater problems in its higher demands for the separation and return of unwanted material. Thus, in brief, both of these conventional methods for obtaining the pebbles necessary for the pebble milling process are unsatisfactory in practice.

An object of the invention is to provide a new and improved process and apparatus of the type set forth which includes the removal of the desired pebbles prior to the feeding of such into the first, or primary, grinding mill.

Another object of the present invention is to provide a new and improved process for the provision of pebbles for the pebble milling process, which new and improved process is simple and economical in operation.

Another object of the invention is to provide a process and apparatus of the type set forth which includes a provision for the supply of a sufficient quantity of suitable pebbles even should the run-of-mine material itself, not include such sufficient supply.

Another object of the invention is to provide a process and apparatus of the type set forth which enables pebbles of sizes other than that desired for said pebble milling process to be removed from the run-of-mine material prior at the same time as the pebbles necessary for said process are removed from said run-of-mine material.

Another object of the invention is to provide new and improved means for the accomplishment of the foredescribed process.

Other objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings. It will be understood that changes may be made in the details of construction and arrangement of parts shown and described as the preferred forms of the invention have been given by way of illustration only.

Referring to the drawings:

FIG. 1 is a schematic view of an apparatus for the production of a ground product from run-of-mine material through the use of a primary autogenous mill and a secondary pebble mill;

FIG. 2 is a schematic view of an apparatus similar to that of FIG. 1, but which system is adapted to function when insufficient pebble sized material is present in the run of mine material;

FIG. 3 is a schematic view of an apparatus similar to those of FIGS. 1 and 2, said system being adapted to remove from the run-of-mine material, in addition to those pebbles of correct size for the pebbling process, those pebbles of a size larger; and

FIG. 4 is a schematic view of an apparatus similar to that of FIG. 3, but which system is adapted to remove pebbles of a size smaller than the desired size in addition to those of the desired size.

Referring more particularly to the drawings wherein similar reference characters designate corresponding parts throughout the several views, and with particular reference to FIG. 1 of the drawings, such illustrates a system for producing a ground product from run-of-mine material through the use of a primary autogenous mill and a secondary pebble mill.

The apparatus employed as shown in FIG. 1 comprises a bin **10** adapted to contain run-of-mine material or ore, feeder **11** which conveys such material to the separation devices or screen **12** and **13**.

The apparatus also includes primary mill **14**, pebble mill **16** and volume or quantity control means **15**.

Primary mill **14** has discharge **17** which is connected to the inlet of pebble mill **16**.

In the process of the present invention and operation of the apparatus shown in FIG. 1, run-of-mine ore from the bin **10** is transported by the feeder **11** to the dual separation devices which comprise the screens or grisslys **12** and **13**.

Said dual separation devices are chosen for any particular application of the system such that said separation devices are at the upper and lower limits of the size pebbles that are required. Thus, assuming for the purposes of example that a pebble size minus 3 inches, plus two inches has been established, the first separation device or screen **12** would be chosen such as to be operative at three inches and the second separation device or screen **13** would be chosen such as to be operative at two inches.

In the embodiment of the system illustrated in FIG. 1, the plus three inch material joins with the minus two inch material for feed to the primary mill **14**. The minus three inch-plus two inch pebbles, on the other hand, are transported through the suitable volume controlling means **15** to the pebble mill **16**, any excess in said minus three inch-plus two inch material being fed to the primary mill **14**. The primary mill discharge which is shown generally at **17** is delivered to the pebble mill **16**.

The mill apparatus and process, as illustrated in FIG. 1 and foredescribed, is adapted for application where the run-of-mine material contains a sufficient quantity of pebbles of the size required for the pebble mill; and where, also, it is neither necessary nor desired to remove certain fractions of the primary mill feed in order to maintain a suitable charge equilibrium within that mill.

With reference to FIG. 2 of the drawings, such illustrates the process of the present invention and the apparatus required where insufficient pebble size material is present in the run-of-mine ore. In such case, a second withdrawal point **18** from the bin **10** is provided in order that a quantity of the ore contained in said bin sufficient to produce the additional required material of pebble size may be provided to the system by means of the jaw, gyratory, or other suitable crushing device **20**, which crushing device **20** has been set to produce pebbles of the desired size.

The discharge **21** from said crushing device feeds the ore crushed by said crushing device into the mainstream of the ore passing through the dual separation devices **12** and **13**.

