July 4, 1972 L. S. HARRIS 3,674,397

MATERIAL COMPACTING APPARATUS

Filed Dec. 7, 1970 2 Sheets-Sheet 1

FIG. 1

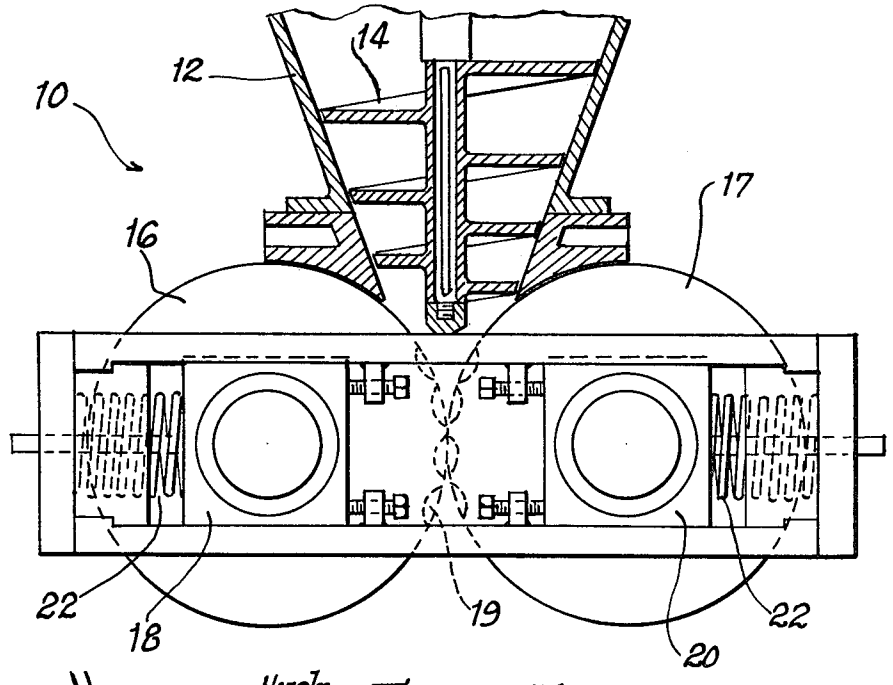
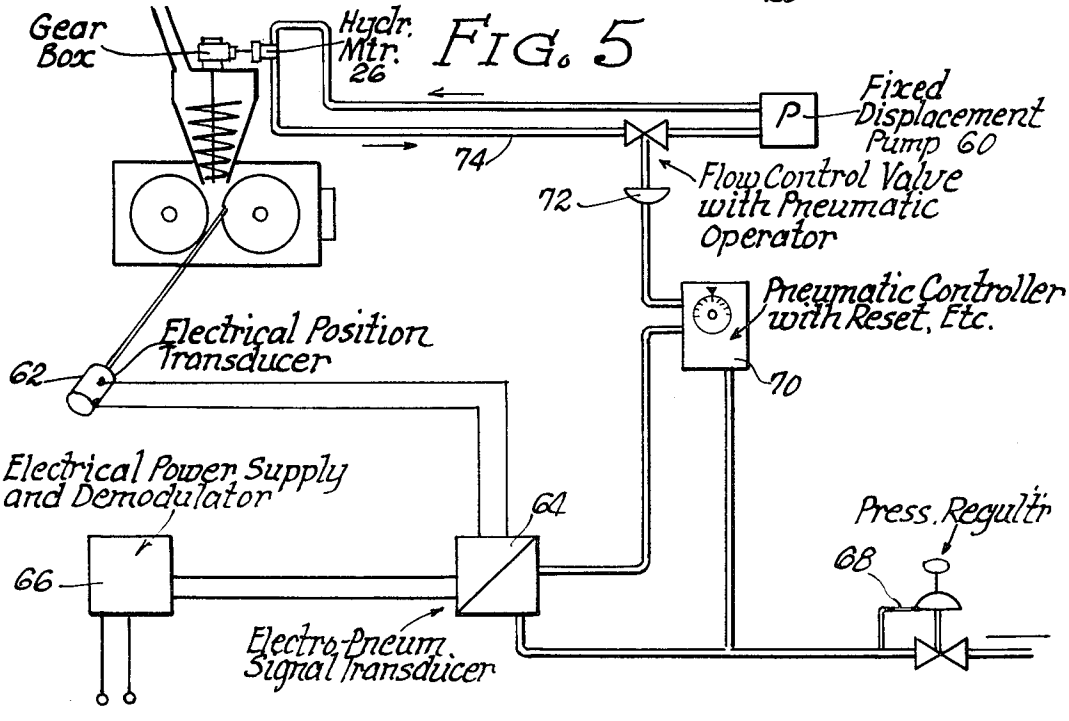


