

May 20, 1969

A. L. VERDIER
ADJUSTMENT OF THE ROLLS OF GRINDERS AND OTHER
MACHINES WHICH INCLUDE ROLLS

3,445,070

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Sheet 1 of 3

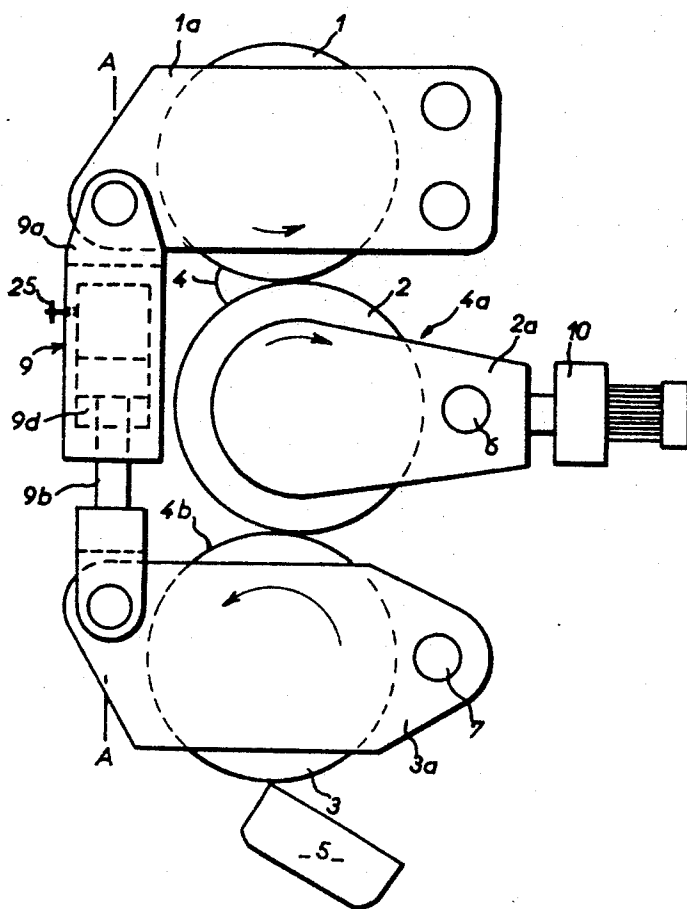


Fig. 1

INVENTOR
André X. Verdier

By *Watson, Co., Grindley & Watson*
ATTORNEYS

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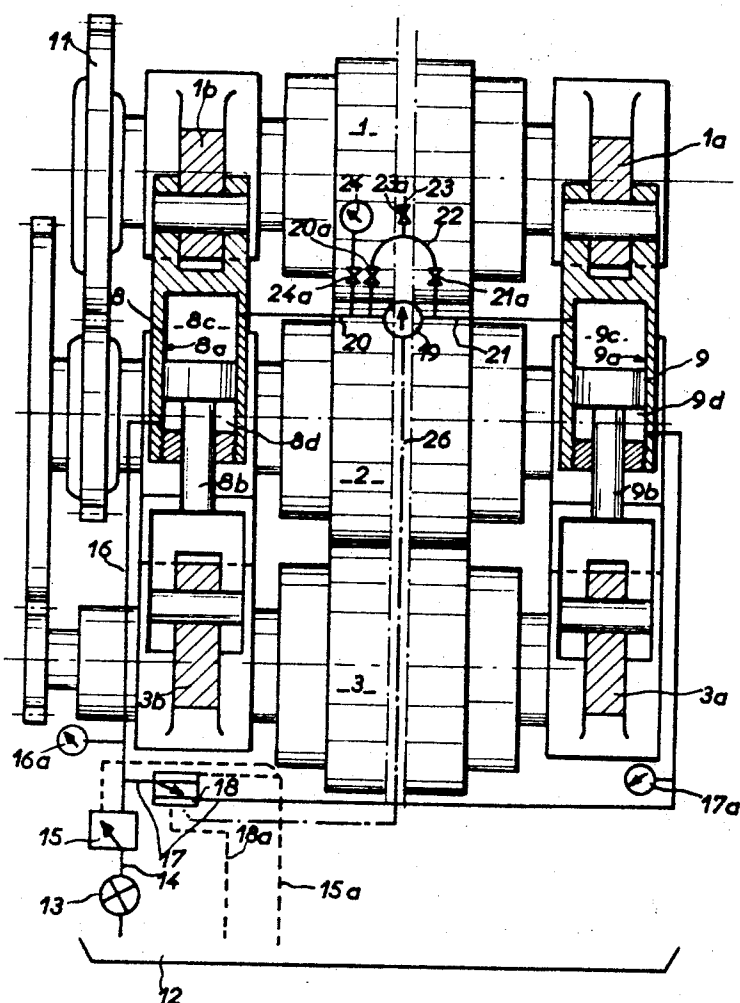


