Feb. 2, 1954

F. H. JACKMAN

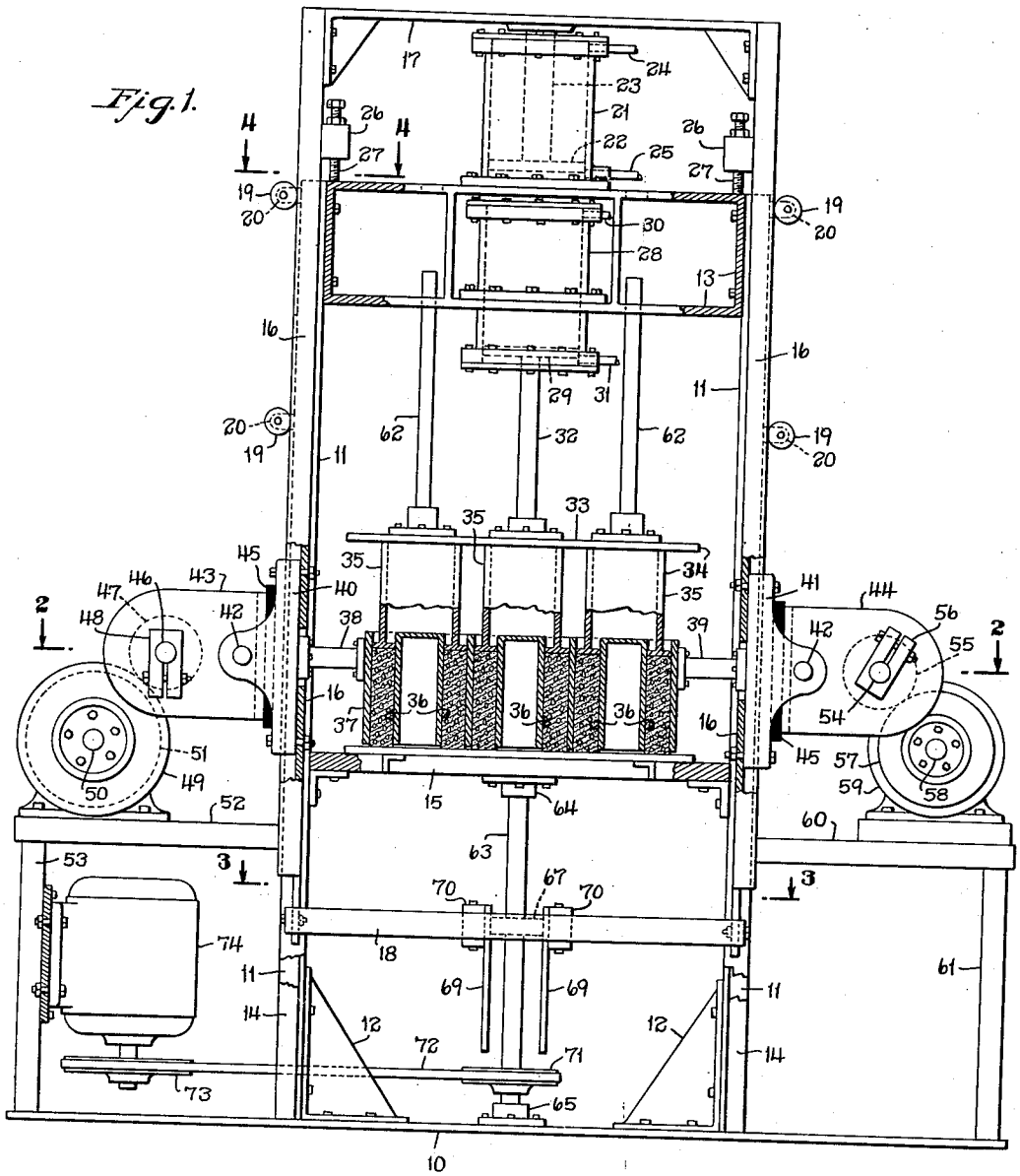
2,667,679

APPARATUS FOR MOLDING BUILDING BLOCKS

Filed June 1, 1949

4 Sheets-Sheet 1

Fig. 1.



