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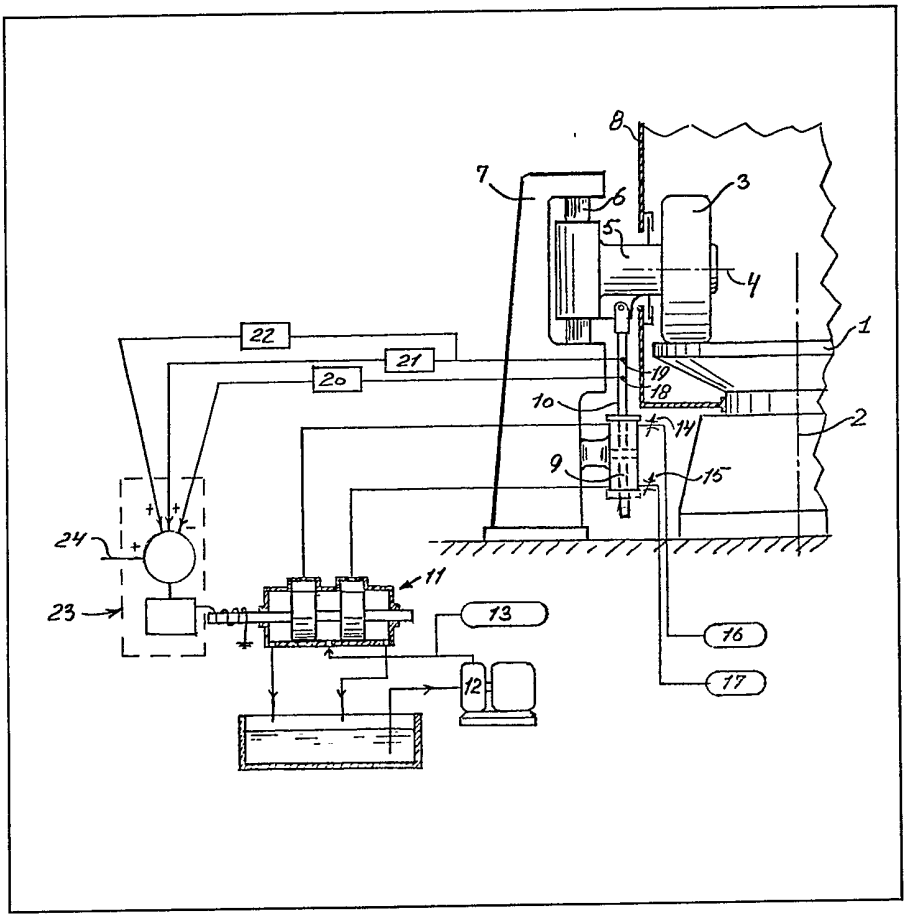
(54) **Vertical roller mill**

(57) In a vertical roller mill, a grinding roller (3) is urged against a grinding path on a grinding table (1) by an hydraulic cylinder (9). The loading on the roller is measured by a transducer (18) and the acceleration of the roller by an accelerometer (19). Resulting signals are combined at a controller (23) which controls a valve (11) through which hydraulic fluid is supplied to the cylinder, so that the loading is compensated for the influence of the instantaneous velocity and acceleration of the roller.



