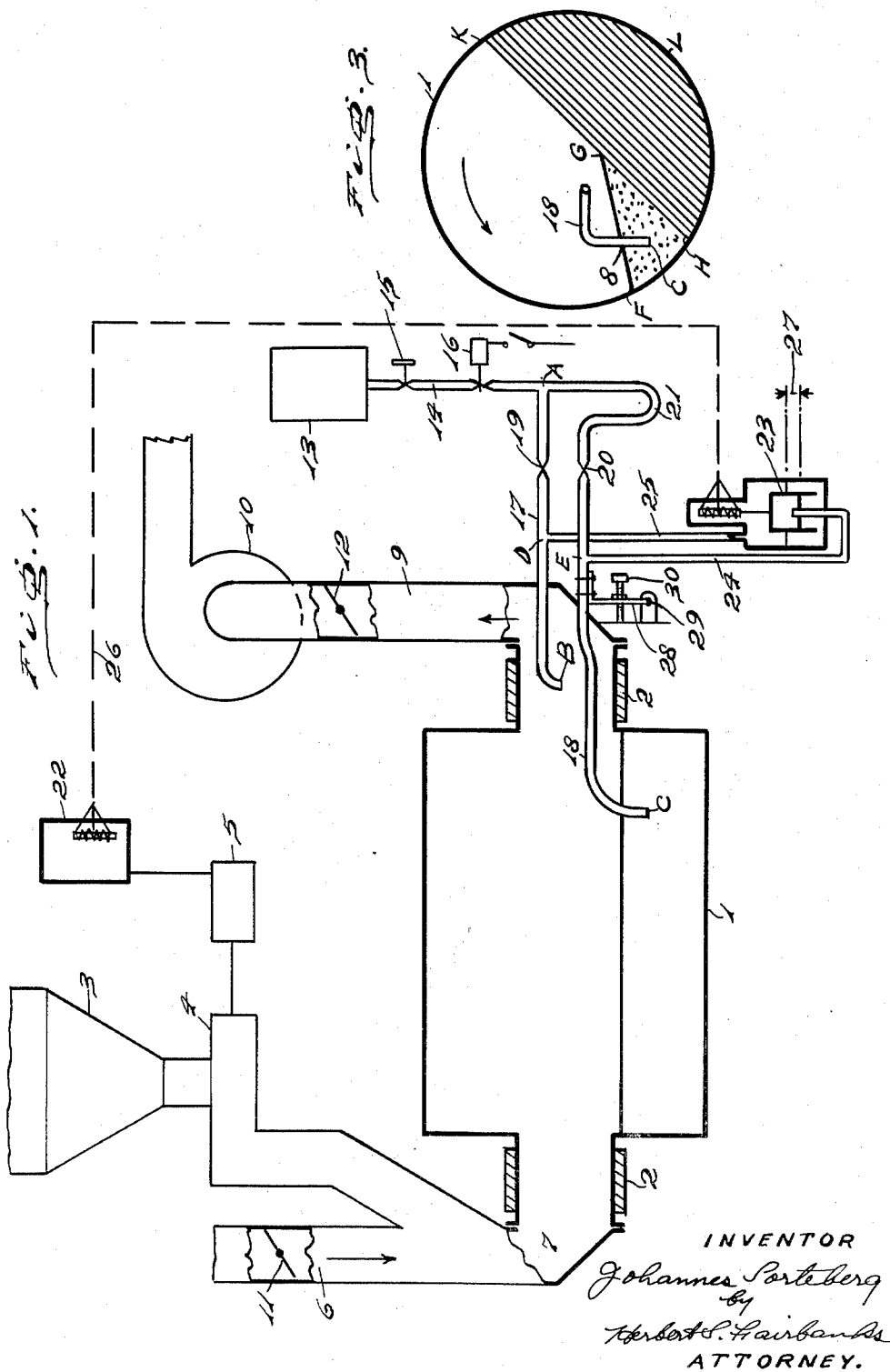


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