

# United States Patent

[11] 3,630,457

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[21] Appl. No. 864,398  
[22] Filed Oct. 7, 1969  
[45] Patented Dec. 28, 1971  
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[32] Priority Oct. 24, 1968  
[33] Czechoslovakia  
[31] 7321/68

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[54] REGULATION OF THE SUPPLY OF RAW MATERIAL TO A CLOSED CIRCUIT GRINDING MILL SYSTEM  
2 Claims, 2 Drawing Figs.

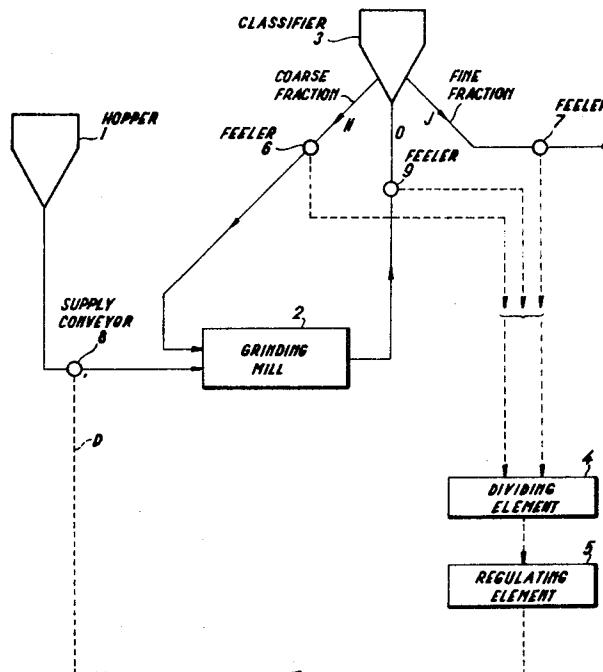
[52] U.S. Cl. ..... 241/34  
[51] Int. Cl. ..... B02c 25/00  
[50] Field of Search ..... 241/34-36

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**ABSTRACT:** The amount of raw material, supplied for grinding to a closed-circuit grinding mill system, comprising a device for feeding the raw material to the grinding mill, a classifier of the ground material, structure for returning coarse material to the grinding mill for repeated grinding, and the respective conveying tracks for the treated material, is adjusted in dependence on the ratio of the weight amount of the fine output from the classifier and of the weight amount of the coarse material returned from the classifier for repeated grinding, whereby the amount of raw material supplied is limited in dependence on a predetermined maximum content of the grinding mill.