Fig. 2

INVENTOR
Andre L. Verdier

By *Watson, Col. Grindler & Watson*
ATTORNEYS

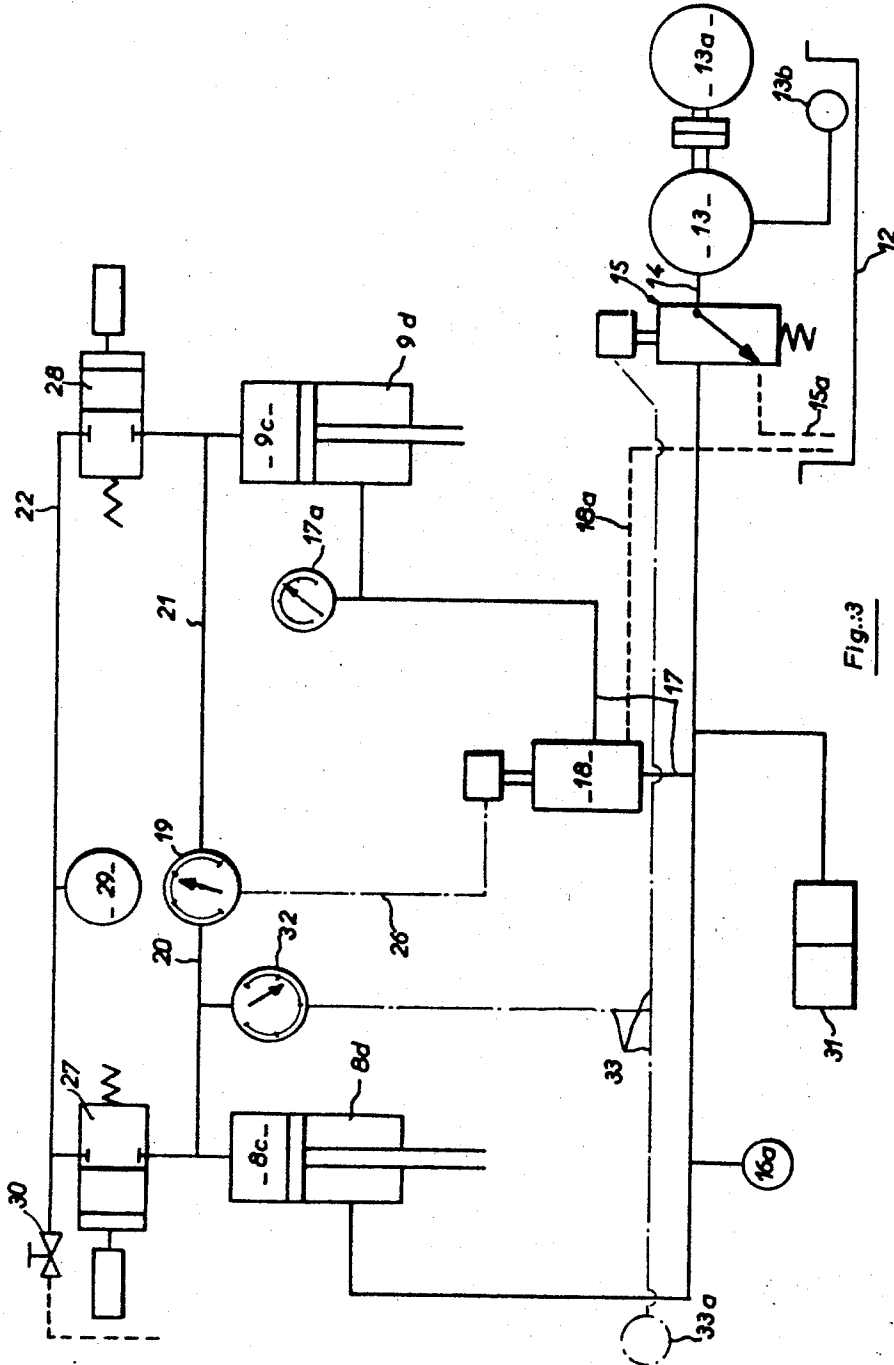
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INVENTOR
André L. Verdier
By Watson, Cole, Grindler & Watson
ATTORNEYS

