United States Patent [19]

Hass

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[54] **ANODE PRESS WITH VIBRATION AND COMPACTION RATE SENSING MEANS**

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[63] Continuation-in-part of Ser. No. 163,766, July 19, 1971, abandoned.

[52] **U.S. Cl.** **425/135**; 425/149; 425/167; 425/419; 425/421

[51] **Int. Cl.** **B30b 11/02**

[58] **Field of Search** 425/415, 421, 423, 425, 425/432, 443, 456, 149, 167, 419; 164/4, 154

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[57] **ABSTRACT**

This disclosure relates to apparatus for forming a carbon anode block comprising a movable mold, a feedbox extendable to a position where it is directly above the movable mold, a stationary bolster encompassed by the movable mold, a vibration means attached to the stationary bolster, and a movable press ram mounted for motion in the vertical plane above the stationary bolster and having protrusions extending from the face thereof. Aggregate used in forming carbon anodes is discharged into the feedbox and the feedbox and mold then move upwardly leaving the aggregate contained within the mold. The feedbox is then removed and the vibration means activated to compact the aggregate by expelling the air therefrom. During the compaction of the aggregate, the press ram is brought downward in proximity to the upper surface of the aggregate with the protrusions in the face thereof extending into the aggregate, and control means then continue to move the press ram downward in response to means which sense the compaction rate of the aggregate whereby the aggregate will form about the protrusions during compaction with substantially little or no pressure being applied by the press ram.

13 Claims, 5 Drawing Figures

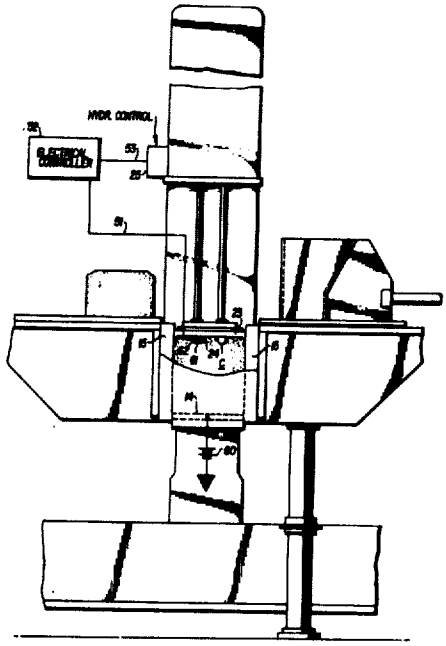
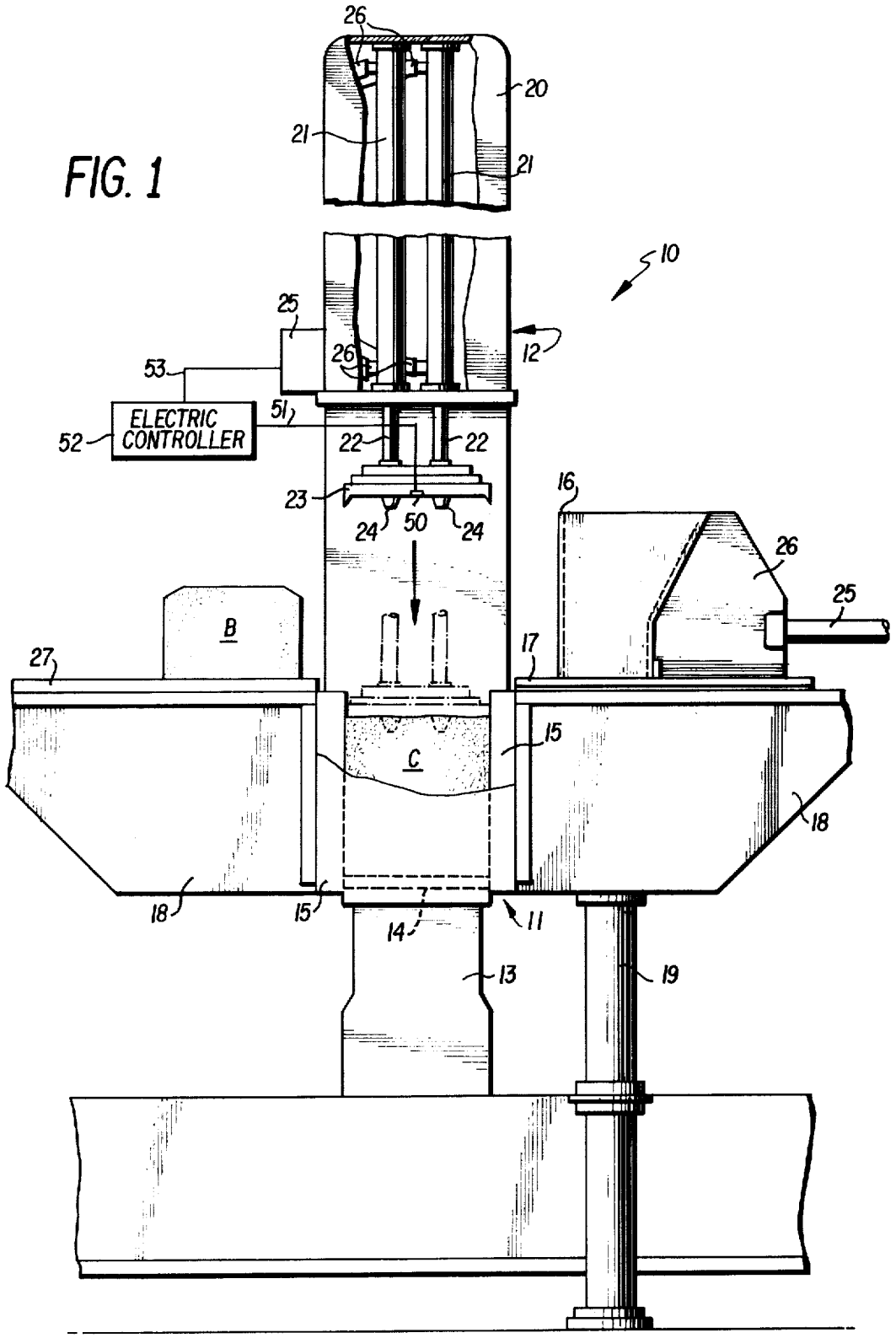


