

[54] **DRIVE MEANS FOR MATERIAL
COMPACTING APPARATUS**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 95,456, Dec. 7, 1970, Pat. No. 3,674,397.

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425/449, 425/78

[51] **Int. Cl.**.....B29c 3/02, B29c 3/04, B29c 3/06

[58] **Field of Search**.....425/145, 78, 367,
425/237, 449

[56] **References Cited**

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[57] **ABSTRACT**

A material compacting apparatus including opposed compacting rolls mounted for lateral displacement to vary the spacing between the rolls depending upon the pressure exerted during compacting. A hopper is positioned above the rolls for holding the material, and a feed screw is located within the hopper for feeding the material to the rolls. Control means are provided for varying the driving action of the feed screw with the variations depending upon any tendency of the pressure applied by the rolls to vary. The feed screw is hydraulically or electrically driven and signals are applied to the drive means for varying the feed screw pressure. Variations in the driving force of the feed screw are designed to offset the forces tending to vary the spacing between the rolls whereby a constant roll spacing, and therefore a product of constant thickness can be achieved.

5 Claims, 6 Drawing Figures

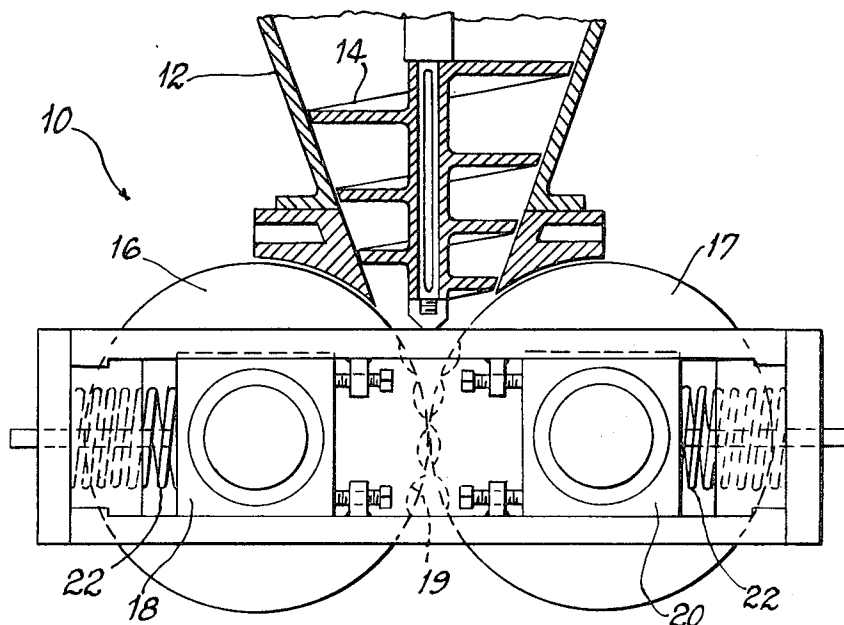


FIG. 1

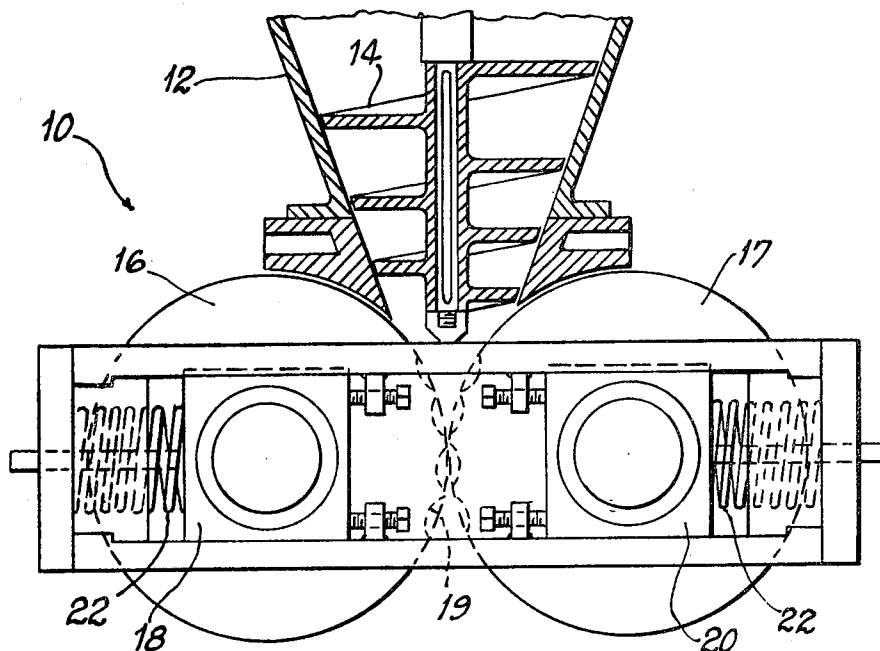
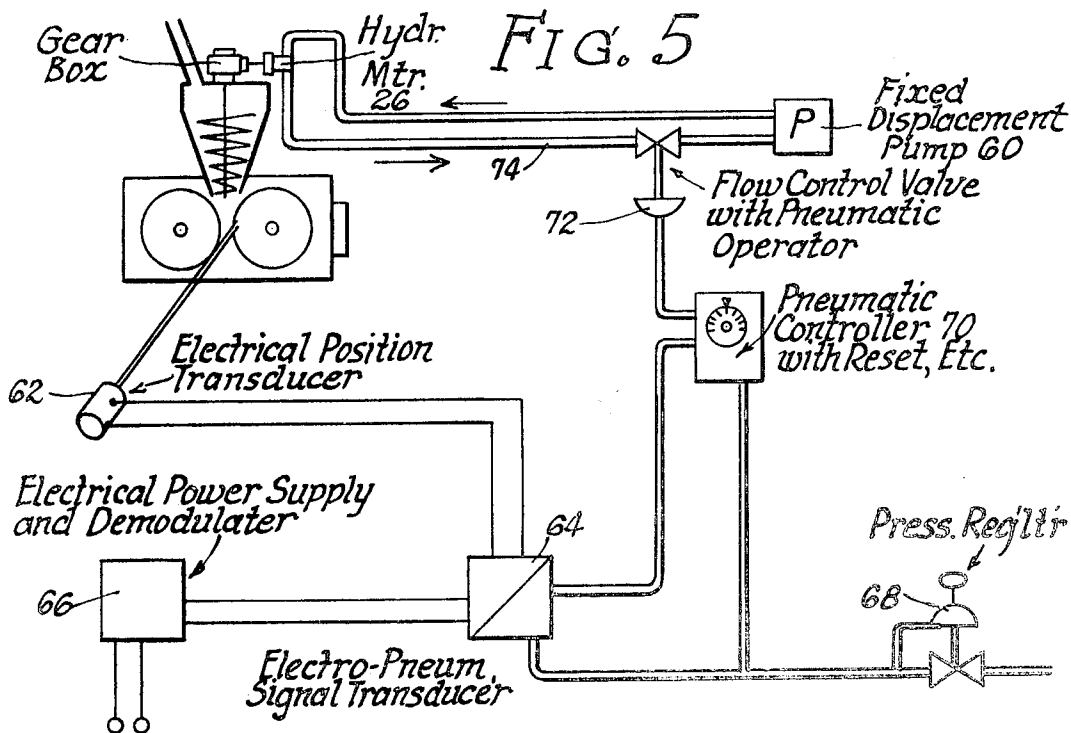