2 Sheets-Sheet 1

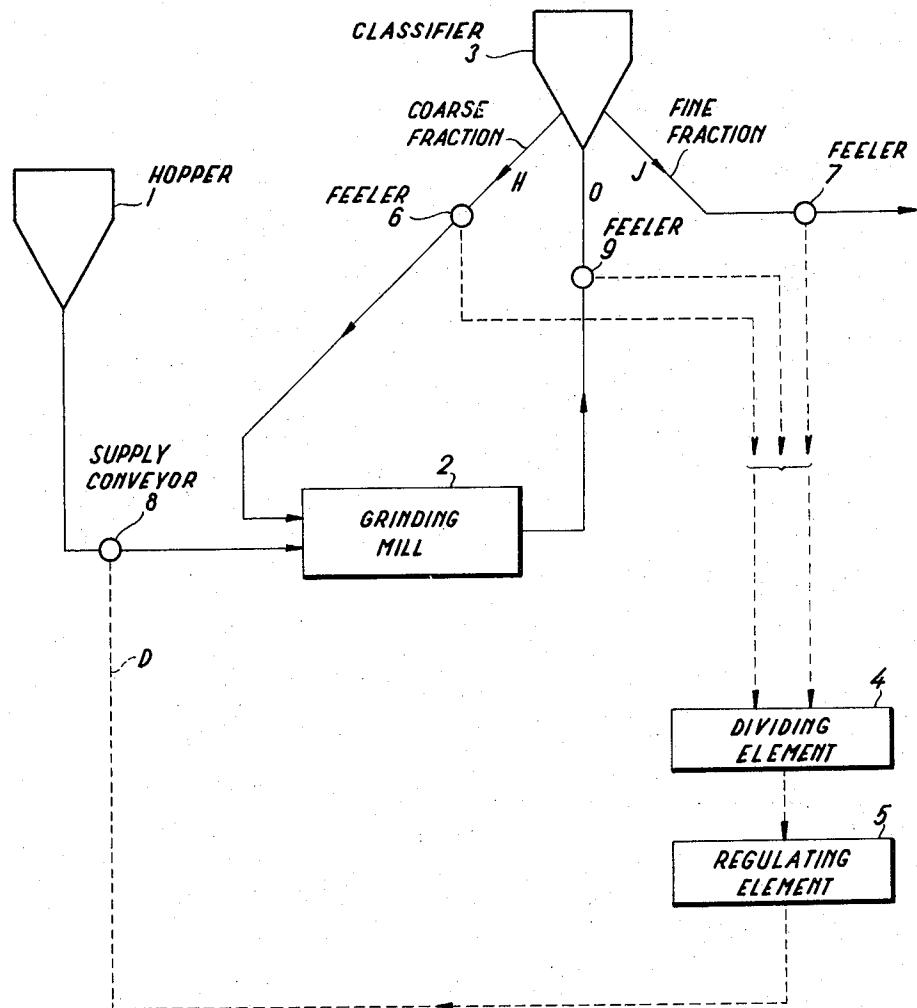


Fig. 1.

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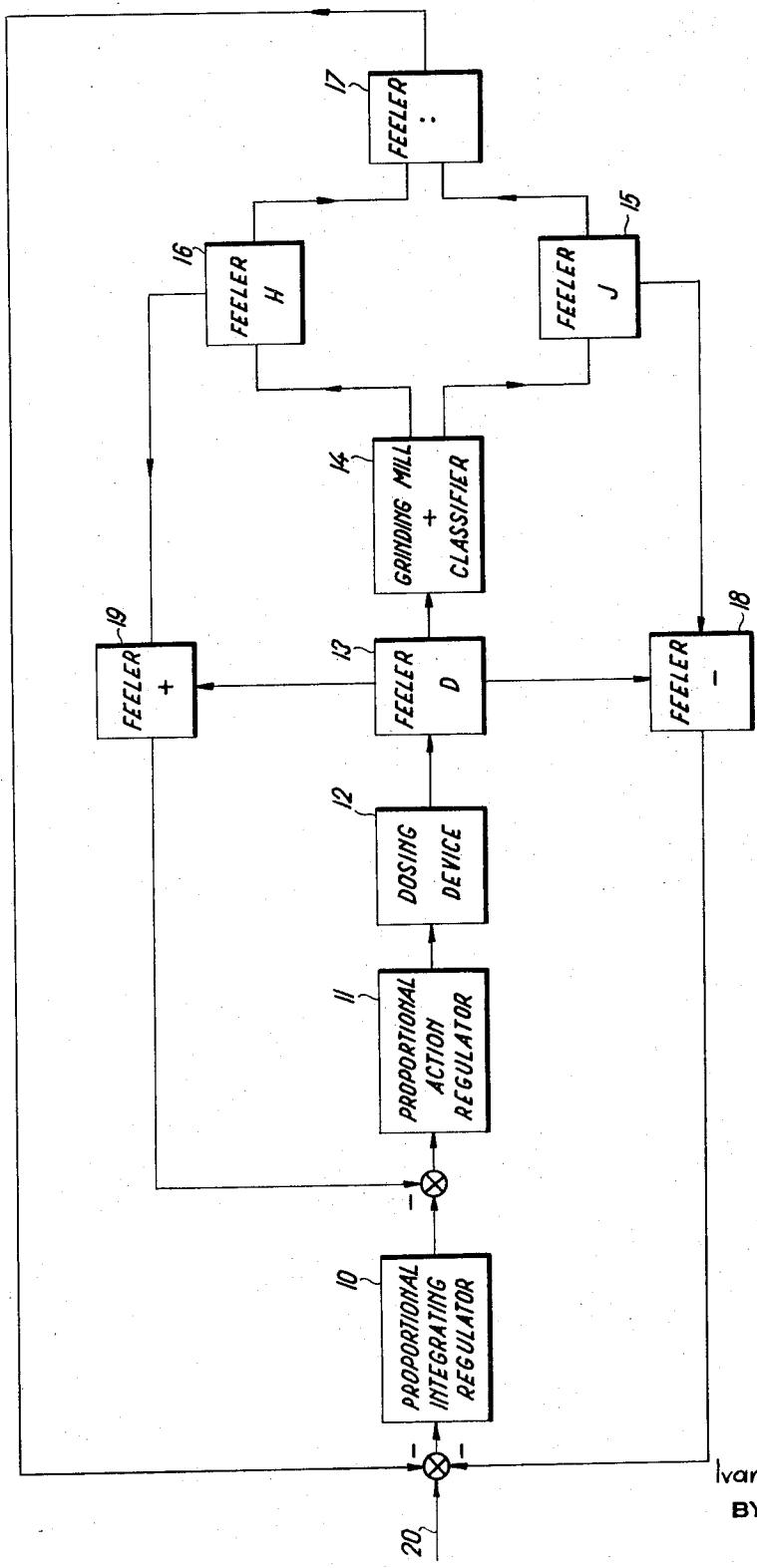