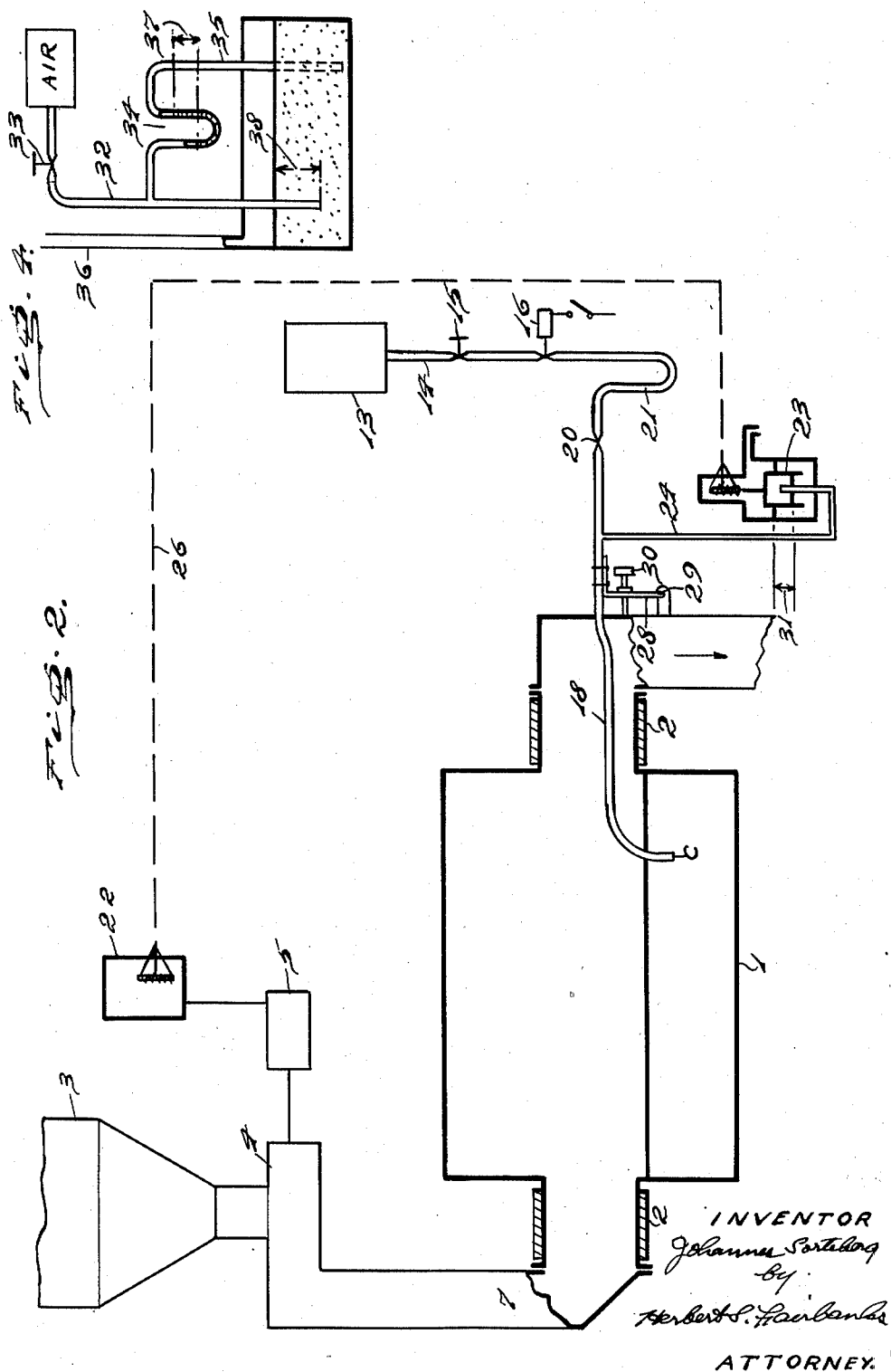
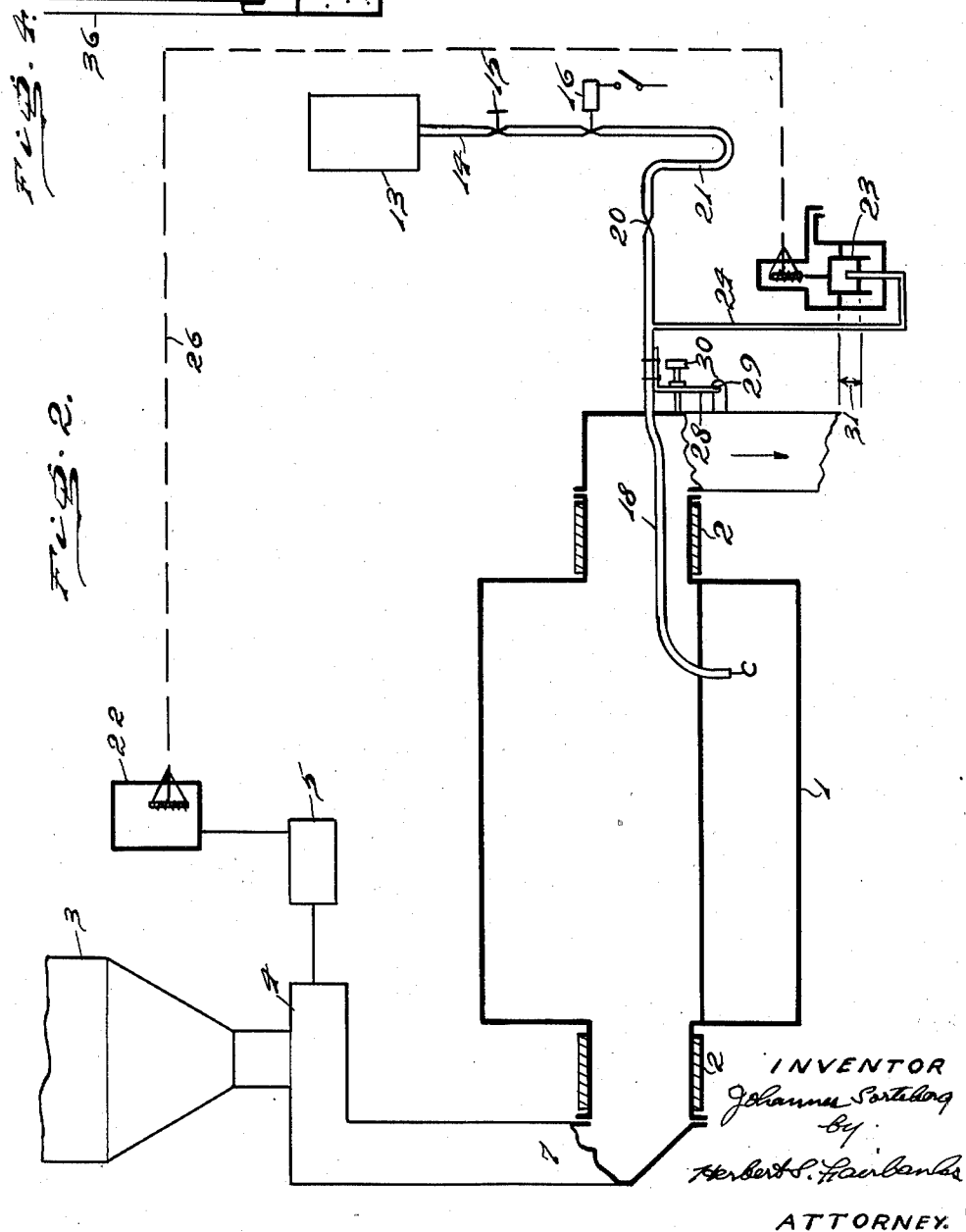
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J. SORTEBERG
METHOD OF CONTROLLING THE FEED
TO A ROTARY DRUM MILL