Inventor

By Frederick H. Jackman

Seymour, Earle & Nichols

Attorneys

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4 Sheets-Sheet 2

Fig. 2.

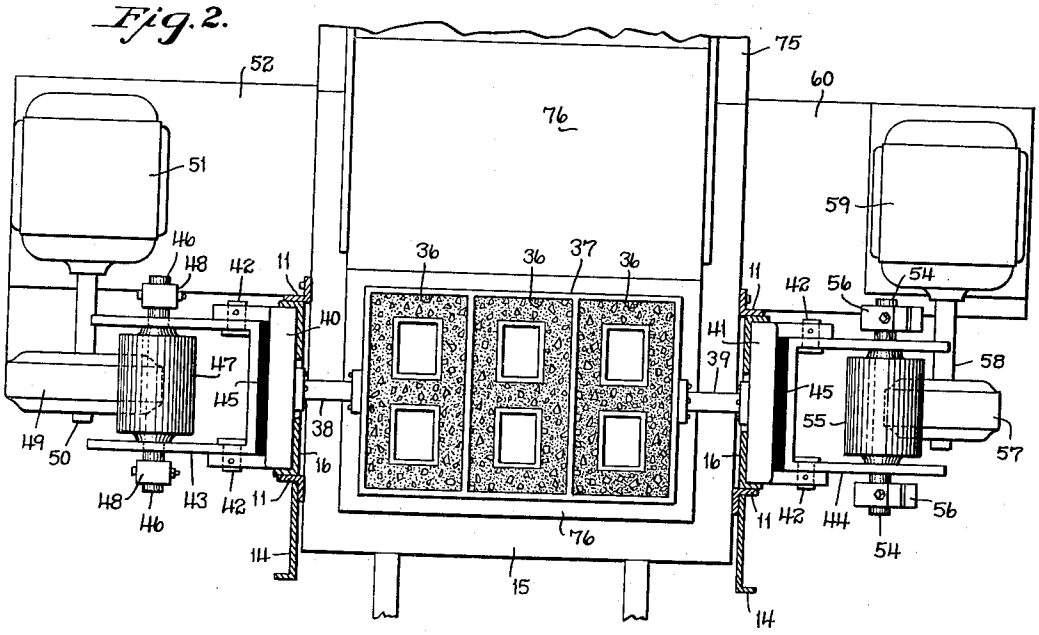
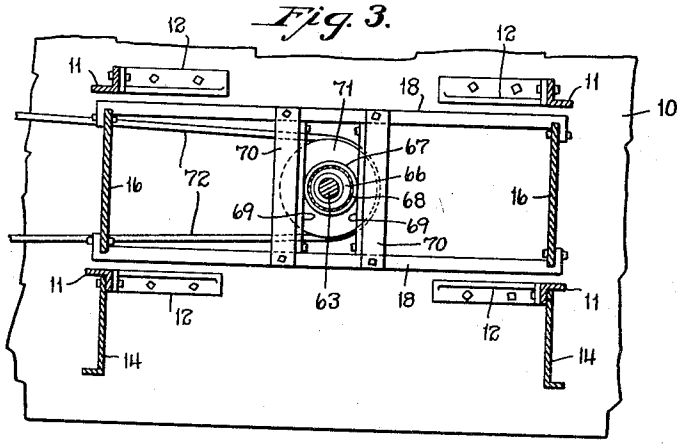


Fig. 3.



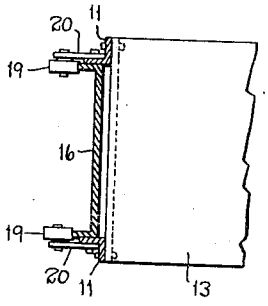


Fig. 4.