1

ADJUSTMENT OF THE ROLLS OF GRINDERS AND OTHER MACHINES WHICH INCLUDE ROLLS

André Louis Verdier, 6 Ave. Daniel-Lesueur,
Paris, France

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8 Claims

ABSTRACT OF THE DISCLOSURE

An adjusting device for controlling the actual spacing of the working surfaces of the rolls of a rolling or milling machine, comprising a pair of gauging means each responsive to the actual distance between the end bearings at one side of the rolls, each gauging means including a chamber whose volume tends to vary in response to variations in said distance, to produce a marginal variation of pressure of a fluid contained in the chamber. Means are provided to control the tightening forces applied to the bearings and/or rotation speeds of the rolls, in response to the pressure variations.

The invention relates to machines such as grinders, calenders and rolling mills, which include at least two rotating rolls pressed one against the other along a generatrix. For a long time past it has been found that it is very difficult to regulate the compression between the rolls in a satisfactory manner and in particular to obtain an equal degree of compression at the two ends of the rolls.

In these machines, one of the rolls is generally mounted on movable bearings which are urged towards the fixed bearings of another roll by adjusting or tightening devices. If the forces applied in this way to the two movable bearings are equal, the rolls are not applied equally one against the other at their two ends when they are rotated and the materials passing between the rolls do not undergo equal compression from one end of the latter to the other.

This difficulty is partially perceptible in grinders comprising rolls driven rotatively at one of their ends and between which there passes a pasty material intended, for example, for the manufacture of substances such as printing inks, paints, soap or chocolate. The unevenness of the pressures is manifested by differences in the colouration of the paste from one end of the rolls to the other. The sole method used heretofore to obtain an approximately uniform pressure along the rolls was to act on the tightening devices, taking this colouration of the paste as a guide.

Difficulties of the same nature are encountered when it is sought to obtain a uniform compression along the rolls of a calender serving, for example, to manufacture a sheet of rubber or of plastics material from a paste, or along the rolls of a rolling mill.

Moreover, in all known machines the tightening forces are regulated as a function of, for example, the speed of rotation of the rolls and the thickness of the pasty or solid layer issuing from the machine, but no means are available for controlling the compression which the layer actually undergoes as it passes between the rolls. The result is that the relation between the tightening or closing effect, the speed and the thickness is chosen empirically and there is a risk that the quality of the product obtained will vary with various factors, such as the composition, viscosity or temperature of the raw material.

It is an object of the invention to eliminate these

2

drawbacks and difficulties by enabling the tightening forces to be regulated in such manner as to maintain at the desired value, the compression which the layer actually undergoes on its passage between the rolls. In particular, it enables the same degree of compression to be obtained at both ends of the roll.