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2 Sheets-Sheet 2



INVENTOR
Johannes Portelberg
By
Herbert S. Fairbanks
ATTORNEY.

UNITED STATES PATENT OFFICE

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METHOD OF CONTROLLING THE FEED TO A
ROTARY DRUM MILL

Johannes Sorteberg, Bethlehem, Pa.

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1 Claim. (Cl. 241—19)

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The object of this invention is to devise a novel method of controlling the feed to a rotary, reducing mill so as to maintain a substantially constant amount of material in the mill regardless of mill output.

A further object of the invention is to devise a novel method whereby the amount of material in the mill, such as a ball or tube mill, can be gauged, and the feed of raw material to the mill can be accurately controlled automatically, or manually if the control instrument is out of order.

With the foregoing and other objects in view as will hereinafter clearly appear, my invention comprehends a novel method of gauging the material in a mill and for controlling the feed of raw material to a rotary, reducing mill.

For the purpose of illustrating the invention, I have shown in the accompanying drawings preferred embodiments thereof which in practice will give satisfactory and reliable results. It is, however, to be understood that the various instrumentalities of which the invention consists can be variously arranged and organized, and the invention is not limited to the exact arrangement and organization of these instrumentalities as herein set forth.

Figure 1 is a schematic view of a rotary, reducing mill, in conjunction with which feed control mechanism embodying my invention is employed, the mill being of the air-swept type.

Figure 2 is a schematic view of a non-air swept type of mill, in conjunction with which another embodiment of my novel control is employed.

Figure 3 is a view taken transversely of the mill shown in Figure 1.

Figure 4 is a schematic view illustrating the principle of the measurement.

Similar numerals of reference indicate corresponding parts.

Referring to the drawings:

The reducing mill has a shell or drum 1, rotatably mounted on bearings 2, and rotated in any desired or conventional manner, now well known in this art.

The raw material to be reduced is fed from a material supply 3 by a feeding device 4 controlled by an actuating device 5. An air inlet passage 6 leads from a source of air supply to a passage 7 communicating with the discharge from the feeding device 4 and with the inlet to the drum 1, whereby the material is fed into the drum. The static head at a detector tube is shown at 8, Figure 3. The drum 1 at its discharge end communicates with a discharge outlet 9 having a fan 10.

The inlet passage 6 may have an adjustable

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damper 11 and the discharge passage 9 may have an adjustable damper 12.

If desired, the fan may be ahead of the mill which will place the mill under pressure as generally the air flows through the mill from the feed end to the discharge end.

Auxiliary air from a pressure source 13 passes through a pipe 14, having a manually actuated valve 15 and a solenoid valve, 16, to a compensating tube 17 terminating in the discharge end of the mill at the bearing, and also to a detector tube 18 terminating in the material pool in the drum. The tube 17 has a throttling device 19, and the detector tube 18 has a throttling device 20. It is not necessary to force air through the compensating tube but it is desirable to do so in order to expel any particles that might otherwise find their way into the tube and eventually clog it. These throttling devices are only a convenient means of securing a desired amount of flow through the tubes.

The air flowing through the detector tube also serves to keep the tube clean and unobstructed and thereby aids in maintaining the measuring system in calibration. The detector tube has a flexible portion 21.

A control instrument 22 has a manometer 23, one leg 24 of which is in communication with the detector tube 18, and the other leg 25 is in communication with the compensation tube 17. The manometer indication is transmitted, mechanically, electrically or otherwise to the control instrument 22 by a transmission line 26, and the control instrument controls the feed actuating device 5. The control instrument and manometer should be calibrated together as a unit and are available in the open market as is also the actuating device.

In the operation of this embodiment of the invention as shown in Figures 1 and 3, air or any suitable gas, depending upon the character of the material to be reduced, is introduced through pipe 14. At point A, the flow is divided, one portion passing through throttling device 19 and compensating tube 17, and the other portion passing through throttling device 20 and detector tube 18. The amount of air passing through the tubes 17 and 18 can be properly adjusted by proper throttling of their throttling devices 19 and 20 as well as by the pressure of the air supply from pipe 14. Comparatively high, auxiliary, air pressure, preferably at a constant pressure, for example about twenty pounds above mill pressure and close throttling is desirable. This will produce most accurate results by keeping the rate

of air flow through the detector tube constant regardless of mill pressure and the amount of material in the mill.