Inventor
Frederick H. Jackman
By Seymour, Earle & Nichols
Attorneys

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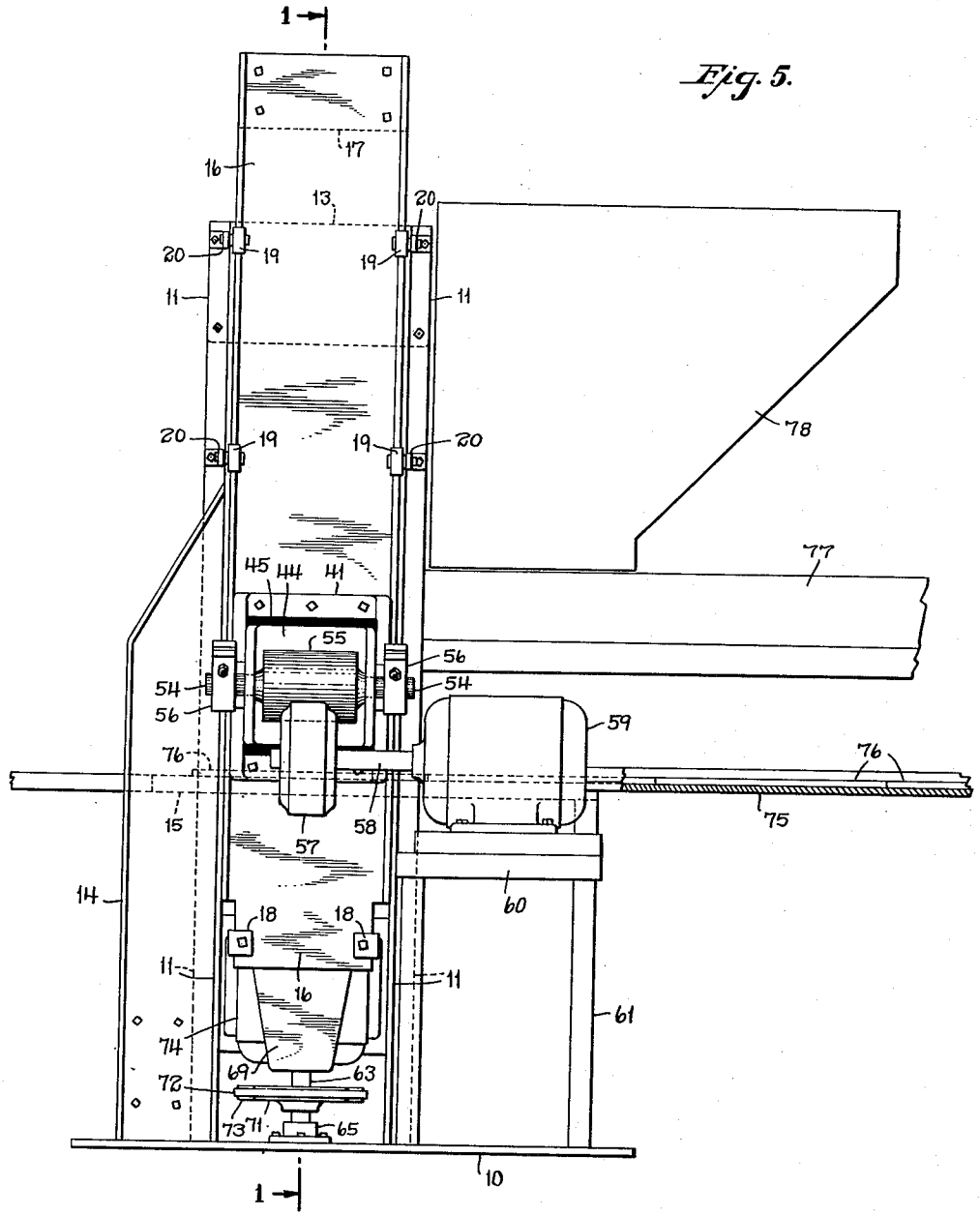
Fig. 5.