FIG. 1


26
20
21
21
10
25
26
12
53
ELECTRIC CONTROLLER
52
51
22
22
23
24
50
24
16
26
25
B
27
17
C
15
18
18
15
14
11
13
19

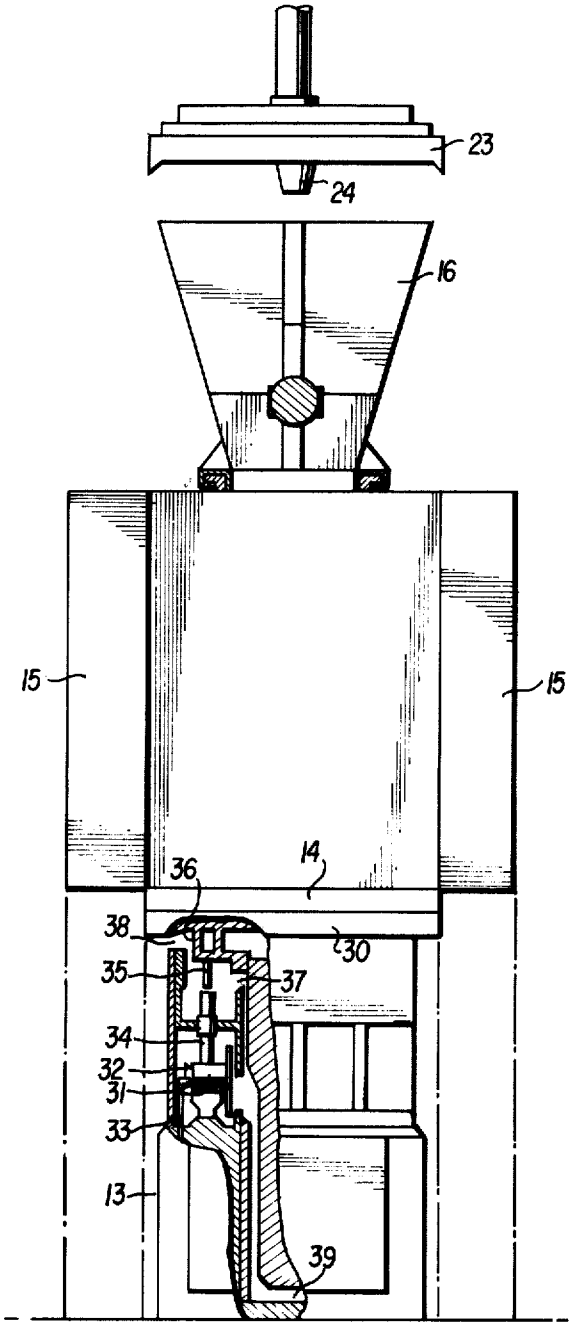


FIG. 2

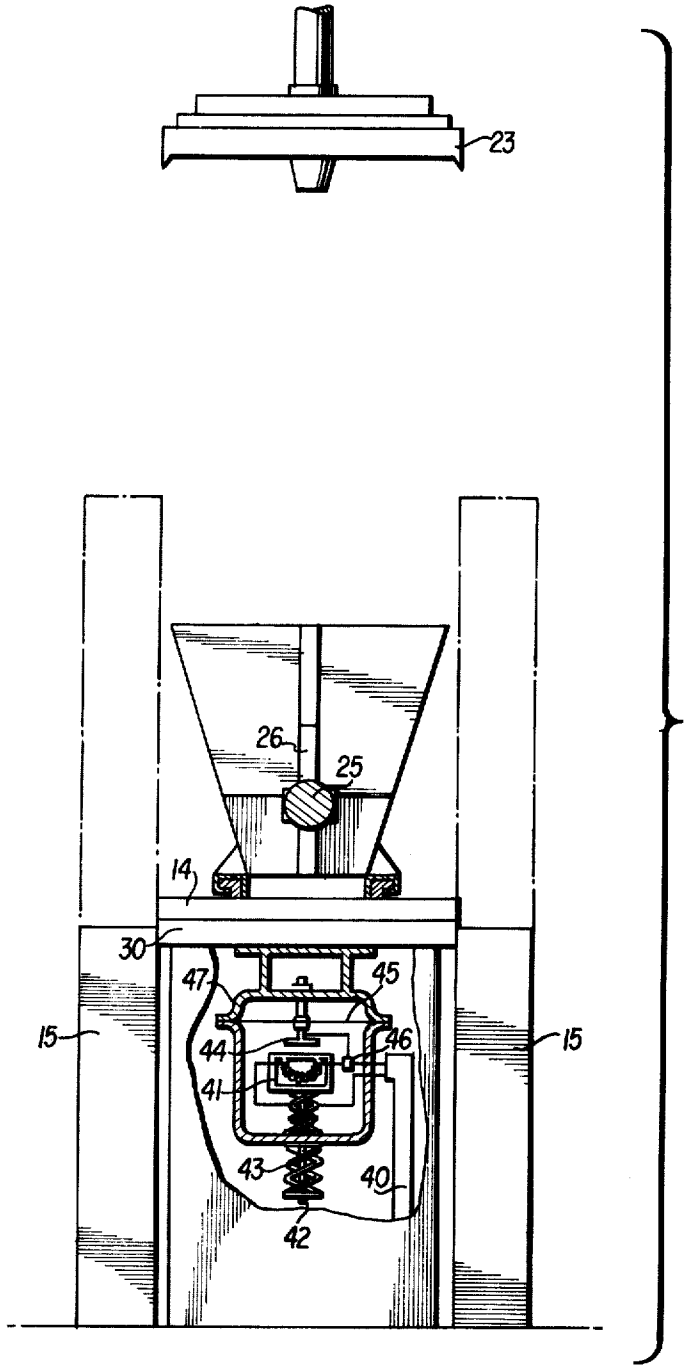
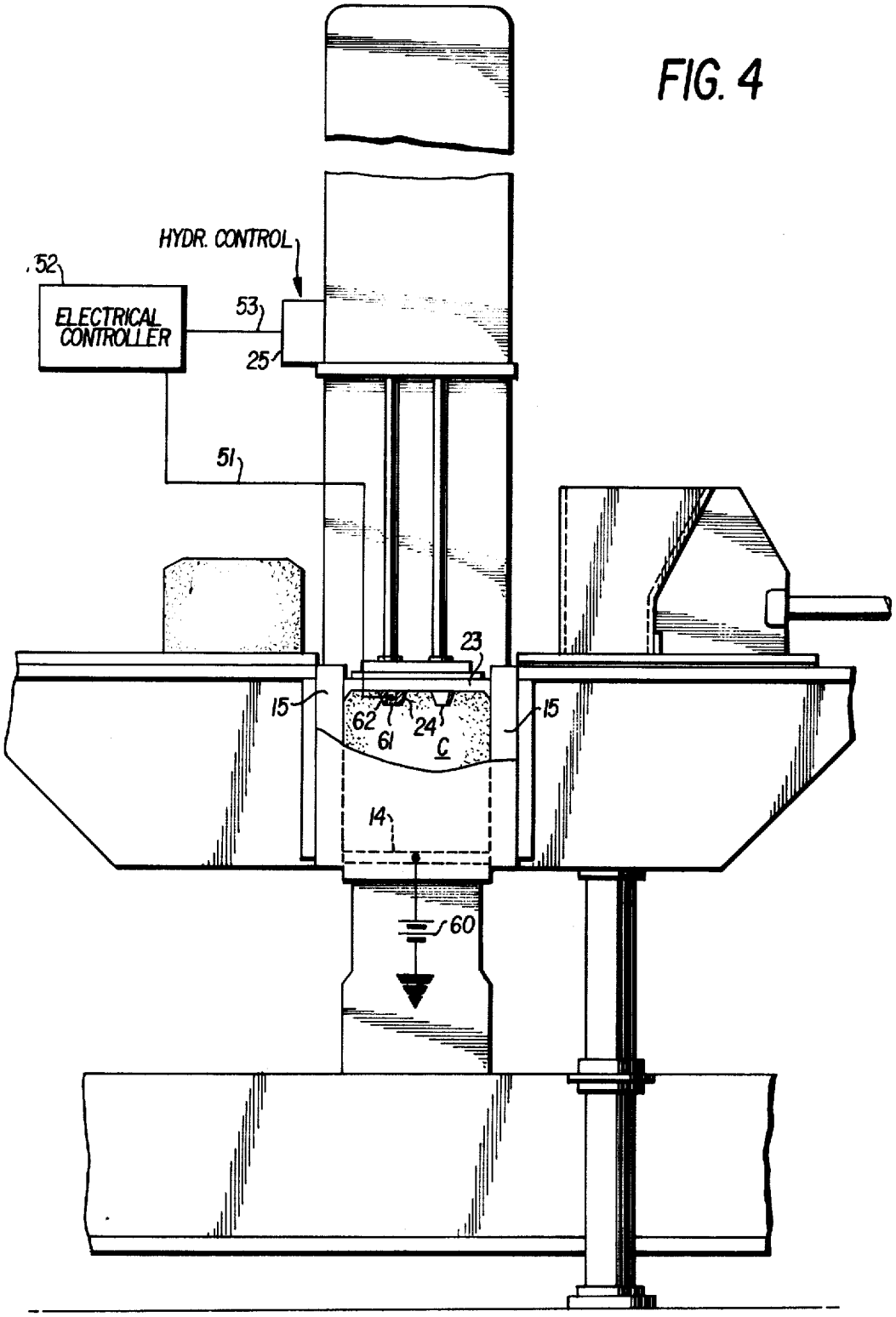