The positions of the compensating tube and the detector tube in relation to the drum and its charge may be adjusted as desired, but once the positions have been decided it is not necessary to change them. In case of the compensating tube, it is necessary that its mouth terminates in such manner that it is affected by static pressure only, and is not so far removed from the mill proper that it does not register such pressure of the mill accurately.

The pressure at point B, which may be positive or negative relatively to atmospheric pressure, and which, for all practical purposes is unaffected by the charge in the mill, is transmitted through the compensating tube 17 to point D, where a static pressure tap is made through which the pressure is transmitted to one side of the manometer 23. In a similar manner, the pressure at point C, which is equal to the pressure at point B plus the static head of the pulverized material in the pool at point C which depends on the amount of material in the mill, is transmitted through the detector tube to point E where a static tap is made to transmit pressure to the other side of the manometer. The manometer will thus measure the difference in pressure between points B and C. This difference in pressure represents the static head of the pulverized material in the pool at point C, and is a reliable means of measuring the amount of material in the mill. The difference in pressure 27 is transmitted through transmission line 26 to the control instrument 22 which controls the feed actuating device 5 which in turn controls feeding

device 4. In a rotary, reducing mill, such as a ball or tube mill, there is, when the mill is in operation, a pool of aerated material as shown in Figure 3. Broadly speaking, the ball charge is contained within the area H—G—K—L—H. The voids between the balls are filled with the material to be ground, and practically all of the grinding is done in this area. On top of the ball charge there is a pool of aerated material, represented by the area F—G—H—F. There is of course no distinct levels F—G or G—K due to the turbulence of the material and ball charge caused by the rotary motion of the mill. There is, however, a rather sharp gradient between the pool and the area above it. Into this pool the detector tube is introduced. Since the pool increases in depth from G towards F, it is most desirable to introduce the detector tube at a point where the pool is deep in order to obtain a suitable static head at the mouth of the detector tube. The offset relatively to the center of the mill also prevents too many stray balls or grinding bodies hitting the detector tube. It will be clear from the disclosure that I maintain a substantial pool of fine material adjacent the downward moving side of the mill. A stream of air is introduced into this pool of material at a point adjacent the periphery of the pool, over the maximum depth of and below the surface of the pool at a point spaced from the end of the mill. I utilize the resistance to passage of air through the pool to vary the amount of material fed to the mill.

The ratio between balls or grinding bodies and the material inside area H—G—K—L—H is reasonably constant as is the material in suspension in the air above line F—G—K. Any

variation in the total amount of material in the mill will, therefore, affect the depth of the pool, i. e. the line F—G will move up or down as the total amount of material increases or decreases. Since point C, after its final adjustment, is fixed in relation to the mill, the static head of the pulverized material at point C is an accurate measure of the total amount of material in the mill.

The detector tube 18 is preferably flexibly mounted by a bracket 28 pivoted at 29 and having an adjusting screw 30, the tube connection 21 being flexible as explained to permit movement of the tube.

As shown in Figure 3, the terminating point C of the detector tube is so low in the mill that it may engage with the ball charge when the mill is at rest or when it cradles due to a shut down of the mill. The primary reason, therefore, for pivoting the tube at 29, which is at approximately the same elevation as point C, is to allow the detector tube to be pushed upwardly by the ball charge and return to its normal position when the mill is running. The flexible connection 21 permits movement of the detector tube. The detector tube is bent for a short distance at its entrance through the wall of the passage 9 to form a circular arc with pivot 29 as a center. This facilitates the sealing of the opening through the wall of 9 and is particularly useful if the mill is operated above atmospheric, internal pressure.

A secondary purpose of pivoting the detector tube is to provide easy adjustment up or down of point C. This feature is not of great importance since the control instrument can be set to control at any desired differential pressure within its range. It is preferable to have the instrument control at about the middle of its scale to allow maximum deviation in either direction when the feed is manually controlled from the indications of the instrument while servicing the control mechanism of the instrument.