Inventor
Frederick H. Jackman
By Seymour, Earle & Nichols
Attorneys

Feb. 2, 1954

F. H. JACKMAN

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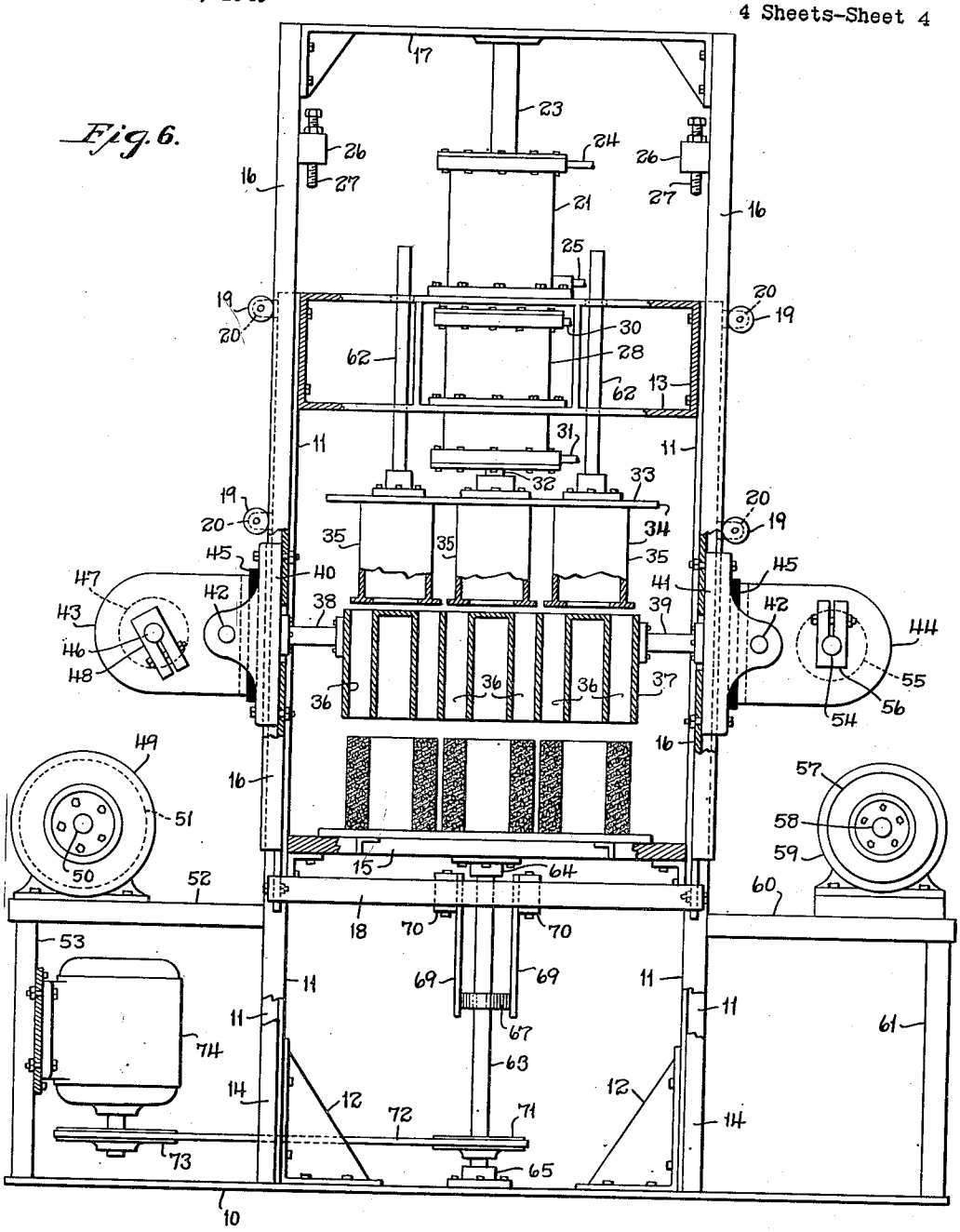
Fig. 6.



Inventor

Frederick H. Jackman

By Seymour, Earle & Nichols

Attorneys

Patented Feb. 2, 1954

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UNITED STATES PATENT OFFICE

2,667,679

APPARATUS FOR MOLDING BUILDING BLOCKS

Frederick H. Jackman, Santa Fe, N. Mex.

Application June 1, 1949, Serial No. 96,533

10 Claims. (Cl. 25—41)

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The present invention relates to improvements in apparatus for molding building-blocks and relates more particularly to apparatus for molding building-blocks from concrete mixes or mixtures of sand, pumice and the like, together with Portland cement or the like.