FIG. 2

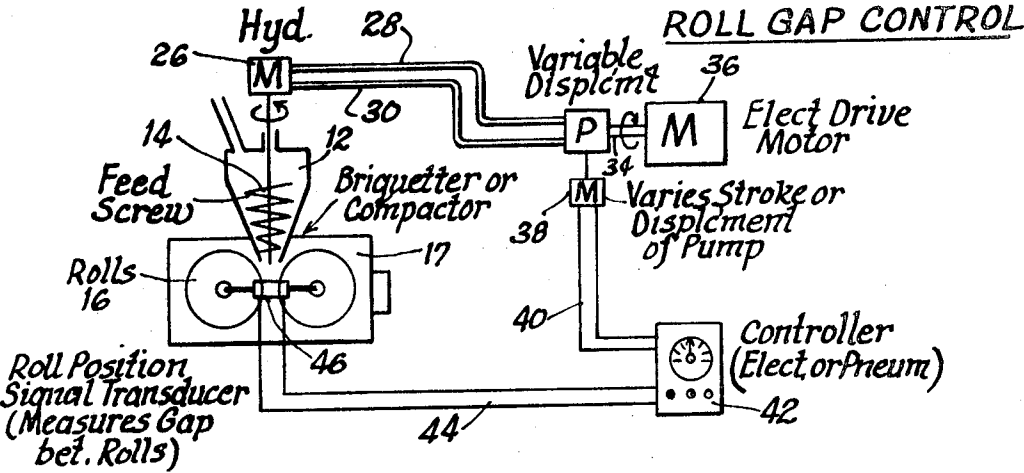


FIG. 3

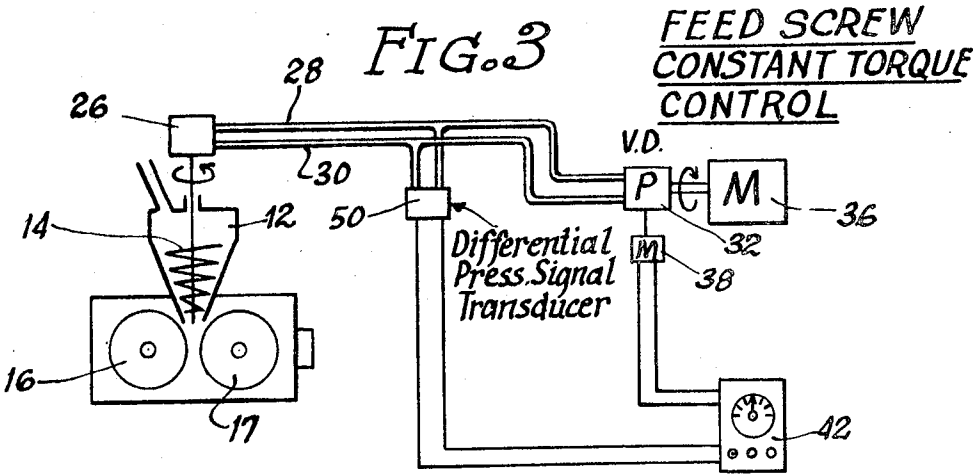
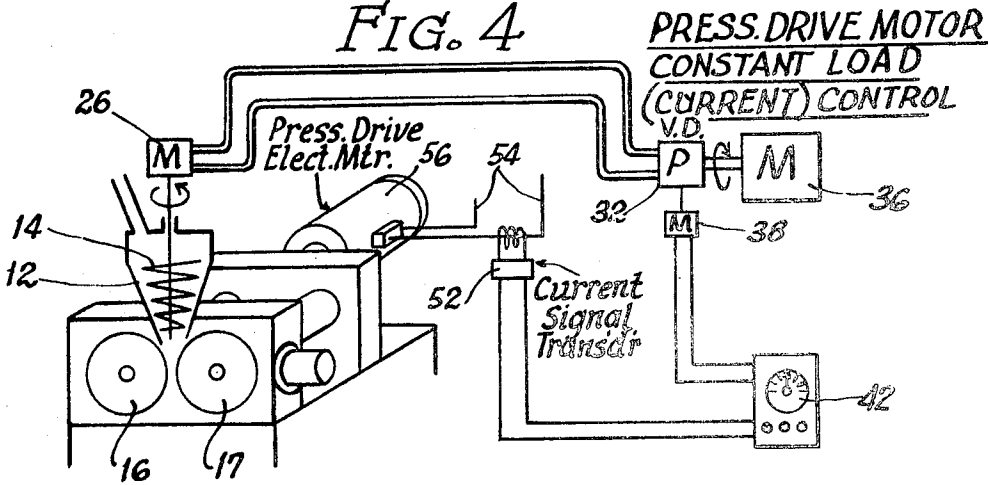


