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(54) Concrete block molding machine having continuously driven vibrating shaft mechanism which can be programmably vibrated and method of programmably vibrating such machines.

(57) A cement block molding machine has a vibratible mold box incorporating at least one molding cavity for a cement mixture which is to be densified in the cavity. A continuously driven shaft assembly mounts an eccentric fixed portion and a circumferentially adjustable balancing mass. The shaft assembly has a cylinder with a piston therein, connected to the mass to produce rotary motion of the mass relative to the fixed eccentric portion. A spring of predetermined rate opposes this. The pressure of the fluid introduced is varied to change the amplitude of the vibration imparted during each cycle.

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CONCRETE BLOCK MOLDING MACHINE HAVING CONTINUOUSLY DRIVEN VIBRATING SHAFT MECHANISM WHICH CAN BE PROGRAMMABLY VIBRATED AND METHOD OF PROGRAMMABLY VIBRATING SUCH MACHINES

The present invention is concerned with vibratile molding machines of the character used in the cement block industry for molding concrete building blocks of varying configuration, and other concrete products such as paving stones and the like, from cement mixes which are vibrated to densify them. Various mechanical vibrator assembles have been utilized to eccentrically provide the vibration for such machines and one such vibrating assembly is disclosed, for instance, in the present assignee's U.S. patent No. 4,312,242 issued January 26, 1980. In conventional concrete block manufacturing machines, the cycle of operation involves the first step of moving the feed box over the empty mold in the machine and starting the vibrating motor. The motor drives a shaft which eccentrically causes the vibration and the motor continues to be driven during a compacting operation, after which a switch is actuated to stop the electric motor which is used as the drive for the system. At this point a stripper is operated to strip the green blocks from the mold and the pallet which has been clamped to the bottom of the mold is released preparatory to transferring it, and the blocks, to a block curing location.

In prior art machines in which the eccentric shafts producing the vibration have been stopped to halt the vibration at the end of the densifying step, large brakes have been required to stop the shafts. Moreover, because of the rapid acceleration and deceleration required in contemporary high production machines, as much as four times the horsepower required to produce the vibration had to be utilized, with the result that much larger motors and shafts were required for reasons other than producing the vibration. In machinery of the type disclosed in the patent mentioned, the vibrating shaft in effect coasts between intervals of operation of the drive motor and so need not be braked and brought up to full speed from a static position. However, the machine still operates by starting and stopping the drive motor and a substantial acceleration of the coasting shaft is required at the time it is desired to produce vibration. Moreover, such prior art machinery is not versatile in the sense that the amplitude of vibration and the forces exerted can be varied during the vibration portion of the cycle.

The invention is directed to a high speed, concrete products forming machine which can be utilized in production operations for manufacturing a variety of shapes from a variety of aggregates. Certain intensities and patterns of vibration are optimally used for any given mold, shape of product, or aggregate mix which is used.

One of the prime objects of the present invention is to provide a system and method which encourages the programming of the best cycle parameters for a particular "run" so that the same parameters can be stored in the memory of a programmable logic controller and used in future runs of a particular product.

Another object of the invention is to provide a system in which the vibrating shaft can be rotated continuously at vibrating speed without the need for intermittent starting, stopping, and braking while providing the capability of changing the amplitude of the vibration during the operating cycle, and even during the product densifying portion of the cycle.

Still another object of the invention is to provide a system of the character described which utilizes a pair of vibrating shaft assemblies which can be so controlled that the vibration occurs in absolute synchronism.

Still a further object of the invention is to provide a system wherein the amplitude of vibration can be varied during the cycle to compensate for the fact that the total weight of the molding system being vibrated changes during the forming cycle.

Still another object of the invention is to design a system of the type described which provides a shaft assembly whose strength is not compromised intermediate its span, and which can more compactly handle the high loads involved in a most efficient and reliable manner.

Another object of the invention is to provide a quieter system which provides a higher density block with much reduced power consumption, and consequently is more economical to operate.

Still a further object of the invention is to provide a system utilizing a spring having a predetermined rate to opposing the axial movement of the weight position adjusting piston-cylinder assembly in a manner such that the spring mechanism is operative to restore the vibration inducing mass to a desired or null position.