The process and apparatus of FIG. 2 is particularly adapted for applications where it is neither necessary nor desirable to control the primary mill **14** charge equilibrium by the removal of sizes of material other than that required for the operation of the pebble mill **16** before the admission of said material into the primary mill **14**. However, if a moderate excess in capacity be produced by the crushing device **20**, some degree of control of the larger sizes of material may be obtained through the operation of said crushing device at a larger setting and greater tonage than is required for the production of the pebble size material alone.

With regard to the process of the invention and apparatus illustrated in FIG. 3, such is particularly adapted for application where, in addition to the removal of pebbles of the proper size for the pebble mill, the removal of material of a size larger than said pebble size is necessary in order to maintain a satisfactory equilibrium within the primary mill **14**.

In such case, a third separation device **22** is added to separation devices **12** and **13** and quantity control devices **23** and **24** are provided in order that the crushing device **20** can be fed the oversize from either or both of the separation devices **22** and **12**, any excess in such joining with the excess of pebble size material and the underflow from separation device **13** for the feeding of the primary mill **14**.

By way of example, assuming that minus three inch-plus two inch material is required for the pebble mill **16**, and, further, that material in the size range of minus six inch-plus three inch should be reduced, the separation devices **22**, **12**, and **13** would be set at six inches, three inches, and two inches, respectively.

With regard to FIG. 4 of the drawings, the process and apparatus illustrated therein is particularly adapted for application where production of pebble size material is desired and, in addition, where material a size fraction smaller than pebble size must be removed and separately treated in order that the primary mill **14** maintain optimum charge equilibrium.

In such case, a third separation device **25** is added to the screening system, said separation device **25** being set for a size smaller than those pebbles required for the operation of the pebble mill **16**. The oversize material from said separation device **25** is transported by way of a suitable quantity control device **26** to a comminuting device such as a crusher, rod, ball, or other suitable type of mill **27** for reduction before return to the operative portion of the system.

In this illustrated form of the system, it is assumed that one stage of crushing will suffice, after which crushing, the crushed product can be fed into the autogenous primary mill **14**. However, in some cases, it may be preferable to treat the oversize from the separation device **25** in a rotary mill, or mills, and to deliver this product either to the primary mill feed, pebble mill feed, or finished product.

By way of specific example, assuming that minus three inch-plus two inch pebble is required for the pebble mill **16**, and that pebbles less than two inches to more than one inch should be treated, the three screening or separation devices **12**, **13**, and **25** would separate at three inches, two inches, and one inch, respectively.

In addition to these four processes and apparatus which have been foredescribed, it is believed to be readily apparent that many variations of said systems are possible. By way of example, the crushing device or devices, primary and secondary mill or mills can be close circuited with the appropriate screen, classifiers, cyclones, and the like as may be desired.

The operation of the process and apparatus herein provided is believed to be apparent from the foregoing description.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of operating a grinding mill system having an autogenous mill for grinding run-of-mine material and a pebble mill for providing further reduction of the material including the steps of; (1) extracting by sorting at least a portion of a predetermined range of size of pebble material from said run-of-mine material prior to entry of the material into said autogenous mill to control the size range of the input to the autogenous mill; (2) passing the residue of said run-of-mine material to the autogenous mill together with any excess of extracted pebble material, for reduction by grinding; (3) passing at least a portion of the output of the autogenous mill to said pebble mill for further reduction therein; (4) and supplying a sufficient portion of the extracted pebble material, to said pebble mill to maintain satisfactory grinding therein, whereby operation of the system is promoted and the build-up of undue quantities of intermediate size material is controlled.

2. The method of claim **1** including the step of crushing a portion of the run-of-mine material prior to said extracting by sorting step, to provide an increased quantity of pebble size material.

3. The method as claimed in claim 1 including the steps of extracting by sorting a portion of said run-of-mine material of a size exceeding a predetermined pebbling size, reducing said portion by crushing to provide additional pebble material, and returning said portion for said sorting step, whereby material larger than pebble size is removed to maintain a desired equilibrium within said autogenous mill.

4. The method as claimed in claim 1 including the step of extracting by sorting at least a portion of material of a size less than a predetermined pebbling size, reducing said portion by comminuting apart from the residue, and returning the reduced material for further milling.

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241—26, 29