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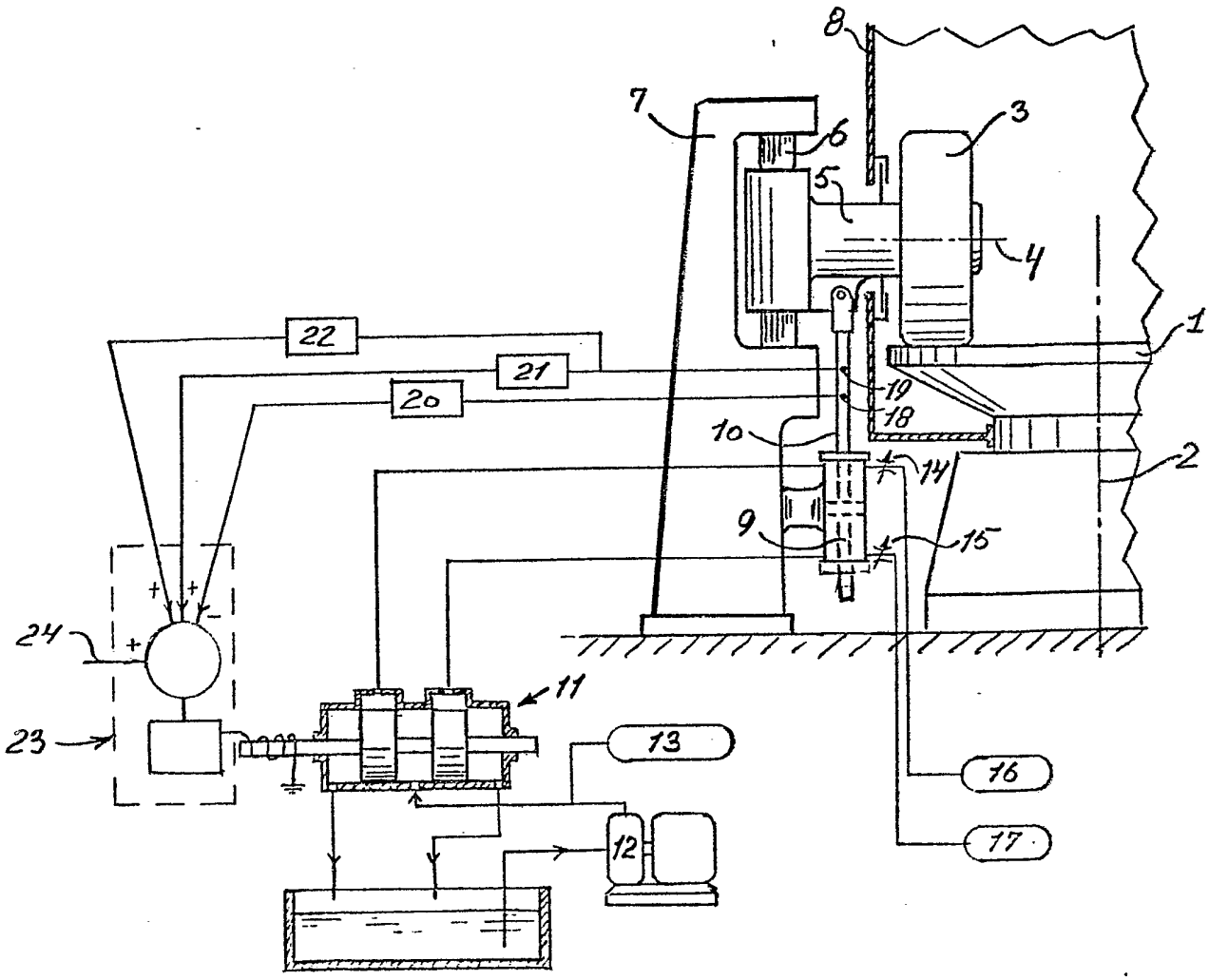

SPECIFICATION

Vertical roller mill

The invention relates to a method, hereinafter referred to as "of the kind described", of controlling the grinding roller pressure in a vertical roller mill which comprises at least one grinding roller urged by a loading force against the grinding path of a grinding table rotating about a vertical axis.

In mills of the above kind it is known to use single acting hydraulic cylinders whose active piston end is influenced by a constant grinding roller loading pressure.

It is also known to use a variable pressure in the cylinder, which is regulated proportionately with the grinding cushion thickness.

Furthermore, it is known to use double acting cylinders with different preset pressures at opposite ends of the piston, thus enabling the cylinder to prevent the rollers from suddenly dropping down onto the grinding path because of large variations in the grinding cushion thickness and especially because of a momentary absence of any grinding cushion. In this way large impacts and consequent detrimental effect on the grinding table and gear etc. can to some extent be avoided or at any rate reduced.

However, as will be known, comparatively large variations occur in the grinding power absorption in large roller mills, and the dynamic loads between the grinding rollers and the grinding table can produce very powerful, detrimental single impacts. Such variations are probably a consequence of the nature of the grinding cushion rolled over. The above known system with double acting cylinders to prevent the grinding rollers from suddenly dropping down is not suited for compensating for such dynamic load variations because of its relatively slow reaction.

It is the object of the invention to eliminate the above disadvantages of the known hydraulic loading systems.

According to the invention, a method of the kind described is characterised in that the instantaneous loading force on the roller is derived and converted into a loading signal; and in that the acceleration and velocity of the roller perpendicular to the grinding path are derived and converted into signals which are combined with the loading signal to produce a final signal controlling means for developing the loading force whereby the loading force is automatically compensated for the influence of the roller velocity and acceleration upon the roller pressure.

In this way, a constant, desired roller pressure is obtained without the detrimental, dynamic influences otherwise known, i.e. impacts upon and shakings of the various mill parts.

The invention also includes a vertical roller mill for carrying out the new method, the mill comprising at last one grinding roller which is urged by a double acting hydraulic cylinder against a grinding table rotating about a vertical axis, and being characterised in that both ends of the hydraulic cylinder are connected to an electro hydraulic servo valve controlled by a loading controller; in that a force transducer for measuring the roller loading force and an accelerometer for measuring the acceleration of the roller in relation to the grinding path is incorporated in the cylinder or its connection to the roller; in that the force transducer is coupled to the controller via a signal amplifier while the accelerometer is coupled to the controller via signal feedback units for the velocity and acceleration of the roller; and in that the controller imparts an output signal to the servo valve to produce a loading force compensated for the instantaneous mass force of the roller.