Fig. 2.

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## REGULATION OF THE SUPPLY OF RAW MATERIAL TO A CLOSED CIRCUIT GRINDING MILL SYSTEM

### BACKGROUND OF THE INVENTION

This invention relates to the regulation of the supply of raw material to closed-circuit or circulating grinding mill systems composed of means for feeding the material into the mill, the grinding mill proper a classifier, and the corresponding transporting and regulating means.

Circulating grinding mill systems are in common use in the industry for the disintegration of different materials. The circulating grinding mill system is composed of a mill, where the material is disintegrated, of the transport means, which convey the disintegrated material into a classifier where the material is classified into the final product, i.e., fine fraction, and the returned material, i.e., the coarse fraction, which is again returned into the mill. The mill is therefore supplied partly by the returned material, and partly by new material. The particle size of the material leaving the mill influences the quality of the product discharged from the circulating grinding mill and thus also the classifying of the material. The operation of the mill depends on the supplied raw material and on its condition and on the particle size of the material returned by the classifier and again entering the mill. The particle size of the discharged ground material is thereby equally affected.

The mill and the classifier represent a complex system with a continuous flow of material in its whole circuit, any changes of the particle size of the material leaving the mill cause a disturbance of the equilibrium of the system which afterwards passes over into a new stabilized condition with another circulation factor, i.e., a new ratio of the amount of circulating material to the amount of fine material discharged from the classifier (final product) and with a new return factor, i.e., the ratio of the amount of coarse material leaving the classifier to the fine material (final product); in case of larger changes there results an inefficient operation of the system.

It is absolutely necessary for an efficient operation of the mill, that is, for its optimum output while producing a high-grade product, to immediately register said changes of the equilibrium condition and limit them or prevent them by adjustment of the supply of new material. A number of regulating systems for grinding mills with circulating material have been developed for this purpose, taking advantage of measurements of the circulating amount of material for instance by measuring the power supply of the motor of an elevator by electroacoustic arrangements, measuring the noise of the mill, by summarizing the amount of new raw material and the amount of the coarse output from the classifier, returned to the mill. A result of all these regulating systems is a reduction of the amount of new raw material entering the mill at an increasing amount of circulating material and equally the adjustment of the amount of new material and of the amount of the coarse discharge from the classifiers so that the sum of both kinds of material remains constant.

There is furthermore a known method of regulation of grinding mills with circulating material using measurements of the grain size of the resulting product by determining the sieve rest on a certain sieve, for instance 4,900 mesh per square centimeter and adjusting on the basis of changes of the sieve rest of the resulting product the charges fed into the mill. Sometimes the sieve rest is replaced by measurements of the specific surface of the grains.

It is however, common knowledge that neither the sieve rest nor the specific surface of the grains distinctly characterize the grain size and thus none of the known methods for regulating the operation of such mills does insure a constant and optimum grain size of the resulting product. In some industrial branches the grainage is a substantial indicator of the quality of the product, for instance for the grinding of cement and similar material.

The above mentioned methods secure a stabilization of the charging of the mill, however, do not stabilize the condition of the grains of the material leaving the mill.