According to the invention, the desired compression between the rolls is obtained by regulating the tightening forces as a function of the amount by which they move apart under the action of the materials passing between them.

For example, by acting on the tightening forces in such manner as to render the distances between the axes of the rolls at their two ends equal, a strictly equal compression of the materials passing between the rolls is obtained from one end of the latter to the other. If it is desired, for any reason whatsoever, to adjust the compression to different values at the two ends, it would of course be possible to act on the tightening forces so as to obtain a smaller interval between the rolls at the end where the compression is to be greater.

An attempt may be made to explain the result obtained in this way in the following manner, it being understood that this explanation is only a hypothesis and does not in any way limit the invention. The applicant has observed that when the tightening forces are the same at both ends, the compression exerted by the rolls of grinders on the paste passing between them is always lower at the end where the rolls are driven in rotation. It may therefore be assumed that the gearing or other driving devices exert a reaction against the tightening force exerted on this side, this reaction being added to that of the paste. The result is that the pressure exerted on the paste by the rolls is lower at the end where the latter are driven and that, at this end, the paste passes through in a greater thickness and moves the rolls apart still more.

If the tightening forces are regulated, either directly or indirectly (for example by acting on the speed of rotation of the cylinders), in such manner as to maintain the distance between the rolls at a predetermined value, the material passing between the latter is subjected to precisely the compression that is desired.

In many machines including rolls and in particular in grinders, the variations in the distance between the rolls and the differences in this distance from one end to the other are very small. They are of the order of one micron in grinders used in the printing ink industry. Devices capable of detecting these variations must therefore be very sensitive.

According to one embodiment of the invention, the distances between the rolls are measured at two points of their axes by devices sensitive to the relative movements thereof. These devices may be mechanically, electrically or electronically operated gauges, but they are constituted with advantage by chambers whose volume varies under the action of the relative movements of the axes of the cylinders, producing variations in fluid pressure which are used to regulate the tightening forces.

The latter may be regulated manually in accordance with indications given by the devices which measure the distances or intervals. However, these indications are preferably used as an input signal for the device for controlling or regulating the tightening forces.

The description which follows with reference to the accompanying drawings and which is given by way of non-limitative example will make the various features of the invention and the manner of carrying them into effect clearly understood, any arrangement appearing both from the text and from the drawings coming within the scope of the invention. In the drawings:

FIGURE 1 is a diagrammatic elevational view of a grinder;

FIGURE 2 shows the same grinder in section on the line A—A of FIGURE 1 and equipped with an improved tightening system according to the invention and

FIGURE 3 is a diagram of an alternative constructional form of the improved tightening system.

The grinder shown comprises three rolls 1, 2 and 3 rotating in the directions indicated by the arrows at graduated speeds, that is to say the roll 3 rotates faster than the roll 2, which itself rotates faster than the roll 1. The paste 4 to be treated and which is intended, for example, for the manufacture of printing ink, passes between the slow roll 1 and the intermediate roll 2, adheres to the latter at 4a by reason of its greater speed and then passes at 4b on to the collecting roll 3, which rotates still more quickly, and is then detached by the scraper 5.

The roll 1 is journaled in two fixed side plates 1a and 1b. The roll 2 is a "floating" roll, that is to say it is journaled in two side plates 2a and 2b which are pivotally mounted on a spindle 6. The roll 3 is also journaled in two side plates 3a and 3b which are pivotally mounted on a spindle 7. In this so-called "floating intermediate roll" arrangement, the intermediate roll 2 is gripped between the roll 1, the bearings of which are fixed, and the collecting roll 3, which is brought into bearing contact by an adjusting or tightening device 8 or 9. Moreover, the grinder may comprise an offsetting device, shown diagrammatically at 10, enabling the spindle 6 to be displaced in height in order to vary the off-setting of the middle roll 2 with respect to the rolls 1 and 3.