A preferred example of a mill constructed in accordance with the invention is illustrated in the accompanying drawing which shows diagrammatically in vertical section such parts of the mill proper and of its equipment which are necessary for an understanding of the invention.

The mill has a grinding table 1 rotating about a vertical axis 2. One or more grinding rollers 3 roll on the grinding table, the axis 4 of the or each roller being stationary in the horizontal plane. In the example shown the roller axis is parallelly displaceable in the vertical plane, as the roller suspension 5 is vertically movable in a parallel guide arrangement 6 on a frame 7. The grinding table 1 and the grinding roller or rollers 3 are encased in a mill housing 8 in a manner known per se.

The grinding pressure exerted by the roller 3 against a grinding path of the grinding table 1 is provided by an hydraulic cylinder 9 whose piston or draw bar 10 is connected to the roller suspension 5.

The cylinder 9 is double acting, and flow and flow direction as well as pressure at the two cylinder ends are controlled by an electro-hydraulic servo valve 11, being fed by a pump 12 having an apertaining hydraulic accumulator 13.

Each of the two ends of the cylinder 9 is connected via an adjustable flow resistance 14 and 15 to an hydraulic accumulator 16 and 17.

A force transducer 18 measuring the tensioning i.e. loading force for the roller 3 and an accelerometer 19 measuring the acceleration of the roller 3 are incorporated in the pistion or draw bar 10.

The force transducer 18 is, via an amplifier 20, and the accelerometer 19 is, via feedback units 21 and 22, connected to a controller 23 controlling the servo valve 11.

In principle the control system operates in the following way, the detailed construction of the individual units of the system i.e. amplifier, couplings, controller, servo valve and so on, being known within the technology and not constituting any part of the invention.

The desired grinding pressure against the material to be ground on the grinding table 2, the so-called grinding cushion, is preset on a potentiometer producing a corresponding signal which is passed to the controller 23 at 24. The force transducer 18 in the piston rod 10 measures the tensioning force of the cylinder 9 and produces a signal representative of this force, which signal via the amplifier 20 is fed back to the controller 23. The two signals are compared in the controller. Any difference causes the controller to give off an output signal which

activates the servo valve in such a way that the actual grinding pressure is adjusted towards the one preset on the potentiometer. This procedure is continued until the desired roller pressure and the tensioning force correspond.

Because of the two hydraulic accumulators 16 and 17 of the cylinder 9 the tensioning force for the roller 3 in case of comparatively slow roller movements is practically constantly independent of the roller displacement or position in relation to the grinding table 1. Conversely, in the case of comparatively quick movements the roller mass force will constantly influence and adjust the roller pressure against the grinding cushion. At worst, the roller may bounce and lose contact with the grinding cushion with subsequent detrimental impacts upon the grinding table and roller suspension when the roller drops onto the grinding cushion again.

The influence of the mass force on the roller pressure can be eliminated by controlling the flow to the cylinder 9 in such a way that the differential pressure in the cylinder is varied in size and phase corresponding to the mass force.

For this purpose, the accelerometer 19 is used, from which, via the feedback units 21 and 22, signals representing both velocity and acceleration of the vertical movements of the roller are transmitted to the summation point of the controller 23.

By this, it can be achieved that the output signal of the controller 23 controls the servo valve 11 so as to produce in the cylinder 9 flow and pressure conditions producing a roller tensioning compensated for the roller mass force and consequently a constant grinding cushion pressure.

It should be noted that naturally the hydraulic system must be dimensioned so as to be capable of producing the necessary force and effect and operate sufficiently fast, but such conditions can be fulfilled by known technology.

CLAIMS

1. A method of controlling the grinding roller pressure in a vertical roller mill which comprises at least one grinding roller urged by a loading force against the grinding path of a grinding table rotating about a vertical axis, characterised in that the instantaneous loading force on the roller is derived and converted into a loading signal; and in that the acceleration and velocity of the roller perpendicular to the grinding path are derived and converted into signals which are combined with the loading signal to produce a final signal controlling means for developing the loading force whereby the loading force is automatically compensated for the influence of the roller velocity and acceleration upon the roller pressure.

2. A vertical roller mill for carrying out the method according to claim 1, the mill comprising at least one grinding roller which is urged by a double acting hydraulic cylinder against a grinding table rotating about a vertical axis, characterised in that both ends of the hydraulic cylinder are connected to an electro hydraulic servo valve controlled by a loading controller; in that a force transducer for measuring the roller loading force and an accelerometer for measuring the acceleration of the roller in relation to the grinding path is incorporated in the cylinder or its connection to the roller; in that the force transducer is coupled to the controller via a signal amplifier while the accelerometer is coupled to the controller via signal feedback units for the velocity and acceleration of the roller; and in that the controller imparts an output signal to the servo valve to provide a loading force compensated for the instantaneous mass force of the roller.

3. A method according to claim 1, substantially as described with reference to the accompanying drawing.

4. A mill according to claim 2, substantially as described with reference to the accompanying drawings.

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