It has been the practice to produce building-blocks of the character referred to by vibrating mold-boxes or the like after charging the same with a damp mixture including Portland cement, in efforts to consolidate such mixture. It has further been proposed to apply multi-directional vibrations to such mold-boxes, which action however has fallen far short of producing optimum results.

Among other things, I have discovered that the consolidation of mixtures of the character above referred to may be accomplished not only more expeditiously and thoroughly, but with a much stronger resultant product by applying to a mold-box and the mix therein a plurality of vibratory forces of markedly different frequencies, in the manner as will be hereinafter described.

One of the main objects of the present invention is to provide a superior apparatus whereby building-blocks of the character referred to may be produced expeditiously and economically.

A further object of the present invention is to provide a superior apparatus of the character referred to whereby building-blocks of superior uniformity, density and strength may be produced.

Another object of the present invention is to provide a superior apparatus whereby building-blocks may be produced with minimum danger of injury to the operators and with minimum manual effort.

With the above and other objects in view, as will appear to those skilled in the art from the present disclosure, this invention includes all features in the said disclosure which are novel over the prior art.

In the accompanying drawings, in which certain modes of carrying out the present invention are shown for illustrative purposes:

Fig. 1 is a view mainly in front elevation of a molding machine embodying the present invention but with portions of the frame, mold-box, pressure-member and carriage in vertical section on the line 1—1 of Fig. 5 and with the parts in the position for molding cement blocks;

Fig. 2 is a broken transverse sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a broken sectional view taken on the line 3—3 of Fig. 1;

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Fig. 4 is a broken sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a view of the machine in side elevation; and

Fig. 6 is a view similar to Fig. 1 but showing the pressure-member and mold-box retired upwardly with respect to the newly-formed cement blocks.

The particular apparatus or molding machine chosen for illustration in the accompanying drawings for purposes of making clear a preferred form of the present invention, includes a relatively-heavy base-plate 10 from which upwardly extend four (more or less) frame-uprights 11, each rigidly attached in spaced relationship at their lower ends in any suitable manner to the base-plate 10 as, for instance, by means of gusset-plates 12, indicated in Figs. 1 and 6.

As is clearly indicated in Figs. 2 and 3, the frame-uprights 11 are spaced from each other in a rectangular pattern and are each of angle-iron form. The said frame-uprights extend in parallelism with each other and at their respective upper ends are rigidly coupled together by a crosshead 13, as is especially well shown in Figs. 1 and 6.

As indicated in Fig. 5, the front frame-uprights 11 may have their lower portions reinforced and braced by suitable brace-members such as 14.

At a point substantially one-third up from their respective lower ends, the frame-uprights 11 have secured to them a bed-plate 15 extending horizontally. In addition to holding the said frame-uprights in spaced relationship, the said bed-plate also provides a support upon which the concrete or equivalent building-blocks may be formed or cast, in a manner as will be hereinafter described.

Carried by the previously-described frame which comprises, in the main, the elements 10 to 15 inclusive, is a vertically-reciprocable carriage comprising, in the main, two relatively-wide vertical channels 16—16 which are parallel to each other and which are rigidly interconnected at their upper ends by a crosshead 17 and at their lower ends by crossbars 18—18, which latter are especially well shown in Fig. 3.

The channels 16—16 of the carriage are mounted with capacity for vertical movement between each end-pair of frame-uprights 11 in a manner which will be clear by reference to Figs. 2, 4 and 5. Each vertical channel 16—16 has the outer edges of its end-flanges riding against a plurality of antifriction rollers 19, each supported by means of a bracket 20 attached to the adjacent

one of the frame-uprights 11, as is especially well shown in Fig. 4.

Mounted centrally on top of the crosshead 13 of the frame is a cylinder 21 in which vertically reciprocates a piston 22 having an upwardly-extending piston-rod 23 connected to the central portion of the crosshead 17 of the carriage. The cylinder 21 has leading into it two tubes 24 and 25 at points respectively above and below the piston 22 so that fluid such as water, air, or the like, may be caused to force the piston either upwardly or downwardly as is desired. The admission of fluid under pressure beneath the piston 22 will serve to force the piston 22, piston-rod 23 and crosshead 17 upwardly, thereby raising the entire carriage comprising the elements 16, 17 and 18 upwardly from the position in which they are shown in Fig. 1 into the position in which they are shown in Fig. 6. Under normal conditions, when it is desired to lower the carriage, gravity will serve this purpose provided fluid is permitted to escape through the tube 25.