It should be understood that the axes of the rolls 1 and 3 are in a substantially horizontal plane, the machine being arranged with the off-setting device 10 at the bottom and the tightening devices 8 and 9 at the top.

The rolls are driven rotatively at different speeds by a driving arrangement located at the side of the plates 1b, 2b, 3b and represented diagrammatically in FIGURE 2 by a train of gears 11.

The tightening system comprises two single-acting jacks 8 and 9, the cylinders 8a, 9a of which are connected to the fixed side plates 1b and 1a respectively, and the piston rods 8b, 9b of which are connected respectively to the movable side plates 3b and 3a of the collecting roll. In known arrangements, the chambers 8c, 9c of the jacks are open to the atmosphere, while the chambers 8d, 9d are placed under pressure to provide the tightening action. The placing under pressure may be obtained in a so-called "static" manner by means of a hydraulic fluid compressed by a piston moving in a cylinder. However, in the embodiment illustrated, the placing under pressure is effected in a so-called "dynamic" manner, the hydraulic fluid drawn from the reservoir 12 being compressed at a constant pressure by a pump 13 and delivered by the pipe 14 into a pressure regulating valve 15 which supplies in parallel, on the one hand, a pipe 16 equipped with a pressure gauge 16a and leading to the chamber 8d of the jack 8 and, on the other hand, a pipe 17 equipped with a pressure gauge 17a and supplying the chamber 9d of the jack 9 through the medium of a pressure reducing valve 18.

Each of the valves 15 and 18 enables the pressure to be regulated downstream thereof by delivering a part of the fluid into a discharge pipe 15a or 18a which returns it to the tank 12.

In the operation of this tightening system, when the rolls are at a standstill or closing action thereof is controlled by regulating, by means of the valve 15, the pressure supplied by the pipes 16 and 17 to the chambers 8d and 9d, until the rolls 1, 2 and 3 are pressed one against the other in the position shown in the drawing. The pressures read on the pressure gauges 16a and 17a are the same. When the rolls rotate, entraining the paste 4, the pressure which they exert on the latter, as has been explained above, is stronger at the

non-driven end, that is to say the end where the plates 1a, 2a and 3a are located, than at the end driven by the gears 11. The pressure in the chamber 9d is therefore reduced by means of the valve 18 so as to decrease the tightening action at the non-driven end, taking the colouration of the paste as a guide, in the manner indicated above.

In order to obtain regulation of the tightening action which is precise and which can be automatic, the arrangement shown in FIGURE 2 will be used. A differential pressure gauge 19 is connected by pipes 20 and 21 to the chambers 8c and 9c which are not open to the atmosphere in accordance with the arrangements usual hitherto but are filled with oil, so that the pressure gauge 19 indicates the difference in the pressures prevailing in these chambers 8c and 9c. Between the pipes 20 and 21 there is arranged a by-pass 22 which can be closed by two cocks 20a and 21a and which leads to a variable outlet 23 controlled by a cock 23a. An auxiliary pressure gauge 24 is connected by a cock 24a to the pipe 20.

In order to use the system, the machine being at a standstill and the rolls moved apart, the two chambers 8c and 9c are first filled with oil by means of cocks such as 25 (FIG. 1) and these cocks are closed. When the preliminary tightening is carried out (rolls at a standstill) in the usual manner, the two cocks 20a and 21a are opened and the outlet 23 is controlled by means of the cock 23a in such manner that the pressure in the chambers 8c and 9c does not reach a value liable to damage the differential pressure gauge 19. The pressure in the respective chambers 8c and 9c is substantially the same since the pistons of the two jacks advance simultaneously and at the same speed, bringing the rolls nearer to one another, and it is read on the pressure gauge 24. When the three rolls are in contact and are tightened or pressed together with the appropriate pressure, which is read on the pressure gauges 16a and 17a, the cock 23a is first closed so that the pressures in the chambers 8c and 9c are strictly equalised owing to the by-pass 22, and then the cocks 20a and 21a are closed. In this position, the rolls are applied one against the other and the oil pressure is precisely the same in the chambers 8c and 9c. The pressure gauge 19 therefore indicates a zero differential pressure.