Other objects and advantages of the invention will be pointed out specifically or will become apparent from the following description when it is considered in conjunction with the appeneded claims and the accompanying drawings.

Figure 1 is a schematic, fragmentary, perspective elevational view of the block making machine, showing the mold and the mold vibrating mechanism thereof;

Figure 2 is a fragmentary, sectional, elevational view, illustrating one of the identical mold vibrating shaft assemblies which is employed in a null mode;

Figure 3 is a transverse sectional view thereof, taken on the line 3-3 of Figure 2; and

Figure 4 is a graph indicating vibration intensity in terms of percentage of maximum amplitude versus cycle time.

Referring now more particularly to the accompanying drawing and in the first instance to Figure 1, a block making machine, generally designated M, of the type disclosed, for instance, in the present assignee's U.S. patents Nos. 4,395,213 and 3,833,331, which are incorporated herein by reference, is illustrated fragmentarily. The machine may be considered to include a multi-compartmented mold box, generally designated 10, comprising side members 10a, end members 10b, and divider or partioning plates 11. In addition, core members 12, such as roof top cores, are provided in the compartments defined by the divider plates 11 for the purpose of forming the core openings in the concrete blocks which may, for example, be formed in this particular mold box.

The lower end of the mold box 10 is, during the forming cycle, closed by a vertically raisable pallet which is releasably clamped to the lower end of the mold box to vibrate with it by a raisable platen having a rubber block top. The upper end of the mold box is open to the reception of concrete mix material from a feed box at the beginning of the cycle. Stripper members are utilized in the usual manner at the end of the cycle to push the blocks formed from the mold as the pallet lowers to a conveyor which moves the green block to a curing area such as a kiln.

As shown, the mold box 10 has mold supporting side arms 13. Spanning the ends of the side arms 13 are twin vibrator shaft assemblies, each generally designated S, and being shown more particularly in Figures 2 and 3. As illustrated, a shaft assembly S is provided at each end of the mold box and both vibrating shaft assemblies are controlled to operate synchronously so that one end of the mold is not vibrated more intensely than the other. This is necessary to ensure uniformity in the blocks being formed in the mold. As Figure 2 particularly indicates, the frame members 13 support bearings 14 which journal each shaft S for rotation. Each shaft assembly S incorporates a shaft 15 which, at one end, has a solenoid operated variator drive sheave 16 fixed to it in the usual manner for receiving a drive belt 17. Drive belts 17 are driven by an electric, or other suitable, motor in the usual manner at the same speed of rotation but the speed of rotation of each may be adjusted equally with adjustment of the sheaves 16. Mounted on each of the drive shafts 15 to rotate therewith, are opposite end hubs or stubs 18 and 19 which, it will be noted in Figure 2, have portions eccentrically disposed relative to the axis x to provide offset weight portions 18a and 19a. Locking ring assemblies 20 secured by bolts 21 are provided in end recessed portions 22 in the hub ends 18 and 19 to unite the shaft 15 and hubs 18 and 19 for conjoint rotation. The stub shaft portions 18 and 19 are also recessed as at 23 to receive roller bearings 24 supporting a circumferentially movable collar 25 which also has a weight portion eccentric with respect to axis x. The offset weight portion 25a of collar 25 is equal in weight to the combined offset weights 18a and 19a of stub shaft portions 18 and 19. The offset weights of the collar 25 and stubs 18 and 19, thus, balance one another in the Figure 2 position when the offset weight portion 25a is 180° removed from the offset weight portions 18a and 19a of stub shafts 18 and 19.

The inner end of stub shaft 19 is concentrically bored to form a cylinder C in which the reduced end 26a of a shouldered piston 26 is received. At its opposite end, piston 26 is annularly recessed as at 27 to provide a spring well for one end of a coil spring 28 whose opposite end is received in a spring well 29 provided in the stub shaft 18. Axial guide pins (not shown) may be provided for the spring 28.