FIG. 3

FIG. 4


HYDR. CONTROL
52
ELECTRICAL CONTROLLER
53
25
51
23
15
62
61
24
C
15
14
60

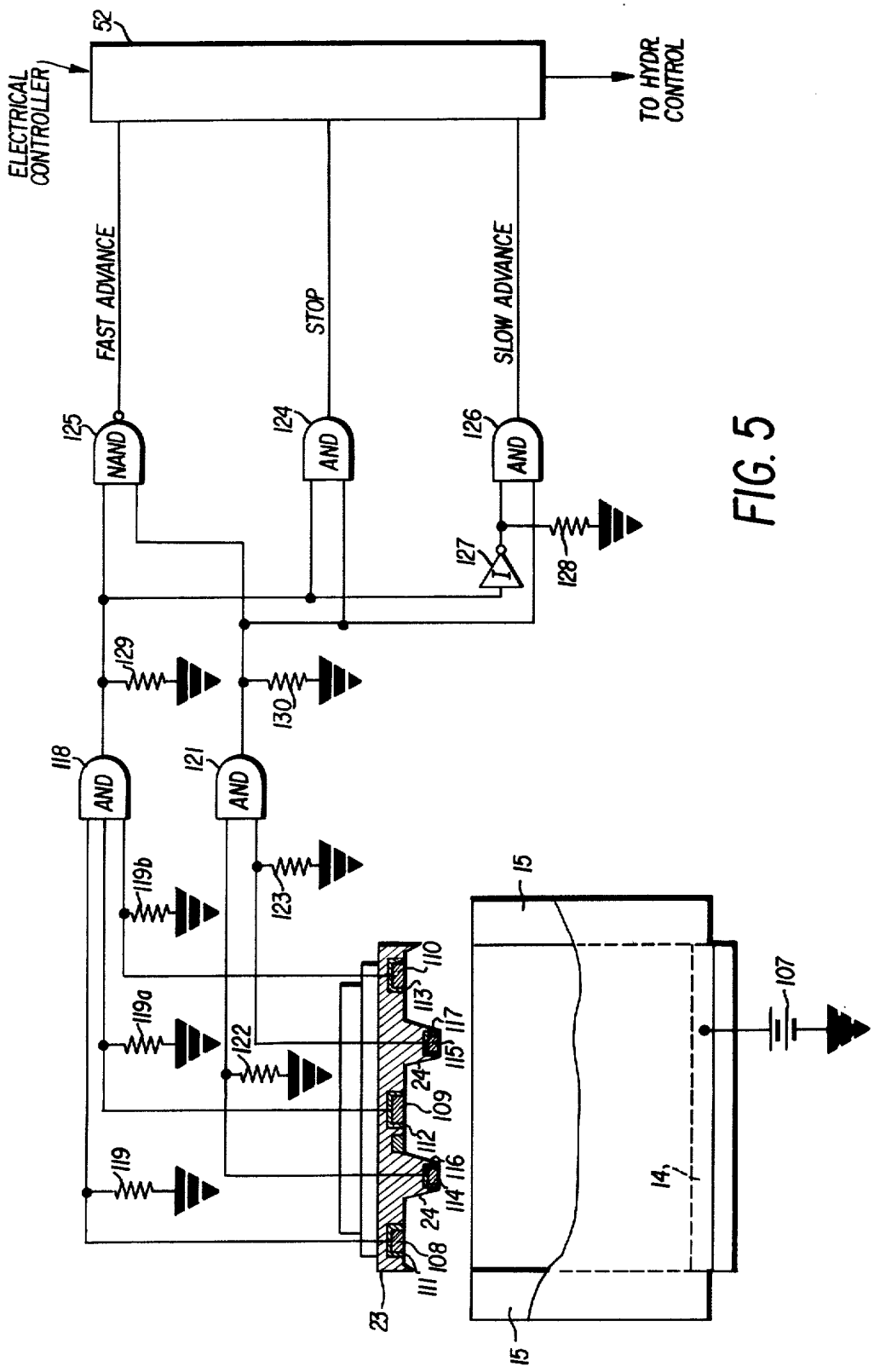

52
ELECTRICAL CONTROLLER
TO HYDR CONTROL
FAST ADVANCE
STOP
SLOW ADVANCE
125
NAND
124
AND
126
AND
127
128
129
130
118
AND
121
AND
119b
123
119a
122
119
110
113
117
115
24
109
112
116
114
108
111
23
15
14
107

FIG. 5

ANODE PRESS WITH VIBRATION AND COMPACTION RATE SENSING MEANS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a Continuation-in-Part of a copending application Ser. No. 163,766, filed July 19, 1971, now abandoned.

This invention relates to an apparatus for forming a carbon anode comprising a jarring or vibrating device which is adapted to compact the anode into a dense block more completely and efficiently than prior art apparatus of this type.

In the process of aluminum reduction, carbon anode blocks are used in the reduction cells. In prior art systems of producing carbon anode blocks, calcined petroleum coke aggregate and coal tar pitch binder are discharged into a stationary stand mold and pressed into a block anode by an overhead press. The density of this anode is not as desirable for use in a reduction cell as is an anode obtained by utilization of the vibrating or jarring apparatus of this invention.

In the aforementioned copending application of which this application is a Continuation-in-Part, it is explained that the press ram which is used to press the carbon aggregate into a block anode includes protrusions in the lower face thereof, such as cones, truncated cones, cylinders, dimples, cubes, and other various shapes which are used to form indentations in the upper face of the anode block. These indentations are used primarily as a means by which the anode control shaft can be affixed and secured to the anode block. Owing to this arrangement, the anode may thereby be raised and lowered in the reduction cell. The anode shaft usually includes a yoke portion at the distal end thereof which is inserted into the indentations formed in the upper face of the anode block and secured therein by solidifying molten metal or the like.

Because of the relatively small surface area at such protrusions, the pressure applied by the press ram against the anode block at such areas is extremely high. Consequently, the prior art methods and apparatus for accomplishing this operation resulted in anode blocks having localized stress areas from which fissures in the block could originate and propagate, and also in regions of higher density relative to the remainder of the block which adversely affect its electrical properties.

In the aforementioned copending application there is described an apparatus for forming carbon anode blocks comprising a vertically movable mold having a lower vibrating table disposed therein. During compaction (vibration) of the aggregate, the mold walls move downward by means of hydraulic cylinders at a rate selected to maintain the relative motion between the aggregate and the mold walls at or near zero. Also during compaction, a press ram is lowered in proximity to the upper surface of the aggregate at a rate corresponding approximately to the compaction rate of the material, applying little or no pressure thereagainst, and allowing the material to freely form around any protrusion extending from the lower face of the press ram. The vibrating or jarring motion of the mold allows virtually all air trapped between the particles of carbon aggregate to be expelled, thereby compacting the aggregate without the application of a large amount of force by the press ram, and permitting the formations of indentations in the upper surface of the aggregate conforming

to the shape of the protrusions in the press ram with the application of substantially little or no pressure being applied by the press ram. Upon completion of material compaction, the vibrating mechanism is deactivated and the press ram is then further lowered to apply sufficient pressure to further compact the material and to finish form the top surface of the material to conform to the shape of the protrusions in the lower face of the press ram.