When the rolls are set in rotation, the paste 4 first passes between the rolls 1 and 2 and then between the rolls 2 and 3, moving them apart to a greater extent at the end where the side plates 1b, 2b, 3b are located than at the end where the side plates 1a, 2a, 3a are located. The result is that the pistons of the two jacks shift slightly towards the bottom of FIGURE 1, reducing the pressure in the chambers 8c and 9c, the pressure decreasing more in the chamber 8c than in the chamber 9c. The differential pressure gauge 19 therefore indicates a lower pressure in the chamber 8c than in the chamber 9c. By reducing the pressure in the chamber 9d of the jack 9 by means of the valve 18, the tightening force applied by this jack to the rolls will be reduced and, consequently, the pressure which the latter exert on the paste at the non-driven end will also be reduced; the reaction of the paste therefore slightly increases the distance between the rolls at this end and the piston of the jack 9 moves slightly towards the bottom of FIGURE 1, thus reducing the pressure in the chamber 9c. When the differential pressure between the chambers 8c and 9c has reached a zero value, which is indicated by the differential pressure gauge 19, the correction of the regulation by the valve 18 is stopped and, in this way, it is ensured that the sum of the distances between the rolls 1 and 2 and between the rolls 2 and 3 is the same on the side where the jack 9 is located as on the side where the jack 8 is located. In one stroke equality has been achieved between the pressures exerted by the rolls on the paste at both ends.

Instead of operating the valve 18 manually in order to bring the readings of the differential pressure gauge 19

to zero, use will preferably be made of the differential pressure between the chambers 8c and 9c in order to actuate a control device operating the valve 18 in such manner as to maintain this differential pressure at a zero value. For example, the differential pressure gauge 19 may be provided with electrical contacts controlling a servomotor which actuates the valve 18, but it is also possible to use other types of control using the differential pressure as an input signal. This control of the valve 18 in response to the differential pressure is indicated diagrammatically in FIGURE 2 by the chain-dotted line 26.

It will be understood that the moving apart of the rolls under the action of the paste passing between them has the effect of shifting the pistons of the two jacks 8 and 9 towards the bottom of FIGURE 2. These movements which, in the embodiment described, are possible because the valves 15 and 18 maintain fixed pressures in the chambers 8d and 9d, are very small. The differences in the movement of the two pistons are of the order of one micron in printing ink grinders. However, the differences in pressure which result therefrom in the chambers 8c and 9c are sufficient to be indicated by the differential pressure gauge 19 or to produce a control signal for the valve 18. Any variation in the reaction of the gears 11, due to a change in the speed of the rolls for example, causes a variation of the differential pressure at the pressure gauge 19, enabling equal compression to be re-established throughout the length of the rolls by means of the valve 18.

However, in this connection, it should be noted that a change in the speed of the rolls causing a variation in the differential pressure will be desired and called for by, and will therefore be dependent on, the will of the person conducting the operation or the programming thereof. On the other hand, a difference of homogeneity in the paste or a difference in temperature, manifesting itself as a difference in the viscosity of the mixture cause unexpected variations in the differential pressure. One of the advantages of the invention is that it permits permanent correction of the differential pressure as a function of the variations of the reactions of the control devices, which themselves depend on the variations of the power consumed during the same operation.

The invention may be applied in the same manner to grinders in which the tightening system is "static," that is to say in which the jacks are placed under pressure by a master cylinder. In machines providing mechanical tightening, the differential pressure gauge 19 may be connected between two chambers similar to the chambers 8c and 9c, fast with the bearings of the roll 1 and having pistons which are fast with the bearings of the cylinder 8.