My invention is not limited to use with an air-swept mill as shown in Figure 1 but is also adapted for use with a mill as in Figure 2 at atmospheric pressure, in which case the compensating tube can be omitted.

In this embodiment seen in Figure 2, the pipe 14 from the pressure supply leads to the detector tube 18 having the throttling device 20. One leg of the manometer tube connects with the detector tube and the other leg with the atmosphere, thereby providing a differential 31 to be utilized to regulate the control instrument 22 and thereby device 5.

The operation of this embodiment of the invention will be clear from the description already given. The differential pressure is utilized to indicate the amount of material in the mill and to control the feed of raw material to the mill.

In my method, I measure the static head at a chosen point in the pool by blowing air or gas through a detector tube, which always keeps it clean and prevents it from becoming clogged even if the water content of the material or air becomes very high. For most accurate control, I need a constant flow of air or gas through the detector tube.

The method employed is based on the well known fact that pulverized material when aerated behaves in many respects similarly to liquids. One similarity of behavior is that one can measure the static head at any point in this

aerated material by introducing a pipe into the material to the point at which one desires to measure the static head and force air through the pipe. A suitable manometer communicating with the pipe by means of a static pressure tap will register the static head of the aerated material when a suitable amount of material is flowing through the pipe. This is, of course, under the assumption that the free end of the manometer is under the same pressure as the material. The free end of the manometer may terminate anywhere within the receptacle or vessel containing the material above or below the surface of the aerated material.

Such principle of measurement is shown in Figure 4, to which attention is now directed.

A pipe 32 having a throttling device 33 leads from an air supply, has its free end submerged in the material and communicates with a manometer 34 to measure differential pressure, the free end 35 of the manometer forming a compensating tube which may terminate at any desired height as shown by the dotted line. The vent is shown at 36. When a suitable amount of air is flowing through the pipe, differential 37 is a measure of the static head 38.

If the material is an incompressible material such as water, the free end of the manometer must terminate above the level of the material in order not to influence the differential 37. If the air flow through the pipe is reduced below a certain minimum, the differential 37 will decrease as the flow decreases until it becomes zero when the flow entirely stops. For small air flows, therefore, the error in measuring the submersion 38 becomes greater and greater as the flow decreases until the error becomes one hundred per cent when the flow ceases. It is self-evident that for accurate measurement of 37 there must be at least sufficient air flowing through pipe 32 to prevent material entering into the pipe and the air flow must not be excessive.

If a mill is operated under a flow and suction principle, the smaller the suction the poorer the control, and the control ceases at atmospheric pressure or above atmospheric pressure. If a detector tube remained clogged under such system, the mill would either fill up or run empty, and this would also be the case if an attempt is made to keep the material level within close limits.

Under my present system, an accurate measurement and automatic control of the feed can be maintained for continuous operation of the reducing mill.

In practice, I have obtained a control as close as one one-hundredths of an inch water pressure. Any limitation which may exist is not traceable to the method but to the control instrument and associated equipment.

It is to be understood that where in the claim I refer to air this term is to include any desired type of gas which may be used for the particular material which is being treated in the reducing mill.

The main switch or control lever for controlling the rotation of the mill is operatively connected with the solenoid valve 16 so that they work in unison, whereby when the mill starts auxiliary air will be blown through the detector tube and also through the compensating tube if such is employed. When the rotation of the mill stops, the flow of air through the detector tube stops and also through the compensating tube is employed.

The reason for the interlock between the mill control and the auxiliary air flow is primarily to prevent high pressure being transmitted to the manometer if the detector tube should be closed when the mill stops. A secondary consideration is the saving of compressed air.

It is of course to be understood that my present control is adapted to be employed for wet grinding as well as dry grinding.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

The method of controlling the feed to a rotary drum mill, which comprises maintaining a substantial pool of fine material adjacent the downward moving side of the mill, introducing a stream of air into the pool of material at a point adjacent the periphery of the pool, over the maximum depth of the pool and below the surface at a point spaced from the end of the mill, and varying the amount of material fed to the mill in accordance with the resistance to passage of air through the pool.

JOHANNES SORTEBERG.

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