Weight collar 25 is rotatable on bearings 24, from a position 180° removed from the eccentric portions of shafts 18 and 19 in which the balanced condition is achieved and no vibration is transmitted to bearings 14, through 180°, for example, to a position in which maximum vibration is transmitted to the bearings 14 because the combined eccentric weight portions 18, 19, and 25 are in a position of circumferential alignment. Provided in the collar 25, is a bore 30 receiving a roller 31 mounted on a pin 32 whose inner end is received in a helical groove 33 provided in the piston member 26. The helical groove 33 extends 180° in piston 26 to rotate collar member 25 from a null position to a position in which maximum vibration is achieved, when the piston 26 is moved from the null position in which it is shown in Figure 2 from right to left against the bias of spring 28.

Provided in the shaft 15, is an axial bore 34 connecting with the radial bore 35 leading to the one end 26b of cylinder C. It is to be understood that air under a controlled pressure may be transmitted through a stationary coupling 36 within which reduced shaft end 15a is rotatable. While air is disclosed as the pressure transmitting medium it should be understood that other suitable fluids may be employed. As Figures 1 and 2 indicate, an air hose 37 leading to each shaft assembly S from air dispensing valve 38 is employed to supply air under the pressure desired for a particular operation to the cylinder C. Solenoid operated valve V, which has ports venting to atmosphere, is controlled by a programmable logic controller PLC. Spring 28 is of a predetermined rate, and its compression to the desired degree to achieve the intensity of vibration desired, is determined by the pressure of the air admitted via ports 34 and 35. This pressure is varied by the control 38 during each cycle of the machine when it is determined, for instance, to operate the machine in accordance with a cycle such as disclosed in Figure 4 (which will be later described). Seal rings 39 are provided to seal the cylinder C. The capability that the machine enjoys of achieving optimum intensity of vibration for the particular operation being performed, provides a machine which can often be adjusted to decrease the noise of operation of the machine, where this is desirable. The machine is capable of vibration at an increasing intensity during the filling of the mold from a feed box FB to achieve the desired uniformity of filling which promotes uniformity in the compaction portion of the cycle.

A typical cycle of operation is diclosed in Figure 4 where it will be noted that approximately a half a second is required to move the material feed box over the empty mold. During this time, each drive shaft 15 is being continuously driven at the selected speed by drive sheave 16 and the collar 25 of each shaft assembly S is in the position indicated in Figure 2 in which the eccentric weight portion 25a of collar 25 counterbalances the eccentric weight portions 18a and 19a of stub shafts 18 and 19 which rotate with the shaft 15. When the feed box is in position, air under the predesignated pressure, is fed from the valve 38 through ports 34 and 35 to move the pistons 26 from right to left in Figure 2 to the extent of 70% of their permissable movement. This revolves the collar 25 through about 126° and achieves an intensity of vibration equivalent to about 70% of maximum, due to the composite offset effect of the eccentric portion 25a of collar 25 with respect to the eccentric portions 18a and 19a of stub shafts 18 and 19. This intensity is increased slightly before rising to full intensity. The spring 28 of predetermined rate controls the axial position of piston 26. With this sytem as, for instance, opposed to a double-acting hydraulic system, there is no need to return oil to a reservoir (which takes time). Further the presence of air in a hydraulic line, variations in oil temperature, and line leaks, which all can affect the metered volume are not problems. The control achieved is particularly critical in machines in which a pair of shafts must operate in synchronism and a common valve needs to be used to ensure that they actuate at the same instant.

Figure 4 demonstrates that filling is completed in two seconds and the air pressure admitted through lines 34 and 35 is increased to move the piston 26 further from right to left to a position in which the eccentric weight portion of 25a of collar 25 and the eccentric weight portions 18a and 19a of stub shafts 18 and 19 are in alignment so that maximum vibration is exerted during rotation of the shaft assemblies S. At the end of four seconds the supply of air through passages 34 and 35 is cut off, and the air pressure in these lines is bled to atmosphere via valve 38 so that spring 28 restores the piston 26 to the Figure 2 position with weight portions 25a, 18b and 19b now in a balanced or null position. No vibration is transmitted via the bearings 14 to the mold box 10 at this time when stripping of the product from the mold is being accomplished, even though the shaft 15 continues to be driven at the designated speed. With the present construction, the motor driving belts 17 need not be started and stopped, and no brakes need be utilized. The vibration obtained is virtually vertical in character with no destabilizing lateral characteristics.