In the alternative constructional form shown in FIGURE 3, the elements performing the same function as in FIGURE 2 are designated by the same reference numerals. The by-pass 22, which in FIGURE 2 is intended to permit the reduction of the volume of the chambers 8c and 9c and to establish equality of the pressures in the chambers upon the rolls being tightened when at a standstill, is improved in this case. The cocks 20a and 21a are replaced by electric valves 27 and 28 and the outlet 23 is replaced by a pressure accumulator 29 of the hydro-pneumatic type; moreover, the by-pass 22 is connected to a cock 30 enabling the volume of oil in the whole of the installation to be adjusted on starting up and, consequently, enabling the cocks 25 of FIGURE 1 to be dispensed with.

On the preliminary tightening operation in the rest state, the two electric valves 27 and 28 are opened and the oil expelled by the reduction in volume of the chambers 8c and 9c is delivered to the accumulator 29. The preliminary tightening operation having been completed, the electric valves 27 and 28, which are controlled by a single electric circuit (not shown), are closed simultaneously and it is

thus ensured that there will be equal pressures in the two chambers 8c and 9c.

Also shown in FIGURE 3 are the motor 13a of the pump 13 and a filter 13b located at the intake of this pump, in the reservoir 12. The valve 18 is an electric valve controlled by the differential manometer 19 through the line 26. The valve 15 is also an electric valve. A manometric contactor 31 is provided which is connected to the pipe 16 and which, by means of electrical connections (not shown) controlling the valve 15 or the pump 13, enables the placing of the installation under pressure to be interrupted in the event of the pressure increasing abnormally.

It will be observed that in FIGURE 2 the pressure gauge 24 measures the pressure in the chamber 8c and consequently gives an indication of the spacing adopted by the rolls under the action of the paste interposed between them. By operating the valve 15 in such manner as to maintain this pressure at a given value, it is therefore possible to give the rolls the desired spacing. In the constructional form shown in FIGURE 3, regulation of the tightening action as a function of the distance between, or spacing of, the rolls is provided, this being represented diagrammatically by a pressure gauge 32 with electrical contacts, which is connected to the pipe 20 and, by a line 33, to the regulating valve 15 and to a control 33a controlling the speed of rotation of the rolls.

Such regulation enables the compression actually undergone by the paste between the rolls to be maintained at the desired value. In machines equipped with rolls and which do not comprise this regulating system, the thickness of the layer formed on the exit or delivery roll such as 3 can be determined by controlling the weight of material supplied during a given time. It is sufficient to know the specific gravity of the material, such as the paste 4, and to take account of the tangential speed and of the width of the layer recovered from the exit roll. This layer thickness, however, does not give any indication of the value of the distance between the last two rolls or between the preceding rolls. The applicant has found that in a machine having rolls with graduated speeds these distances are distinctly smaller than the thickness of the layer recovered.

The applicant has also found that the reduction of the distances has a considerable influence—for a mixture of a given viscosity—on the one hand on the velocity of flow within the paste, which is considerably higher than in contact with the rolls and on the other hand on the maximum pressure within the paste, which increases very rapidly when the distance between the rolls decreases.

Thus, the variations towards an increase or a decrease in the distance have a considerable influence on the qualities of the products obtained.

In known grinders it is, therefore, possible to control the quality of the product obtained and, by successive experiments, to determine the conditions to be observed for the preparation of the mixture, its viscosity and its other characteristics, as well as for the various adjustments of the machine, so as to obtain a product of the desired quality, but no means are available for knowing and producing the most favourable distances between rolls. Although it is possible to reproduce a given manufacturing operation exactly—provided that all the factors are strictly identical to those of the reference manufacturing operation—there may be considerable variations in the distance between the rolls if one of the factors concerning the engagement or introduction of the material is different. It will be understood that under these conditions it is impossible—if the composition of the mixture or the nature of the manufacturing operation is changed—to obtain distance values identical to those which have given the best results during previous experiments or manufacturing operations.