FIG. 4



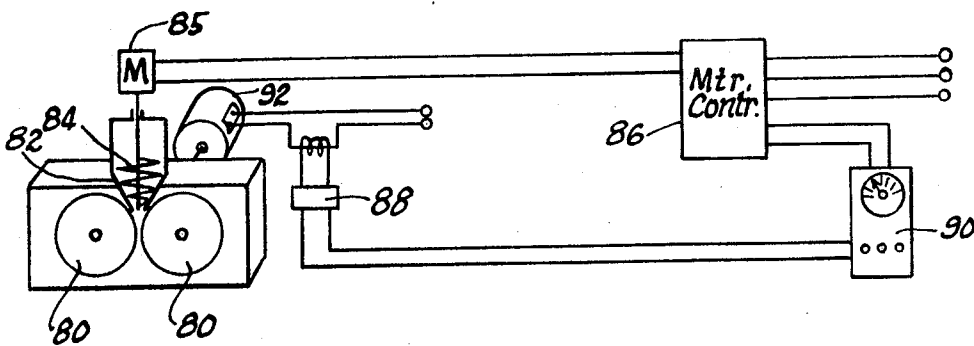


FIG. 6

DRIVE MEANS FOR MATERIAL COMPACTING APPARATUS

RELATED APPLICATION

This application is a continuation-in-part of applicant's copending application Ser. No. 95,456, now U.S. Pat. No. 3,674,397, filed on Dec. 7, 1970.

This invention relates to an apparatus for compacting material. In particular, the invention is concerned with constructions such as briquetting machines wherein material is continuously fed between opposed rolls. The rolls are driven at a specified rate whereby a continuous length of compacted product will issue from between the rolls.

Briquetting machines and other types of compacting equipment preferably employ compacting rolls which are laterally displaceable depending upon the pressure between the rolls. Reference is made for example to Komarek, et al. U.S. Pat. No. 2,977,631 which illustrates an agglomerating construction having one compacting roll mounted for rotation on a stationary axis with an opposing compacting roll mounted in displaceable bearing blocks. Spring means normally urge the displaceable block to a specific position; however, if the pressure between the rolls exceeds the spring pressure, then the bearing blocks will yield whereby this pressure can be relieved.

Compacting constructions also preferably employ pressure feeding means for delivering the material to be compacted to the compacting rolls. Such screw feeding means are illustrated in the aforementioned patent and also in Komarek Pat. No. 3,269,611. By controlling the rate and pressure of material delivery to the compacting rolls, the uniformity of the resulting product can be controlled. U.S. Pat. No. 2,977,631 discusses a control system for the feed screw providing means for controlling the rate of feed of the particulate material to the nip of the compacting rolls for purposes of providing varying feed pressure depending upon the type of material being handled.

In applicant's Ser. No. 95,456, an arrangement is described whereby the spacing between compacting rolls can be maintained at a substantially constant distance through the use of means for detecting variations in roll pressure and controls for hydraulic feed screw drive means whereby variations in feed screw activity are accomplished in accordance with changes in pressure being exerted by the rolls on the material being compacted. This application is directed to the same concept and also refers to control means for operating electrical drives whereby certain advantages can be accomplished along with those referred in the previous application.

It is a general object of this invention to provide an improved means for the operation of compacting equipment whereby highly uniform, efficient, and controllable production of compacted material can be achieved.

It is a more specific object of this invention to provide improved screw feed drive and control systems for feed screw drives in a briquetting machine or the like whereby a uniform compacted product can be achieved.

These and other objects of this invention will appear hereinafter and for purposes of illustration, but not of limitation, specific embodiments of the invention are shown in the accompanying drawings in which:

FIG. 1 is an elevational view of a briquetting machine of the type suitable for incorporation of the control system of this invention;

FIG. 2 is a schematic illustration of one form of control system utilizing means for detecting the spacing between compacting rolls;

FIG. 3 is a schematic illustration of an alternative system utilizing a torque measuring arrangement;

FIG. 4 is a schematic illustration of a further alternative system utilizing load measuring means;

FIG. 5 is a schematic illustration of a further alternative system utilizing means for detecting the spacing between compacting rolls; and,

FIG. 6 is a schematic illustration of an electric motor drive and control arrangement characterized by the features of this invention.