For the purpose of accurately predetermining the lowermost position of the carriage, each channel 16 is provided with an inwardly-projecting lug 26, in which is vertically mounted one of two stop-screws 27—27. The said stop-screws 27—27 are each adapted to engage with the upper surface of the crosshead 13 of the frame, under conditions as will hereinafter appear.

Also carried by the crosshead 13 of the frame in axial alignment with the cylinder 21, is a cylinder 28 having a piston 29 reciprocating therein. The said cylinder is provided with tubes 30 and 31 respectively leading into its upper and lower ends and through which fluid may be caused to flow to effect either the raising or lowering of the said piston.

Projecting downwardly from the piston 29 and through the bottom of the cylinder 28 is a piston-rod 32 rigidly secured at its lower end to the upper surface of the head-plate 33 of a pressure-member generally designated by the reference character 34. Depending from the head-plate 33 are three (more or less) pressure-feet 35 of hollow form and respectively adapted to freely fit into the adjacent one of three S-shaped cavities 36 formed vertically in a mold-box 37. The particular shape of the cavities 36 may vary widely and in the present instance is of substantially-standard form and best apparent by reference to Fig. 2.

The mold-box 37 above referred to is carried by the carriage which comprises the elements 16, 17 and 18, by being provided at its respective opposite ends with oppositely-projecting supporting-studs 38 and 39. The said supporting-studs respectively have their outer ends rigidly attached to the base of similar yokes 40 and 41 rigidly mounted against the respective outer faces of the adjacent channels 16 of the carriage.

Respectively pivotally mounted in the yokes 40 and 41 by means of studs 42 are pivotal yokes 43 and 44 which are adapted to pivot slightly in a vertical plane around the studs 42 as a center. Interposed between the outer face of the base of the yoke 40 and the inner face of the base of the yoke 43 is a resilient pad 45 of rubber or equivalent material. A similar pad 45 is interposed between the inner face of the base of the yoke 44 and the outer face of the base of the yoke 41—all as is especially well shown in Fig. 2.

Journaled in the respective arms of the pivotal yoke 43 is a vibrator-shaft 46 having rigidly attached thereto a wheel 47 which is located between the side-arms of the yoke 43 and which, through the intermediary of the yokes 43 and 40, is carried by the adjacent channel 16 of the carriage. Firmly clamped to the respective opposite ends of the vibrator-shaft 46 are vibrator-weights 48—48 (Fig. 2) which are driven by the wheel 47 in a manner as will presently appear.

The periphery of the wheel 47 above described is adapted to normally rest against the periphery of a drive-wheel 49 rigidly mounted upon the forward end of a motor-shaft 50 extending in parallelism with the vibrator-shaft 46 above described and located below and slightly outwardly with respect thereto—as is especially well shown in Fig. 1.

The motor-shaft 50 projects forwardly from an electric motor 51 or other suitable source of power, and the said motor, in turn, is secured to the upper face of a platform 52 extending horizontally outwardly from the rear portion of the frame and supported at its outer end on one or more posts 53—as is indicated in Figs. 1 and 6.

The pivotal yoke 44 in a manner similar to the pivotal yoke 43, has journaled in its respective opposite sides a vibrator-shaft 54 having a wheel 55 rigidly attached thereto intermediate the side-arms of the yoke 44. At its respective opposite ends exteriorly of the yoke 44, the vibrator-shaft 54 has rigidly attached thereto vibrator-weights 56—56 functioning in a manner similar to the vibrator weights 48—48 before referred to.

The periphery of the wheel 55 is adapted to engage with the periphery of a drive-wheel 57 mounted upon the forward end of a motor-shaft 58 extending in substantial parallelism with the vibrator-shaft 54. The shaft 58 forms a feature of an electric motor 59 or other suitable drive-means. The motor 59 is attached to the upper surface of a platform 60 extending horizontally from the side of the apparatus opposite the platform 52 and supported on one or more suitable posts 61.