### SUMMARY OF THE INVENTION

It is an object of this invention to eliminate said drawbacks by an automatic regulation of a grinding mill with material circulation. In accordance with the invention, for the adjustment of the amount of raw material charged into the mill either the ratio of the amount of material leaving the classifier at its coarse and fine outputs, or the ratio of the amount of material supplied to the classifier and of the material discharged at its course or fine output, or the reciprocal values of these relations are used up to the limit of filling of the mill, the charging being adjusted to this limit value.

The arrangement for automatic regulation is applied to circulating grinding mill systems composed of a dosing or feeding device for raw material, a mill, a classifier and conveying means. The conveying means executes the regulation according to this invention and regulating the charging of raw material to the mill in dependence of the ratio of the weight amounts of the coarse and fine material discharged from the classifier and stabilizing the regulating process in dependence on the difference of weight amounts of the material entering the mill and of the material leaving the mill. The regulating means comprises a feeler or sensor of the ratio of the weight amounts of the coarse and fine fraction discharged from the classifier, one input of which sensor is connected to the output of a sensor of the weight amount of the coarse material returned from the classifier to the mill and the second input to the output of a sensor of the weight amount of the fine product discharged from the classifier and its output is connected together with the input of the predetermined regulating value of regulation to the input of a proportional integrating regulator. Said regulating means furthermore comprises a sensor of the amount of the difference of the weight amount of the charge into the mill and of the weight amount of the fine product, one input of which is connected to the output of the sensor of the dose charged into the mill and the second input to the output of the sensor of the weight amount of the fine product discharged from the classifier and its output is connected to the input of the proportional integrating regulator. Still further, it comprises a sensor of the sum of the weight amount of the coarse material returned to the mill and of the weight amount of the dose charged into the mill, to one input of which is connected the output of the sensor of the weight amount of the coarse material returned to the mill and to the second input the output of the sensor of the dose charged to the mill and its output connected together with the output of the proportional integrating regulator to the input of a proportional regulator, the output of which is connected to an operating device of the system, to which the sensor of the dose charged into the mill is connected.

### DESCRIPTION OF THE DRAWINGS

The attached drawings illustrate the arrangement for automatic regulation of the circulating grinding mill according to this invention.

FIG. 1 is a schematic overall view of an example of the execution of the automatic regulation of the circulating grinding mill, and

FIG. 2 schematically illustrates in detail the arrangement for automatic regulation of circulating grinding mills.

With reference to FIG. 1 the raw material is charged into the mill 2 by a supply conveyor 8 from hoppers 1. The ground material indicated in the drawing by the letter O is conveyed over the feeler or sensor 9 of the amount into a classifier 3, where the material is classified. The fine fraction, indicated in the drawing by the letter J, is discharged from the classifier as final product for further application by way of a feeler 7 of the amount; the coarse fraction, indicated in the drawing by the letter H is returned over the feeler 6 of the amount into the mill for further disintegration. The values obtained from feelers 6, 7, or 7, 9 or 6, 9 are transmitted to a dividing element 4, where the respective ratio H/J, O/H, O/J or their reciprocal values are evaluated.

The resulting value from the dividing element 4 is treated by the regulating element 5 which controls the dosing of the raw material into the mill 2 by means of the supply conveyor 8.

The arrangement of the circulating grinding mill according to FIG. 2 consists of a dosing device 12 and a mill 14 with a classifier. The arrangement according to this invention comprises a feeler 17 of the ratio of the amount of the coarse and of the fine fraction discharged from the classifier; to one input of feeler 17 there is connected the output from the feeler 13 of the amount charged into the mill 14 and the second input to the second output of the feeler 15 of the weight amount of the fine product discharged from the classifier. The output of the feeler 18 is connected to the input of a proportionally integrating regulator 10. The arrangement to this invention further comprises a feeler 19 of the values of the sum of the weight amount of the coarse material from the classifier returned to the mill and or the weight amount of the charge into the mill 14; to one input of feeler 19 there is connected the output of the feeler 16 of the weight amount of the coarse material returned to the mill 14 and to the second input of feeler 19 there is connected the output of the feeler 13 of the dose charged to the mill 14; The output of the feeler 19 is connected, together with the output of the proportionally integrating regulator 10, to the input of the proportional action regulator 11 which is connected with its output to an operating element 12 of the system, in the case given to a controlled dosing device, to which the feeler 13, indicating the amount of the dose charged into the mill 14, is connected.