This invention is generally directed to a material compacting apparatus including opposed compacting rolls which are mounted for lateral displacement whereby the spacing between the rolls can vary in response to variations in pressure during compacting of material between the rolls. The hopper is provided for holding material to be compacted, and a feed screw is located within the hopper for feeding material between the rolls.

The improvements of the invention are directed primarily to means for maintaining constant spacing between the rolls so that the compacted powder will have uniform thickness. For example, in the case of briquetting machines, the briquet size and connecting web thickness is controlled and in the case of sheet, the thickness is controlled. The constant spacing is achieved by a system which determines changes in pressure during compacting, and which then acts to adjust the system to introduce compensation whereby the variations can be substantially instantaneously offset.

It has been found that the desired control can be ideally achieved in a system which includes hydraulic drive means for the material feed screw. A variable or fixed displacement pump is utilized for delivering hydraulic fluid to the hydraulic drive motor. Separate means are provided for detecting changes in the pressure exerted by the compacting rolls on the material being compacted. When any variations are detected, the detecting means develops a signal proportional to the degree of variation. This signal is in turn applied whereby the input to the drive motor from the pump can be altered in accordance with the degree of variation. This will in turn affect the pressure applied by the feed screw which introduces a compensating factor into the system. In practice, the great sensitivity of a system of the type described results in a substantially constant thickness of compacted product since any variation in pressure detected is immediately compensated for so that there are no significant variations in the roll spacing.

It has also been found that electric motor drives and control systems can be efficiently employed in conjunction with the material feed screw of briquetting and compacting machines. In such case, variations in pressure exerted by compacting rolls are detected and are preferably transmitted to a process control means which applies its output to motor control means whereby the electric motor for driving the feed screw can be controlled to achieve uniformity of the compacted product.

FIG. 1 of the drawings illustrates a material compacting system 10 including a material feed hopper 12 and a feed screw 14 positioned within the hopper. The feed screw 14 is adapted to deliver material into the nip of the briquetting rolls 16 and 17. Each of these briquetting rolls defines pockets 19 whereby the resulting compacted product will comprise a plurality of briquets which can be separated for use.

The briquetting roll 16 is mounted for rotation within a displaceable bearing block 18. The briquetting roll 17 may be rotatable about a stationary axis or, as illustrated, the roll may be mounted for rotation in a displaceable bearing block 20. Springs 22 are employed for resiliently maintaining the briquetting rolls in a proper spaced relationship but permit yielding when the pressure between the rolls exceeds a certain level.

As long as this spaced relationship is maintained, the product issuing from between the rolls will be of uniform dimensions. In the event that there is a pressure change between the rolls and the material being compacted, then the displaceable rolls will move in opposition to the springs 22 with the amount of movement depending upon the extent of pressure build up. Such movement is relatively common in briquetting operations since the material being compacted is, in the usual case, somewhat non-uniform and, therefore, there may be stages of operation where comparatively hard material is being briquetting whereby there will be a tendency for the rollers to spread.

FIG. 2 illustrates one system which is suitable for controlling the feed screw operation of a compacting system whereby a uniform product can be obtained. In this system, it will be understood that the rolls 16 and 17 may be of various types, and in addition, various means may be employed for mounting of the rolls. For example, hydraulic means may be applied to one of both of the bearing blocks for purposes of resisting displacement of the bearing block while permitting such displacement in the event variable pressure conditions develop during compacting.

The system of the invention involves the use of a hydraulic motor 26 for driving the feed screw 14. Hydraulic supply and return lines 28 and 30 extend between the motor 26 and the variable displacement hydraulic pump 32. The pump 32 includes a rotating shaft 34 connected to an electric drive motor 36. A second electric motor 38 is connected to the pump, and this motor serves to control the stroke of the pump to thereby control the power applied by the motor 26 to the feed screw 14.