While one cycle has been illustrated, many others will be used. Typically filling will take place in from 3/4 to 2-1/2 seconds and compaction from 1-1/2 to 3-1/2 seconds. The speed of rotation of shafts 15 can also be varied by the PLC via adjustment of the sheaves 16 to change the frequency of vibration. The program for a given operation will consider both the frequency and amplitude of vibration.

In an alternate operation which is indicated by the chain lines in Figure 4, the intensity of vibration during the time of compacting vibration may be varied in the manner indicated at y, for example, for a particular product. The change may be made while the machine is operating.

While one embodiment of the invention has been de-scribed in detail, it will be apparent to those skilled in the art that the disclosed embodiment may be modified. There- fore, the foregoing description in all aspects is to be considered exemplary rather than limiting in any way, and the true scope of the invention is that defined in the following claims.

Claims

1. In a cement block molding machine having a vibratible frame with a mold box incorporating molding cavities therein for a cement mix which is to be densified in the cavities; the combination comprising:

a. at least one vibration causing shaft assembly supported on said frame to impart vibrating motion thereto;

b. bearings on said frame for journaling the ends of said shaft assembly;

c. drive means connected with said shaft assembly for driving said shaft assembly in continuous rotation;

d. said shaft assembly comprising opposite end stubs having circumferentially fixed portions eccentric to the axis of rotation of said shaft assembly and a circumferentially movable balancing mass mounted for rotation on said stubs for movement between circumferential positions in which said mass substantially balances the centrifugal force imparted eccentrically by said eccentric portions of the stub shafts to produce a null level of vibration and a second position in which densifying vibration is produced, the said mass in the first position being substantially 180° opposite the eccentric portions on the stub shafts;

e. one of said stub shafts being recessed to provide a piston cylinder with a piston therein;

f. means interconnecting said piston and mass to produce rotary motion of said mass relative to the stub shafts with axial movement of the piston in said cylinder, to move said mass from a balancing position in relation to said eccentric portions toward a radially offset position;

g. spring means of predetermined rate opposing axial movement of said piston and operative to move said piston in an opposite direction to restore said piston and mass when pressure on the piston is released;

h. and fluid pressure supply means for supplying fluid under a predetermined pressure to one end of said piston in opposition to said spring means to control the axial position of said piston and consequentially the circumferential position of said mass relative to said eccentric portions of the stubs via said spring.

2. The invention of claim 1 wherein said spring means is a coil spring and said piston and said opposite stub are recessed to provide opposing spring wells for the opposite ends of said coil spring.

3. The invention of claim 2 wherein said shaft assembly includes a radially inner shaft portion, and said stubs and piston are bored to receive it; said piston and coil spring being in a surrounding position relative to said shaft portion.

4. The invention of claim 3 wherein said shaft portion has radially enlarged shaft sections at its ends and said stubs have enlarged recesses to receive them; there being rings on the outboard sides of said enlarged shaft sections connected to confine relative axial movement of said stubs and shaft portion.

5. The invention of claim 1 wherein said fluid pressure supply means is a source of air under pressure.

6. The invention of claim 5 wherein a pair of said vibration causing shaft assemblies are mounted by said frame at opposite ends thereof; and a valve connected between said source and the piston chamber in each stub provides an equal pressure at the same instant to the piston chamber in each stub.

7. The invention of claim 1 wherein said interconnecting means comprises a helical slot in said piston and a depending pin protruding from said mass, said slot extending substantially 180°.

8. A concrete product molding machine having a vibratible frame with a mold box incorporating molding cavities therein supported above a pallet member, and mechanism for supplying a cementitious mix to be molded and densified to said cavities; the system comprising:

a. at least one vibration causing shaft assembly journaled on the vibratible frame to impart vibrating motion thereto;

b. a drive connected with the shaft assembly for driving the shaft assembly in continuous rotation about an axis of rotation;

c. said shaft assembly mounting a centrifugally relatively fixed portion eccentric to the axis of rotation of the shaft assembly and a circumferentially movable balancing mass mounted off-axis for rotation on the shaft assembly between circumferential positions in which said mass substantially balances the centrifugal force imparted eccentrically by the fixed eccentric portion to produce a null level of vbration and a second unbalanced position in which densifying vibration is produced, said mass in the first position being substantially 180° opposite the eccentric portion;