While it is known from the prior art to form blocks from particulate material by compressing the material in a movable mold after vibration to expel air therefrom, the prior art does not disclose means for controlling the movement of such press rams at a rate corresponding substantially to the compaction rate of the particulate material (i.e., owing to the vibration thereof) whereby the aggregate will form about such protrusions during compaction thereof with substantially no pressure being applied by the ram. For example, in U.S. Pat. No. 2,057,466 issued to P. G. Willetts, there is disclosed a molding apparatus which includes a vertically movable mold which is adapted to contain a granular material supported on a bottom plate and vibrated to expel air therefrom by means of a vibrating table. The apparatus further includes a top plate which is adapted to rest on the upper surface of the aggregate and to move downwardly relative to the movable mold in conjunction with a heavy anvil which rests on the top of the plate and which is adapted to provide a compacting force thereagainst. A pneumatic hammer is positioned above the anvil and is adapted to apply impact blows against the anvil to compact and compress the aggregate contained within the mold. As the anvil and top plate move downwardly under the influence of their own weight as well as the impact blows provided by the hammer, the hammer must be continuously repositioned downwardly so that it will be in position to strike the downwardly moving anvil. This is accomplished by hand by means of a rack, pinion, and hand wheel.

It should be understood that the Willetts apparatus does not include means for controlling the movement of the press ram at a rate corresponding substantially to the compaction rate of the aggregate. On the contrary, the Willetts press ram is intended to compact and compress the material during vibration thereof without regard to the degree of pressure being applied.

Similarly, the U.S. Pat. Nos. to Locke 3,537,157, Hirt et al 3,712,785, Weinhold 3,555,599 and McElroy 2,909,826 also fail to disclose any means for controlling the movement of the press ram at a rate corresponding substantially to the compaction rate of the aggregate whereby the aggregate will form about protrusions in the lower face of the ram during compaction with substantially little or no pressure being applied by the ram. While each of these patents discloses a press ram and a vibrating mold, none discloses the cooperation between the vibrating means and the mold to effect the result of the instant invention. In the Locke patent, for example, a packing head is brought down against the aggregate after vibration thereof to compact the material. There is no disclosure of any control means by which the downward movement of the packing head could be controlled in accordance with the compaction rate of the aggregate.

It is, therefore, a primary object of this invention to provide an improved apparatus whereby a carbon

anode block may be formed into a more compact and dense product than that provided by prior art apparatus, and which provides a more suitable anode for use in an aluminum reduction cell.

Another object of this invention is to greatly increase the capacity of existing anode presses, or to allow the use of a much smaller press than would normally be required to produce a carbon anode of desirable density.

A further object of this invention is to provide apparatus for forming carbon anode blocks having indentations formed in the upper surface thereof, while avoiding the formation of deleterious over-stressed areas in the surface thereof.

More particularly, it is an object of this invention to provide apparatus as above described having a vibrating mold and a vertically movable press ram, and means for controlling the movement of the press ram at a rate corresponding substantially to the compaction rate of the aggregate from which the anode block is formed, whereby the aggregate will form about the protrusions during compaction thereof with substantially little or no pressure being applied by the press ram.

Briefly described, the apparatus of this invention includes a mold having vertically movable walls which, in their lowermost position, encompass a bolster having a vibrating plate affixed to the upper portion thereof. A feedbox, which is formed by a hollow receptable having upper and lower openings for receiving and discharging calcined petroleum coke aggregate and coal tar pitch binder, is movable to a position over the mold whereupon the aggregate may be discharged therein to be supported on the vibrating plate. The feedbox is then removed and a press ram, having protrusions extending from the lower face thereof, is lowered until the protrusions enter the aggregate. The vibrating mechanism, which may be either pneumatically or electrically activated, is then started and the aggregate compacted due to the air being expelled therefrom.

During the aggregate compaction (vibration), the mold walls are moved downwardly by hydraulic means at a rate selected to maintain the relative motion between the material and mold walls at or near zero. Also, during compaction the press ram is lowered at a rate corresponding approximately to the compaction rate of the aggregate, applying little or no pressure thereagainst, and allowing the aggregate to form around the protrusions in the lower face thereof. This is accomplished by monitoring the compaction rate of the aggregate (i.e., the rate at which the upper surface of the aggregate descends), and generating a control signal in response thereto by which the hydraulic system of the press ram can be controlled to move the press ram downwardly at the appropriate rate.

In one embodiment of the invention, the monitoring means takes the form of a pressure sensor or cell disposed in the lower face of the ram (preferably in one of the protrusions), and an electrical control circuit having limiting means by which the descent of the press ram may be retarded or stopped upon the occurrence of a predetermined pressure sensed at the face of the ram.

In another embodiment of the invention, the monitoring means includes means for generating an electrical current through the aggregate, such current flowing only when the face of the ram makes sufficient contact with the aggregate, which condition would be such as to signal the hydraulic control system of the press ram to retard or stop its descent.

In a preferred embodiment of the above-described electrical monitoring means, a logic circuit is provided which generates FAST ADVANCE, STOP and SLOW ADVANCE signals to the hydraulic control system of the press ram whereby the descent of the ram may be more closely controlled.

With the above and other objects in view that may become hereinafter apparent, the nature of the invention may be more clearly understood by reference to the several views illustrated in the attached drawings, the following detailed description thereof, and the appended claimed subject matter:

IN THE DRAWINGS

FIG. 1 is a front elevation view of the anode forming apparatus of this invention, and illustrates the hydraulically actuated press ram (partially broken to conserve space), movable mold, bolster, and electrical and hydraulic control systems for the press ram shown schematically; and depicts in phantom the press ram with protrusions therefrom extending into the aggregate in the mold;

FIG. 2 is a front elevation view of the anode forming apparatus, the mold walls shown in their uppermost position, and is partially broken away to illustrate a pneumatically operated vibrator which is shown in section;

FIG. 3 is a front elevation view of the anode forming apparatus, the mold walls shown in their lowermost position encompassing the bolster and vibrating means, and is partially broken away to illustrate an electrically operated vibrator shown in cross-section;

FIG. 4 is a front elevation view of the anode forming apparatus similar to FIG. 1, and further illustrates schematically another embodiment of the electrical and hydraulic control system for the press ram;

FIG. 5 is a schematic diagram of a preferred embodiment of the electrical control circuit which may be used with the apparatus of FIG. 4, portions of the apparatus being shown diagrammatically.