The controlling value the regulation is the output of the feeler 17, which provides information about the value of the ratio of the coarse and fine fraction discharged from the classifier. This output is connected, together with the input of the stipulated regulated value 20, to the input of the proportionally integrating regulator 10, whereby the output of the feeler 18 is employed as a stabilizing coupling. The output of feeler 18 is proportional to the difference of the weight amounts of the material supplied to the regulated system and of the material discharged from the system, i.e., of the fine fraction discharged from the classifier such latter value being measured by the feeler 15. The output from the proportionally integrating regulator 10 is connected to the input of the proportional action regulator 11 as the value required for the regulator 11. Simultaneously, the actual value is supplied from the feeler 19; said actual value supplied from feeler 19 is proportional to the instantaneous value of the sum of the weight amount of the coarse material from the classifier returned to the mill measured by the feeler 16 and of the dose charged to the mill 14 as measured by the feeler 13.

The regulation of a grinding mill with circulating ground material according to this invention eliminates drawbacks of prior systems and maintains a constant granulation of the resulting product. Thus the invention meets, for instance one of the main requirements for high-grade cement in the cement industry. The manufacture of cement, particularly of cement of better quality with guaranteed optimum granulation, permits the reduction in the consumer industry of the amounts of cement employed in concrete mixtures, and also results in savings to the cement producing industry.

In addition to the cement industry, in all branches applying circulating grinding mills for the grinding of material.

The arrangement for automatic regulation of circulating grinding mills according to this invention furthermore the stabilization of the quality of the ground product, with all the economic advantages resulting therefrom.

5 In the above, the regulation in dependence on the ratio of weight amounts of the coarse and fine material leaving the classifier has been described, it is to be understood, that this regulation includes any conditions, when this ratio is in some way emphasized, for instance the ratio between the material 10 entering the classifier and the fine product leaving the classifier, and similar ratios or of their reciprocal values.

We claim:

1. In a closed circuit grinding mill system provided with a device for feeding raw material, a grinding mill, a classifier of the ground material, means for returning coarse material separated in the classifier for repeated grinding into the grinding mill, the improved apparatus for automatically regulating the feeding of material to the grinding mill, comprising means for sensing the ratio of the weight amount of the fine output 15 from the classifier and of the weight amount of coarse material returned from the classifier for repeated grinding, means responsive to the last-named means for regulating the supply of raw material, and additional material feeding regulating means limiting the amount of raw material supplied to the 20 grinding mill in dependence on a predetermined maximum content to the grinding mill.

2. A system according to claim 1, comprising a proportional integrating regulator, a proportional action regulator, a number of feelers of weight amounts of the treated material at 30 different places of the grinding mill system, said feelers including a first feeler, of the regulation of the weight amount of the coarse and fine fraction leaving the classifier, one input of said first feeler being connected to the output of a sensor of the weight amount of the coarse material returned from the classifier to the mill, the second input of said first feeler being connected to the output of a sensor of the fine product discharged from the classifier and the output of said first feeler connected together with the input of the stipulated regulated limit value to the input of a proportional integrating regulator, a second feeler, of the difference of the weight amount supplied to the mill and of the weight amount of the fine product discharged from the classifier, one input of said second feeler being connected to the output of a sensor of the dose of raw material charged to the mill, the second input 40 of said second feeler being connected to the output of a sensor of the weight amount of the fine product discharged from the classifier, the output of said second feeler being connected to a proportional integrating regulator, and a third feeler, of the sum of the weight amounts of the coarse material returned from the classifier to the mill and of the weight amount of the dose of raw material charged to the mill, one input of said third feeler being connected to the output of a sensor of the coarse material returned to the mill, the second input 45 connected to the output of a sensor of the dose of raw material supplied to the mill, the output of said third feeler being connected together with the output of the proportional integrating regulator to the input of a proportional action regulator the output of which is in turn connected to an operating element of the system, to which the sensor of the dose of raw 50 material supplied to the mill is connected.

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