d. the said shaft assembly having a cylinder with a piston therein, one of which is axially movable relative to the other;

e. means interconnecting said axially movable one of the cylinder and piston with said mass to produce rotary motion of said mass in one circumferential direction relative to the
fixed eccentric portion to move said mass from a balancing position relative to said eccentric portion toward a radially offset position;

f. spring means of pre-determined rate opposing axial movement of said movable one of the piston and cylinder and operative to move it in an opposite direction to restore said mass; and

g. fluid pressure supply means for supplying fluid under a predetermined pressure to said cylinder in opposition to said spring means to control the axial position of the movable one of said piston and cylinder, and consequentially the circumferential position of said mass relative to said eccentric portion, via said spring means.

9. A method of programmably vibrating a ce-

ment block molding machine having a vibratible frame with a mold box incorporating at least one molding cavity for a cement mixture which is to be densified in the cavity; at least one vibration-causing shaft assembly supported on the frame to impart vibrating motion thereto; bearings on the frame for journaling the ends of the shaft assembly; a drive connected with the shaft assembly for driving the shaft assembly in continuous rotation; the shaft assembly mounting a relatively centrifugally fixed portion eccentric to the axis of the shaft assembly and a circumferentially movable balancing mass mounted for rotation on the shaft assembly between circumferential positions in which said mass substantially balances the centrifigal force imparted eccentrically by the fixed eccentric portion to produce a null level of vibration and a second position in which densifying vibration is produced, the said mass in the first position being substantially 180° opposite the said eccentric portion; said shaft assembly having a cylinder with a piston therein, one of which is axially movable relative to the other; means interconnecting said axially movable one of the cylinder and piston with said mass to produce rotary motion of said mass in one circumferential direction relative to the fixed eccentric portion to move said mass from a balancing position relative to said eccentric portion toward a radially offset position; spring means of predetermined rate opposing axial movement of said movable one of the piston and cylinder and operative to move it in an opposite direction to restore said mass; and fluid pressure supply means for supplying fluid under a predetermined pressure to said cylinder in opposition to said spring means to control the axial position of the movable one of said piston and cylinder and consequentially the circumferential position of said mass relative to said eccentric portion via said spring means, the steps of:

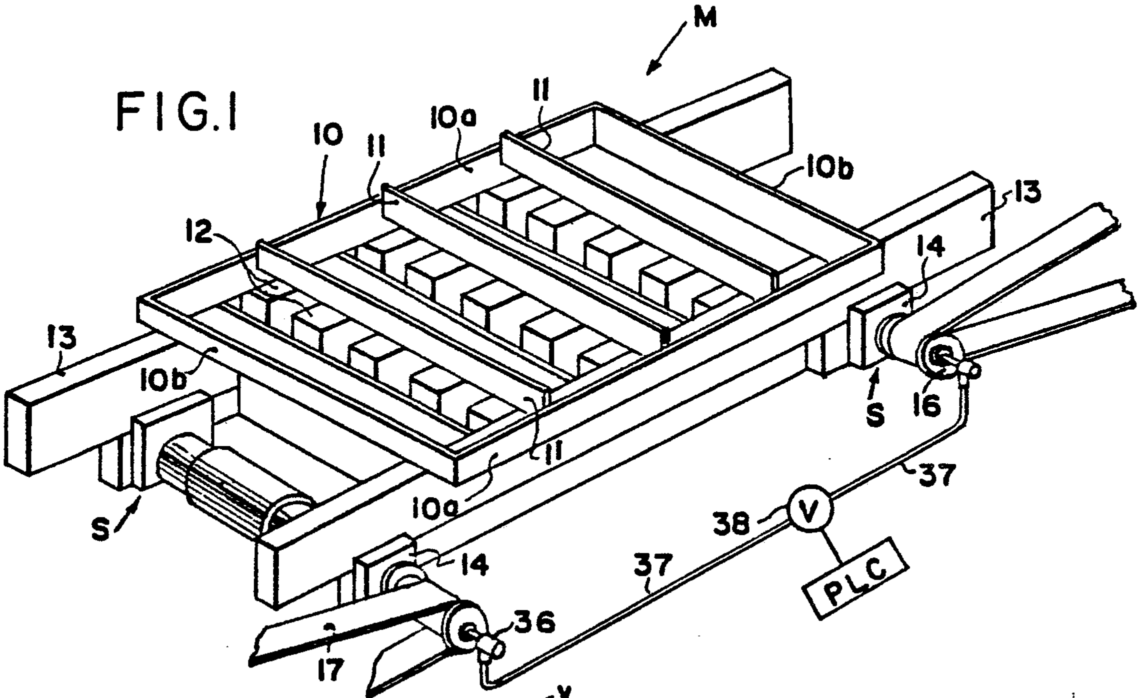
a. continuously rotating said shaft assembly; and