The motor 38 is connected by means of lines 40 to controller 42. This controller is in turn connected through lines 44 to a roll position signal transducer 46. The signal transducer 46 may be of any conventional design which will detect differences in spacing between the rolls. When a variation is detected, a signal is transmitted to the controller 42 which applies a proportional signal to the motor 38. Depending upon the magnitude of the signal applied, the motor 38 will vary the stroke of the pump 32 for varying the driving power applied by the motor 26 to the screw 14.

In the modification shown in FIG. 3, a differential pressure or constant flow signal transducer 50 is connected across the lines 28 and 30 which extend between the motor 26 and pump 32. The signal transducer will, therefore, measure any changes in pressure in these hydraulic feed lines. The variations in pressure

produce a signal which is directed to controller 42. The controller in turn controls the operation of motor 38 whereby the stroke of the pump 32 can be varied.

It will be appreciated that with the system of FIG. 3, the pressure of the fluid in the lines 28 and 30 will change when the screw 14 driven by the motor 26 is subjected to changing conditions. For example, if the material being fed between the compacting rolls increases in density, then the pressure exerted by the rolls on the material will increase. The system will tend to automatically seek relief by a displacement of one or both of the compacting rolls.

The system of this invention avoids any significant displacement, however, by utilizing the signal developed in the transducer 50. In the example given, the signal will result in a reduction in the drive pressure applied by the motor 26 to the screw 14. This reduction in drive pressure will compensate for the tendency toward pressure increase between the compacting rolls whereby the spacing between the rolls can remain constant.

FIG. 4 illustrates an additional modification of the invention wherein a current signal transducer 52 is associated with power supply line 54. This line is connected to the electric motor 56 which operates to drive the compacting rolls.

The transducer 52 will generate signals and apply these to controller 42 for purposes of operating the motor 38 associated with the pump 32. The nature of the signals generated by the transducer 52 will depend upon the power requirements of the motor 56. Whenever variations in the material being compacted result in changes in the pressure between the rolls and material, these variations will affect the power requirements of the electric motor 56. Such changes will in turn vary the conditions in line 54 whereby a proportional signal can be developed by the transducer 52. The system will then develop compensating changes in the operation of the screw 14 whereby the conditions between the material being compacted and the compacting rolls can be maintained constant.

The system shown in FIG. 5 provides an additional modification wherein a fixed displacement pump 60 is provided for supplying the drive motor 26. In this system, a signal is applied by means of a roll position signal transducer 62 of the type utilized in conjunction with the system of FIG. 2. The signal transducer is connected to an electro-pneumatic signal transducer 64 which is provided with power supply 66. A supply pressure regulator 68 is connected to the transducer 64, and to controller 70. The pneumatic signal output of the controller is, in turn, connected to a flow control valve 72 which may be a Taylor Precisor type with pneumatic operator or a Foxboro Valvactor type.

The flow control valve is connected in the line 74 between the pump 60 and hydraulic motor 26. This valve will, therefore, control the operation of the motor 26 since it will determine the flow of hydraulic fluid to the motor. This combination is possible with a fixed displacement pump since such pumps include means for diverting fluid whereby the pumps dump hydraulic fluid depending upon the setting of a control valve included in the line connected to the output of the pump. It will be appreciated that the controller 70 and flow control valve 72 may be operated by other signal producing systems such as those illustrated in FIGS. 3 and 4.

An adjustable by-pass valve could also be connected to a controller and thereby serve to vary the effects of a pump such as shown at 60. It will be appreciated that, in all of the systems described above, the hydraulic control of the feed screw 14 is connected to a compensating system. Thus, the invention calls for changes in the displacement of an hydraulic pump 32 or 60 for controlling the power applied by the feed screw to the material being compacted.

FIG. 6 provides a schematic illustration of a construction incorporating the features of the invention and employing an electrical system. The construction includes briquetting rolls 80 and a feed screw 82. The motor shown at 85 may be, for example, (1) variable speed D. C. motors operated by conventional SCR and/or thyatron or thyristor circuitry or (2) variable speed eddy current clutch and motor drives with clutch operated by conventional circuitry or (3) variable speed A. C. motor with motor speed controlled by varying electrical A. C. frequency using conventional circuitry. The variable speed control is shown at 86.