FIG. 5



MATERIAL COMPACTING APPARATUS

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FIG. 2 ROLL GAP CONTROL

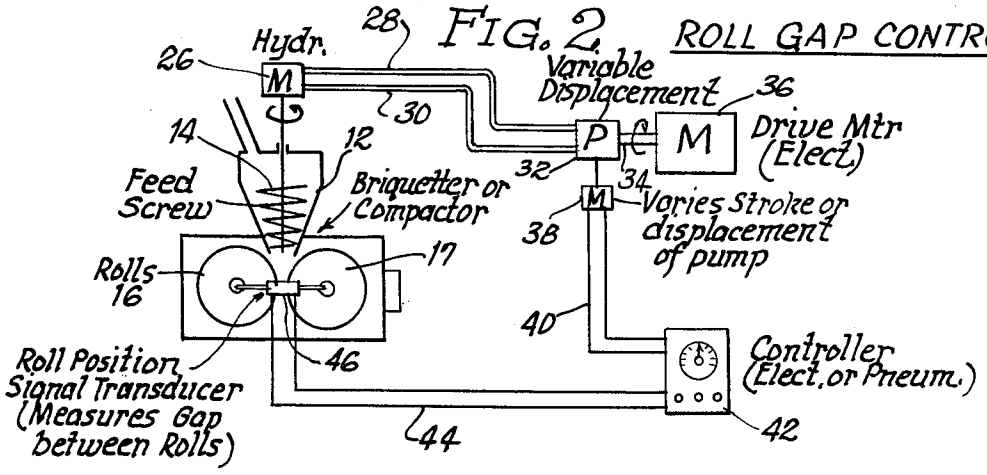


FIG. 3 FEED SCREW CONSTANT TORQUE CONTROL

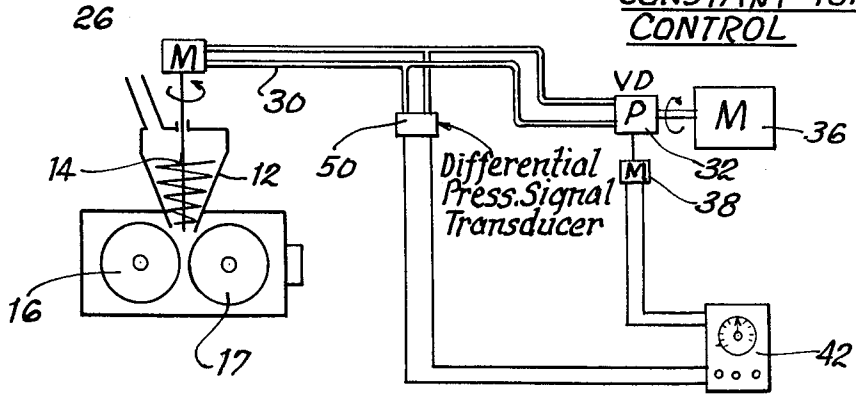
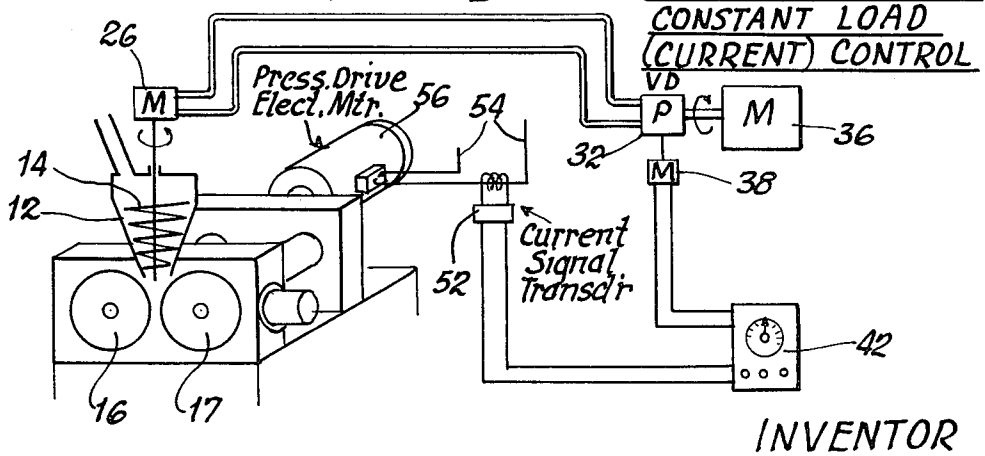