b. cyclically successively introducing fluid under a predetermined variable pressure to said cylinder and piston assembly in opposition to the force exerted by said spring to relatively move said mass and said eccentric portion from substantially a position of 180° circumferential opposition in which the vibration produced is substantially null to a position out of substantial centrifugal balance to produce densifying vibration.

10. The method of claim 9 including the step of varying the pressure of the fluid introduced to change the amplitude of the vibration imparted to the vibratible mold frame and mold box during each cycle.

11. The method of claim 10 including the step of changing the speed of rotation of said shaft assembly at the end of a cycle.

FIG.1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10a
11
10b
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14
37
36
17

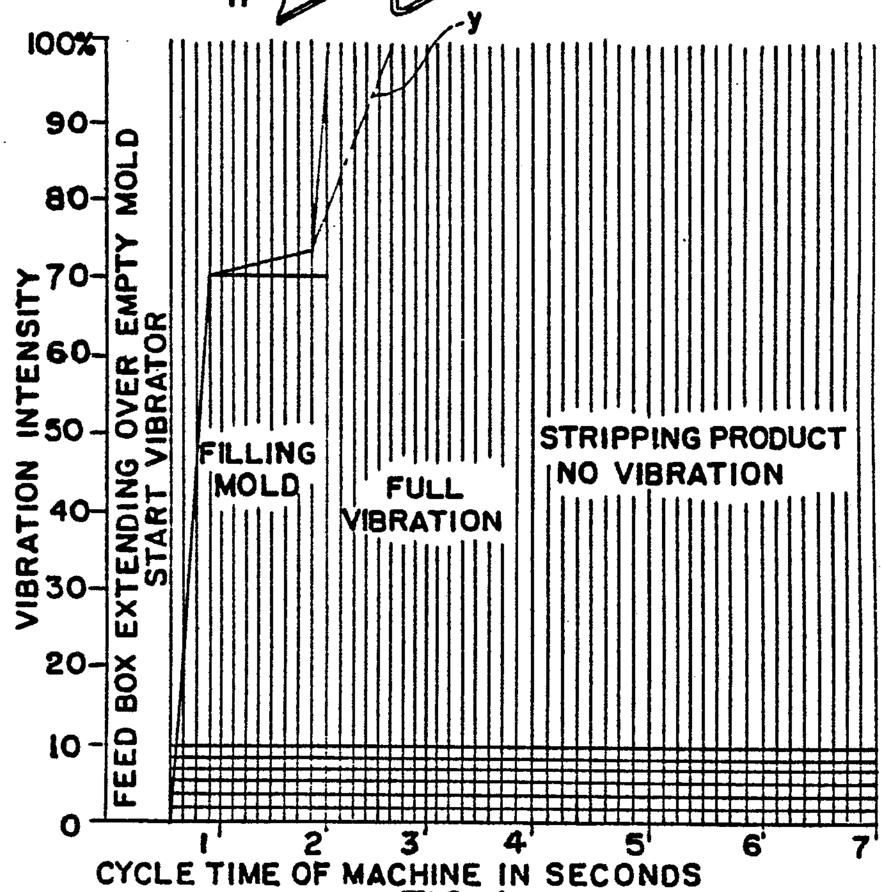
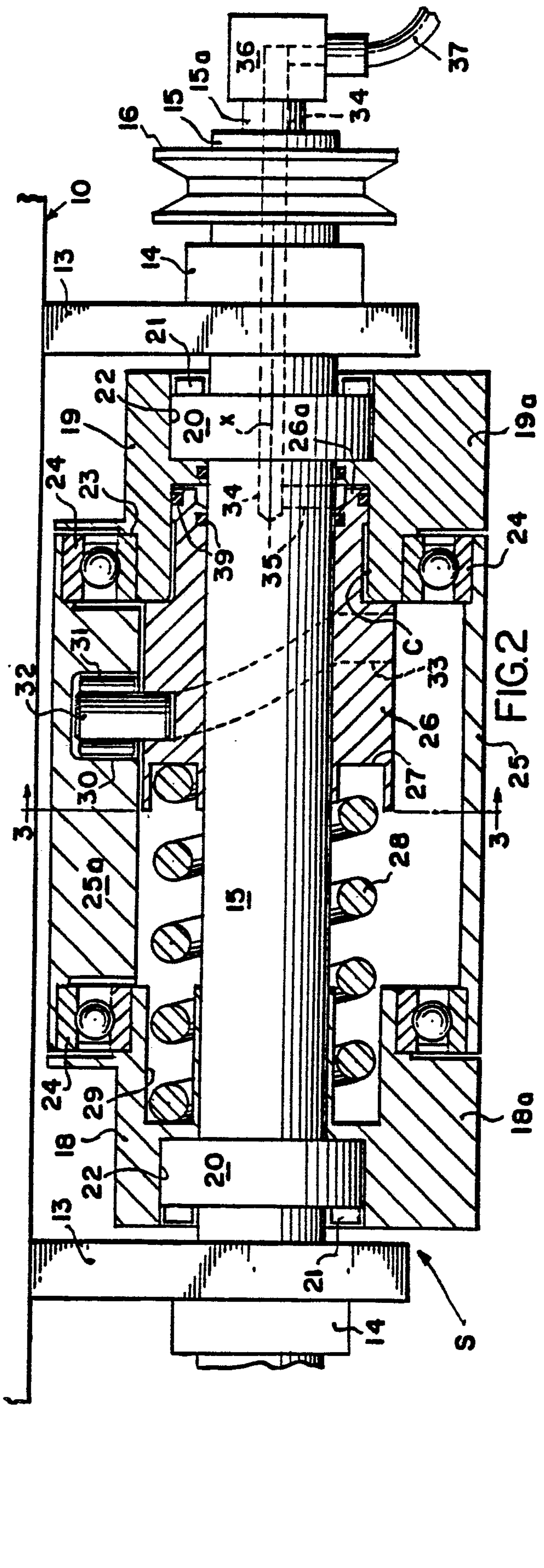