Referring now to the drawings in detail, there is illustrated in FIG. 1 an anode vibrator and press apparatus designated generally by the numeral **10**. The apparatus **10** includes a movable mold **11** and a press **12**. The mold **11** includes a bolster portion **13** having a vibrating plate **14** disposed at the upper end thereof and vertically movable side walls **15** (shown in their uppermost position), which, in their lower most position, encompass the bolster **13** as seen more clearly in FIG. **3**.

A feedbox **16** is movable horizontally on rails **17** carried by support member **18**. The support member **18** is vertically movable by a hydraulic lift **19** for a purpose to be hereinafter described.

The press **12** includes a housing portion **20** which contains hydraulic cylinders **21** from which rods **22** extend to support a press ram **23**. The press ram **23** includes truncated conical protrusions **24** extending from the lower face thereof. Conventional hydraulic control means **25** having conduits **26** extending into the hydraulic cylinders **21** are provided to raise and lower the press ram **23** between the mold walls **15** of the movable mold **11**.

The operation of the apparatus **10** is as follows: With the feedbox **16** containing a charge of carbon aggregate, the support member **18**, which carries the movable mold walls **15** as well as the feedbox **16**, is lowered

by means of the hydraulic lift **19** to a position as shown in FIG. **3** where the mold walls **15** encompass the bolster **13**. A hydraulic ram **25** is then actuated to slide the feedbox **16**, through the medium of a connecting pushing member **26**, horizontally along the rails **17** to a position over the vibrating plate **14**. The hydraulic lift **19** is then raised, thereby raising the feedbox **16** and leaving the carbon aggregate C retained in the mold **11** between the mold walls **15** which have been correspondingly raised by the hydraulic lift **19** and the support member **18**. The feedbox **16** is then withdrawn to the right by the hydraulic ram **25** to the position shown in FIG. **1**. The hydraulic control mechanism **25** is then activated to bring the press ram **23** down into proximity to the upper surface of the aggregate C and the vibration mechanism (FIGS. **2** and **3**) activated to vibrate the table **14** and thereby initiating the compaction of the material. The press ram **23** then continues downward with the protrusions **24** entering into the aggregate C and permitting the aggregate to form thereabout. As the upper surface of the aggregate descends owing to the compaction thereof, the press ram **23** continues to move downwardly keeping the protrusions **24** imbedded in the aggregate while means (to be described hereinafter) control the downward movement of the press ram **23** such that it applies little or no pressure against the aggregate C. Also, as the aggregate is being compacted, the mold walls **15** are being moved downwardly by means of the hydraulic lift **19** and support member **18** such that the relative motion between the aggregate C and mold walls **15** is approximately zero. Upon completion of material compaction, the vibrating mechanism is deactivated and the press ram **23** continues to lower and applies sufficient pressure to further compact the aggregate C and to finish form the upper surface thereof to conform to the shape of the protrusions **24**. With support member **18**, hydraulic lift **19**, and mold walls **15** in their lowermost positions, the hydraulic ram **25** moves the feedbox **16** to the left to push the formed anode block B off of the vibrating plate **14** onto receiving table **27** which constitutes the upper surface of the left-most portion of the support member **18**. The anode block B is subsequently removed from the table **27** and baked into a finished product.

Referring now to FIG. **2**, it can be seen that the bolster **13** includes a vibrating device **30** which is mounted below the vibrating plate or table **14**. The bolster **13**, vibrating device **30**, and vibrating plate or table **14** are designed so that when deactivated will withstand the full working load of the press ram **23**. The vibrating device **30** is operated by air entering air cylinder **31** through air intake **32** by way of conduit **33**. This forces a shaft **34**, extending from air cylinder **31**, upward into contact with a striking pin **35** which is mounted on a connecting member **36**. The connecting member **36** is fixedly attached to the vibrating device **30**. The motion of the shaft **34** is transmitted through the striking pin **35** and connecting member **36** to the vibrating device **30**. Vibrating device **30**, in turn, shakes the vibrating plate or table **14** and thus the aggregate contained within the mold walls **15**. Exhaust air flows through an air passageway **37** and exits at exhaust openings **38** and **39**. The vibrator operates until virtually all air trapped between the aggregate particles is expelled, thereby compacting the aggregate into the desired anode form.

An electrical vibrator is illustrated in FIG. **3** which may be substituted for the pneumatic vibrator discussed above in connection with FIG. **2**. Current enters the electric vibrator through conductors within conduit **40** and is transmitted to coil **41** which is mounted on a shaft **42**. A balancing or stabilizing spring assembly **43** surrounds the shaft **42**. When current flows through the coil **41**, a force field is created which attracts a contact plate **44**. The contact plate **44** is mounted through and beneath a flexible diaphragm **45**. When the coil **41** and contact plate **44** make contact, an overload switch **46** interrupts the current flow to the coil **41**. The diaphragm **45** and spring assembly **43** then return to their original positions, thus creating vibration. The frequency of this connection and disconnection is predetermined by the design parameters and specifications of the diaphragm **45**, coil **41**, spring assembly **43**, and overload switch **46**. The movement of diaphragm **45** transmits vibtration through a vibrator superstructure **47** which is connected to the vibrating device **30** which, in turn, is connected to the vibrating plate **14**.