The regulation represented diagrammatically in FIGURE 3 by the pressure gauge 32 and the line 33 enables the distance between the rolls to be maintained automatically at the desired value by acting, on the one hand,

on the tightening pressure by means of the valve 15 and, on the other hand, on the speed of rotation of the rolls by means of the control 33a as a function of this distance, which is measured by the pressure in the chamber 8c.

The pressure gauge 32, for example, comprises a plurality of electrical contacts arranged to transmit to the line 33 signals which are used by the valve 15 to supply to the chamber 8d a tightening pressure which will maintain the chamber 8c at the desired pressure, the pressure in the chamber 9c being maintained equal to the pressure in the chamber 8c by the control device described above. If the valve 15 cannot respond to a call for an increase in the tightening pressure (for instance because the latter is already equal to the pressure of the pump 13), the signal transmitted over the line 33 actuates the control 33a for slowing down the rolls. The effect of this slowing down is to reduce the quantity of paste which is introduced between the rolls, the result is that the distance between the rolls decreases until the pressure in the chamber 8c, which measures this distance, has reached the desired value. The contacts of the pressure gauge 32 are adjustable and this enables the pressure which is automatically maintained in the chamber 8c by the regulating arrangement to be adjusted at will.

It is obvious that the embodiments described are only examples and these could be modified, in particular by substituting technical equivalents, without thereby departing from the scope of the invention as defined by the claims. In particular, the relative movements of the bearings of the rolls may be detected by gauges of very different types and the invention is applicable both to machines comprising only two rolls and to those which comprise three or more rolls. It also applies to machines in which each roll is provided with independent tightening means and in such cases it enables the distance between each pair of associated rolls to be adjusted independently.

The invention applies not only to machines (such as grinders and calenders) comprising rolls which rotate at graduated speeds, but also to machines (such as calenders and rolling mills) in which the rolls rotate at equal speeds.

What is claimed is:

1. In a working machine having at least two rolls urged towards one another and adapted for the passage therebetween of material to be worked and bearings supporting the said rolls at their ends, an adjusting device for the rolls comprising two jacks disposed between the said bearings, each jack having a first chamber, means for applying pressure to said first chamber so as to exert a force at the end of the rolls and a second chamber with fluid therein constituting a gauge to measure the relative movements of the ends of the rolls and to regulate the forces exerted on the rolls as a function of the said movements.

2. In a working machine having at least two rolls each rotatably mounted in opposite first and second end bearings, first and second biasing means for exerting respective

forces on said first and second end bearings, respectively, to urge the rolls towards each other, power means for rotating the rolls, and means for feeding material therebetween; an adjusting device comprising: first gauging means responsive to the distance between the first end bearings, second gauging means responsive to the distance between the second end bearings, each gauging means including a chamber having two relatively movable wall portions respectively connected to the respective end bearings of the rolls, to move therewith to produce marginal variations of pressure of a fluid contained in the chamber, and means for sensing the pressure variations; and control means for controlling at least one of said power means and biasing means in response to the pressure variations.

3. A device as claimed in claim 2, in which the control means are responsive to the pressures in the chambers to control the biasing means and power means to maintain said pressures at preselected values.

4. A device as claimed in claim 2, comprising a differential pressure gauge responsive to the difference of pressures in the chambers.

5. A device as claimed in claim 4, comprising first and second pipes connecting the differential pressure gauge to the respective chambers of the first and second gauging means, respectively, an obturable by-pass connecting both pipes, and means for selectively connecting said pipes to a pressure discharge means.

6. A device as claimed in claim 5, in which the pressure discharge means comprise a pressure accumulator.

7. A device as claimed in claim 4, in which the rolls are driven by the power means adjacent the first end bearings, comprising means responsive to the differential pressure gauge for controlling the second biasing means to minimize the pressure differential.

8. A device as claimed in claim 7, in which the control means are responsive to the pressure in the first chamber to control the first biasing means and power means to maintain the pressure in said first chamber at a preselected value.

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ROBERT C. RIORDON, *Primary Examiner*.

D. G. KELLY, *Assistant Examiner*.

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