100%
90
80
70
60
50
40
30
20
10
0
VIBRATION INTENSITY
FEED BOX EXTENDING OVER EMPTY MOLD
START VIBRATOR
y
FILLING MOLD
FULL VIBRATION
STRIPPING PRODUCT
NO VIBRATION
1
2
3
4
5
6
7
CYCLE TIME OF MACHINE IN SECONDS

FIG.4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26a
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18
18a
S

FIG.2

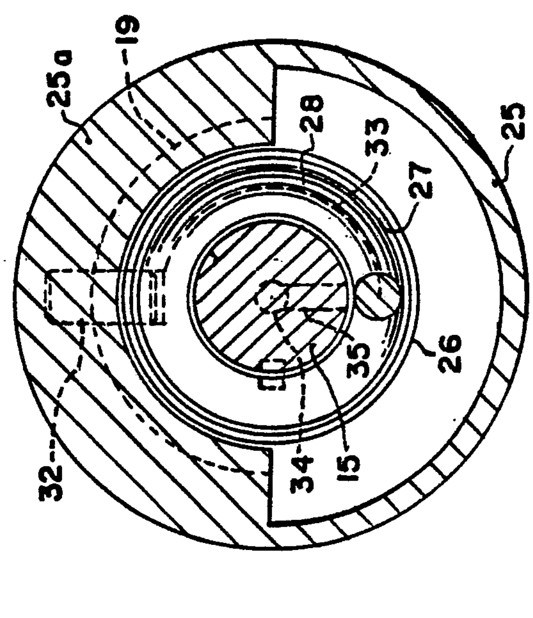
25a
19
28
33
27
25
32
34
35
15
26

FIG.3