In accordance with this invention, means are provided for controlling the movement of the press ram **23** at a rate corresponding to the compaction rate of the aggregate C. Such means may include any means which is capable of sensing or monitoring the compaction rate of the aggregate and generating a signal in response thereto by means of which the hydraulic control system **25** of the press **12** can be controlled. Referring once again to FIG. **1**, it can be seen that the press ram **23** includes a pressure transducer **50** disposed in the lower face of the ram **23** between the protrusions **24**. The pressure transducer **50** is electrically connected by means of control line **51** to an electrical controller **52**, such as a solenoid, servo-motor or the like, which is, in turn, connected through appropriate means **53** to the hydraulic control system **25**. The pressure transducer **50** is so designed that upon the appearance of a predetermined pressure thereagainst, owing to its engagement against the carbon aggregate C, an electrical signal will be generated which is transmitted through the line **51** to the electrical controller **52**. The electric controller **52**, through the connecting means **53**, then controls the hydraulic control system **25** to either slow or stop the descent of the press ram **23**. Consequently, the press ram **23** will descend at a predetermined rate until such time as the pressure transducer **50** bears against the aggregate C with sufficient pressure to activate the controller **52**. It should be apparent, therefore, that if the threshold pressure is sufficiently low, the press ram **23** will follow the descent of the upper surface of the aggregate C at a rate corresponding to the compaction rate of the aggregate.

Referring now to FIG. **4**, there is illustrated therein an alternate embodiment of the control apparatus of this invention. A DC voltage source **60**, having its negative pole grounded, has its positive pole connected to the vibrator plate **14**. An electrical contact **61** is recessed into one of the protrusions **24** on the face of the press ram **23** and is electrically insulated therefrom by insulator **62**. The electrical contact **61** is connected to the electrical controller **52** through line **51**, and the controller **52** is, in turn, connected to the hydraulic control system **25** through connecting means **53** as in the embodiment of FIG. **1**.

The operation of the control system of FIG. **4** should be apparent. Provided that the mold walls **15** are insu-

lated or otherwise non-conductive, no current will flow from the voltage source **60** until the press ram **23** is brought down into contact with the aggregate C and contact is made at the electrical contact **61.** At this point, current will flow through the line **51** to the electrical controller **52** which thereby commands the hydraulic control system **25** to retard or stop the downward advance of the press ram **23.** However, as soon as contact is broken between the aggregate C and the electrical contact **61,** which occurs, of course, when the upper surface of the aggregate C descends owing to the compaction thereof as it is being vibrated, the control circuit is broken and the hydraulic control system **25** will cause the press ram **23** to advance. It should be understood, therefore, that the press ram **23** will follow the upper surface of the aggregate C downwardly at a rate corresponding to the compaction rate of the aggregate.

A preferred embodiment of the electrical control circuit of FIG. **4** is illustrated schematically in FIG. **5.** As seen in FIG. **5,** a DC voltage source **107,** having its negative pole grounded, has its positive pole connected to the vibrator plate **14.** The lower face of the press ram **23** is provided with three recessed electrical contacts **108, 109** and **110;** these contacts are insulated from the ram **23** by respective insulators **111, 112** and **113.** Two additional recessed electrical contacts **114** and **115** are provided respectively in the lowermost surface of the protrusions **24,** respectively. The contacts **114** and **115** are respectively insulated from the ram **23** by insulators **116** and **117.**

The three electrical contacts **108, 109** and **110** are respectively connected to individual input terminals of an AND circuit **118.** Each of the three input connections of the AND circuit **118** is also connected to ground via a respective resistor **119, 119***a* and **119***b.*

The two electrical contacts **114** and **115** are respectively connected to individual input terminals of an AND circuit **121.** Each of the two input terminals of the AND circuit **121** is also connected to ground via a respective resistor **122** and **123.**

The output terminals of the AND circuits **118** and **121** are connected to respective input terminals of a further AND circuit **124,** and to respective input terminals of a NAND circuit **125.** The output terminal of the AND circuit **121** is also connected to an input terminal of an additional AND circuit **126.** The output terminal of the AND circuit **118** is connected to an input terminal of the AND circuit **126** via an inverter **127.** The output terminal of the inverter **127** is connected to ground via a resistor **128.** The output terminals of the AND circuits **118** and **121** are also connected respectively to ground via resistors **129** and **130,** respectively.

The output terminals of the NAND circuit **125,** the AND circuit **124** and the AND circuit **126** are each connected to the electrical controller **52** so as to supply command signals thereto. The NAND circuit **125** provides a ONE signal as fast advance command signal, the AND circuit **126** provides a ONE signal as a slow advance command signal, and the AND circuit **124** provides a ONE signal as a stop command signal.

The operation of the control circuit of FIG. **5** is to be described briefly below, starting with the assumption that the press ram **23** is in the position shown; that is, spaced from the top surface of the carbon aggregate C. In this position no current flows from the DC source **107** through the mass of carbon granules. In this condition, all input signals to the AND circuits **118** and **121** are ZERO, and their respective output signals are ZERO. The NAND circuit **125** produces a ONE signal, in response to the two ZERO signals it receives, which ONE signal is fed to the controller **52** as a fast advance command signal. The electrical controller **52** energizes the hydraulic control system **25** (FIGS. **1** and **4**) to cause the ram **23** to move downwardly at a relatively fast rate until both of the contacts **114** and **115** contact the upper surface of the carbon aggregate C.

When contact is made between each of the contacts **114** and **115** and the carbon aggregate, current flows through the resistors **122** and **123** placing ONE signals on the input terminals of the AND gate **121.** A ONE signal appears consequently on one input terminal of the NAND gate **125,** causing its output signal to become ZERO, thus terminating the fast advance command signal to controller **52.** The output signal from the AND circuit remains ZERO, the output signal appears as a ONE signal on one input terminal of the AND circuit **126** because of the inverter **127.** The other input terminal of the AND circuit **126** receives the ONE signal from the AND circuit **121** and, consequently, produces a ONE signal on its output. This ONE signal is fed to the controller **52** as a slow advance command signal. The controller **52** effects relatively slow, downward movement of the ram **23** until each of the three contacts **108, 109** and **110** contact the upper surface of the carbon aggregate.