In each of the above, the commanding electrical signal to the conventional motor speed control circuitry is received from a process controller. This controller may be either electric or pneumatic and is shown in FIG. 6 at 90. An electric controller is preferred. The process controller senses the system operating condition by means of a signal received from the electrical transducer on the press drive motor electrical leads, sensing the motor amperage, load or energy. The process controller could also receive its system condition sensing from a roll gap position transducer shown in FIG. 2, item 46, or a sensing method sensing the torque or load on the feed screw motor, equivalent to that shown in FIG. 3, item 50.

The controller 90 may be any suitable mechanism for operating as described above whereby a signal will be transmitted to the motor control 86 in accordance with variations detected in the operation of roll drive motor 92. Thus, if the conditions of operation vary such that a greater or lesser demand is made on the motor 92, this will be measured by the signal transducer with the deviation being detected by the process controller 90, the process controller then applying a corrective signal to the motor control 86 for thereby affecting the operation of the motor 85.

A Vutronik (trademark) deviation indicating control station of the type manufactured by Honeywell, Inc. is a suitable process controller. Similar controllers are manufactured by Robert Shaw-Fulton, Fisher and Porter, General Electric, and others. Louis Allis and General Electric manufacture motor controls of the type shown schematically at 86.

Roll gap detectors, electrical position transducers, and other means for producing a differential signal may be employed, and reference is made to the above discussion relative to hydraulic motor systems for the particulars concerning applications of this nature. It will be appreciated, however, that the concepts of this invention are applicable to such systems as well as to other systems employing hydraulic or electrical drive means in feed screw applications.

As indicated, various means may be employed for determining the signal sent by the controllers 42, 70 or 90

to the displacement motor 38, flow control valve 72 or motor control 86. In all instances, however, the operation of the controller is determined by any tendency toward variation in pressure between the compacting rolls and the material being compacted. Thus, it has been recognized that any tendency toward variation in pressure in this area will affect various portions of the system with the effects being measurable. Specifically when the pressure applied tends to increase due to a change in density of the material, this will tend to cause spreading of the compacting rolls, an increase in the power requirement for the screw drive motor, and also an increase in the power requirements for the roll drive motor. As shown, signal transducers can be located for measuring the conditions which result due to these tendencies. Furthermore, it has been recognized that compensation can be most efficiently introduced by controlling the stroke or displacement of a hydraulic motor or input to an electric motor used for driving the feed screw.

It will be understood that various changes and modifications may be made in the above described systems which provide the characteristics of the invention without departing from the spirit of the invention.

That which is claimed is:

1. In a material compacting apparatus including opposed compacting rolls, said rolls being mounted for lateral displacement relative to each other whereby the spacing between the rolls will vary depending upon the pressure exerted during compacting of material between the rolls, and a feed screw for feeding material to said rolls, the improvement comprising means for maintaining the spacing between said rolls at a substantially constant distance comprising an electric motor for driving said feed screw, a control for said motor, process control means for varying the input applied by said control to said motor, means for detecting variations in the pressure exerted by said rolls on the material between the rolls, means for measuring the degree of variation, means for translating the degree of variation into a proportional output and means for applying said proportional output to said process control means for varying the input of said control to said motor to thereby vary the operation of said motor whereby the pressure applied by said feed screw will vary directly with changes in pressure between the rolls.

2. An apparatus in accordance with claim 1 wherein the pressure exerted by said rolls on said material is determined by measuring the spacing between said rolls.

3. An apparatus in accordance with claim 1 wherein the pressure exerted by said rolls on the material is measured by determining the torque applied to said feed screw.

4. An apparatus in accordance with claim 1 including a motor for driving said rolls, and wherein the pressure exerted by said rolls on said material is measured by determining the load on said motor.

5. An apparatus in accordance with claim 4 wherein the load on said roll motor is determined by applying a current signal transducer to the electrical supply for said roll motor, the output of said current signal transducer being applied to means adapted to apply signals to said controller.

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