FIG. 4 PRESS. DRIVE MOTOR CONSTANT LOAD (CURRENT) CONTROL



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MATERIAL COMPACTING APPARATUS

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U.S. Cl. 425—145 10 Claims

ABSTRACT OF THE DISCLOSURE

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 materal, 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 driven and signals are applied to the fluid delivery 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.

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. 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. 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.

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 an improved control system for a feed screw in a briquetting machine or the like whereby a compacted product which is extremely uniform, particularly from a thickness standpoint, can be readily 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; and

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

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 product 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 is 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.

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 briquetted 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 or 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.

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 the hydraulic pump **32** for controlling the power applied by the feed screw to the material being compacted.

As indicated, various means may be employed for determining the signal sent by the controller **42** to the displacement motor **38**. 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, thus 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 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, a hopper for holding material to be compacted, and a feed screw located within said hopper for feeding material to said rolls, the improvement comprising means for maintaining the spacing between said rolls at a substantially constant distance comprising a hydraulic motor for driving said feed screw, a pump connected to said hy-

draulic motor, means for varying the input applied by said pump to said hydraulic 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 means for varying the input of said pump to thereby vary the rate of delivery of hydraulic fluid from said pump to said hydraulic 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 said pump is a variable displacement pump and wherein a proportional electric signal is applied to the drive means for the pump for varying the stroke of the pump.

3. An apparatus in accordance with claim 1 wherein said pump is a variable displacement pump, and including a pneumatic control for varying the stroke of the pump, said proportional output being applied to said pneumatic control.

4. 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.

5. 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.

6. An apparatus in accordance with claim 5 wherein said torque is measured by applying a differential pressure signal transducer to the hydraulic fluid lines extending between said hydraulic motor and said pump.

7. 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.

8. An apparatus in accordance with claim 7 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 said pump for varying the stroke of said pump.

9. An apparatus in accordance with claim 5 wherein said torque is measured by applying a constant flow signal transducer to the hydraulic fluid lines extending between said hydraulic motor and said pump.

10. An apparatus in accordance with claim 1 wherein said pump is a fixed displacement pump having means for diverting the output of the pump from the fluid feed line extending between the pump and said hydraulic motor, and including a flow control valve in said lines with the setting of said valve determining the amount of fluid diverted, and means for applying said proportional output to said flow control valve for thereby controlling the setting of said flow control valve.

References Cited

UNITED STATES PATENTS

2,977,631	4/1961	Komarek et al.	18—9 X
3,269,611	8/1966	Komarek	222—189
3,328,843	7/1967	Murphy, Jr., et al.	18—21
3,366,717	1/1968	Pohaus	18—9 X
3,450,529	6/1969	MacDonald	264—40 X

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U.S. Cl. X.R.

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