Upon contact between each of the contacts **108, 109,** 110 and the carbon aggregate, current flows in each of the resistors **119, 120** and **121** thereby placing a ONE signal on each input terminal of the AND circuit **118,** causing its output terminal to exhibit a ONE signal which, because of the action of the inverter **127,** appears as a ZERO signal at one input terminal of the AND circuit **126.** Consequently, the output signal of the AND circuit **126** becomes ZERO thereby terminating the slow advance command signal to the controller **52.**

The two input terminals of the AND gate receive the two ONE signals from the AND circuits **118** and **121** causing its output terminal to exhibit a ONE signal, which signal is supplied to controller **52** as a stop command signal. In response to the stop command signal, the controller **52** energizes the hydraulic control system **25** to halt the advance of the ram **23.** This condition will prevail until the upper surface of the carbon aggregate falls away from any of the contacts **108, 109,** 110, 114, and **115.** In the event the surface of the carbon aggregate, due to action of the vibrator plate **14,** falls away from any of the contacts **108, 109** and **110,** a slow advance command signal is again produced. In the event the surface of the carbon aggregate falls away from either the contacts **114** or the contact **115,** a fast advance command signal is again produced.

It is to be appreciated that the control circuit of FIG. **5** functions quickly and, in effect, advances the ram **23** at substantially the same rate as the surface of the mass of carbon granules moves downwardly. Moreover, the control circuit operates to assure that the protrusions **24** remain in the mass of carbon aggregate because of the fast advance command signal.

It should be understood that other control circuits could be used within the scope of this invention, and particularly other logic circuits in connection with the embodiment of FIG. **5.** For example, while electrical

and pressure sensing control means have been specifically illustrated and described herein, it is contemplated that wave energy sensing means could be utilized such as proximity switches and other sonic sensors which can be used to maintain the press ram **23** in a predetermined spaced relation from the mass of carbon aggregate.

The press of the present invention need exert only approximately one-tenth the pressure required by prior art presses to form anodes of comparable size and density. Prior art presses require a minimum of approximately 4,000 psi to form an anode of advantageous size and density, whereas the press of the present invention requires only approximately 400 psi pressure. Thus, the present invention allows use of a much smaller press, saving equipment costs and operating expense.

Although only preferred embodiments of the invention have been specifically described and illustrated herein, it is to be understood that minor variations may be made without departing from the spirit of the invention.

I claim:

1. Apparatus for forming a carbon anode block from carbon aggregate comprising a mold movable between an upper and lower position, a feedbox, means for extending said feedbox to a position directly above said movable mold, a normally stationary bolster, said bolster being encompassed by said movable mold in the lower position thereof, vibration means attached to said bolster for vibrating carbon aggregate contained within said mold to expel air therefrom thereby compacting the aggregate at a measurable rate, a movable press ram having protrusions formed in its lower face mounted for vertical movement above said bolster and adapted to apply pressure against the aggregate in said mold, a hydraulic control system for moving said press ram, means in operative communication with the aggregate for continuously sensing the compaction rate thereof, means for generating a signal in response to said sensing means, and means responsive to said signal and operatively connected to said hydraulic control system for operating said system to continuously control the movement of said press ram at a rate corresponding substantially to the compaction rate of the aggregate whereby the aggregate will form about said protrusions during compaction thereof with substantially no pressure being applied by said ram.

2. Apparatus as defined in claim **1**, wherein said sensing means includes a pressure transducer.

3. Apparatus as defined in claim **1**, wherein said sensing means includes means for transmitting an electrical current through the aggregate in said mold.

4. Apparatus as defined in claim **1**, wherein said signal generating means includes logic circuit means for applying command signals to said operating means.

5. Apparatus as defined in claim **4**, wherein said logic circuit means includes means for applying FAST ADVANCE, SLOW ADVANCE and STOP command signals.

6. Apparatus as defined in claim **1**, wherein said vibration means is a pneumatically actuated vibrator.

7. Apparatus as defined in claim **1**, wherein said vibration means is an electrically actuated vibrator.

8. Apparatus as defined in claim **1**, wherein said press ram is adapted to move downwardly in engagement with the aggregate during compaction thereof.

9. Apparatus as defined in claim **1**, wherein said sensing means is positioned in said movable press ram and is adapted to operatively engage the aggregate during compaction thereof.

10. Apparatus for forming a compacted block from particulate material comprising a mold, a press ram disposed above said mold and mounted for vertical movement therein, means for vibrating particulate material contained within said mold to expel air therefrom thereby compacting the material and causing the surface thereof to descend at a given rate, means in operative communication with the particulate material for continuously sensing the rate at which the surface of the material descends, and means responsive to said sensing means for continuously controlling the movement of said press ram at a rate corresponding substantially to the rate at which the surface of the material descends whereby said press ram will apply substantially no pressure against the material during compaction thereof.

11. Apparatus as defined in claim **1**, wherein said press ram is adapted to move downwardly in engagement with the particulate material during compaction thereof.

12. Apparatus as defined in claim **1**, wherein said sensing means is positioned in said press ram and is adapted to operatively engage the surface of the particulate material as it descends during compaction.

13. Apparatus for forming a compacted block from particulate material comprising a mold, a press ram disposed above said mold and mounted for vertical movement therein, means for vibrating particulate material contained within said mold to expel air therefrom thereby compacting the material at a rate which varies inversely as a function of the density thereof, means for moving said press ram downwardly in engagement with the particulate material, means in operative communication with the particulate material for continuously monitoring the compaction rate thereof, and means responsive to said monitoring means for continuously correlating the movement of said press ram with the compaction rate of the particulate material whereby said press ram will apply substantially no pressure against the particulate material during compaction thereof.

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