Both of the drive-wheels 49 and 57 are preferably in the form of air-inflated rubber-tired wheels to thereby provide desirable resiliency and frictional coaction with the wheels 47 and 55 respectively.

In addition to having rigidly connected to it the piston-rod 32, the pressure-member 34 has rigidly upstanding from it on each of the respective opposite sides of the said piston-rod, one of two guide-rods 62—62 adapted to extend with a sliding fit through the crosshead 13 of the frame—as is especially well shown in Figs. 1 and 6. The said guide-rods 62 serve to aid in maintaining the pressure-member 34 in registration with the cavities 36 in the mold-box 37.

Extending vertically between the central portion of the bed-plate 15 and the base-plate 10 is a vibrator-shaft 63. The said vibrator-shaft is journaled at its upper end in an antifriction-bearing 64 attached to the underface of the said bed-plate 15 and journaled at its lower end in an antifriction-bearing 65 secured to the upper face of the base-plate 10. Rigidly attached to the vibrator-shaft 63 eccentrically with respect thereto, is an inner ball-race 66 surrounded by an outer ball-race 67. Interposed between the outer surface of the inner ball-race 66 and the inner surface of the outer ball-race 67, is a plurality of balls or other suitable rolling-members 68, as is indicated in Fig. 3.

Respectively located on opposite sides of the vibrator-unit comprising the parts 66, 67 and 68

are thrust-plates 69—69 which are rigidly attached at their upper ends to transverse bars 70—70 extending in spaced relationship transversely between the crossbars 18—18 at the lower ends of the channels 16 of the carriage, as is especially well shown in Fig. 3. The thrust-plates 69—69 are spaced from each other a distance just sufficient to slidably accommodate between them the outer ball-race 67.

Rigidly secured to the vibrator-shaft 63 adjacent its lower end is a grooved pulley 71 receiving an endless belt 72 which also extends around a grooved pulley 73 driven by an electric motor 74 or other suitable source of power.

Registering with and projecting rearwardly from the bed-plate 15 of the frame is a platform 75 as is indicated in Fig. 5, and on which may be stored a plurality of pallets 76 preparatory to being fed forwardly onto the upper surface of the bed-plate 15, upon which latter one such pallet is shown.

While forming no essential feature of the present invention, there is preferably employed in conjunction with the present invention, a suitable type of feeder such as 77 indicated in Fig. 5 and by means of which the mold-box 37 or its equivalent may be charged with a moist concrete mix containing Portland cement. In turn, the feeder 77 may be supplied by means of a hopper 78 also indicated in Fig. 5.

Operation

For convenience of description, let it be assumed that the carriage is lowered until its stop-screws 27—27 rest upon the upper surfaces of the crosshead 13 of the frame thereby holding the under edge of the mold-box 37 spaced slightly from the pallet 76 then located upon the bed-plate 15, as is indicated in Figs. 1, 2 and 6. The clearance between the lower surfaces of the mold-box 37 and the upper surface of the pallet 76 will preferably be in the order of $\frac{1}{8}$", for purposes as will hereinafter appear.

It is to be further assumed that the cavities 36 in the mold-box 37 have been previously filled with the concrete mix referred to and that the pressure-member 34 is continuously subjecting the said mix to downward pressure by fluid-pressure in the cylinder 28 to maintain the bottoms of the pressure-feet 35 in engagement with the upper surface of the aggregate during the consolidation thereof, as is shown in Fig. 1.

It should further be assumed that all of the electric motors 51, 59 and 74 are energized.

Under the conditions above described, the concrete mix in the mold-box 37 will be under continuous pressure and the vibrator-weights 48—48 and 56—56 will be rapidly rotating with an off-center effect thereby creating vibration. Simultaneously, the eccentric composed of the elements 66, 67 and 68 will be also causing the lower portion of the carriage to vibrate, with the result that the bed-plate 15 and the pallet 76 thereon will be vibrated in a direction lengthwise of the mold-box 37.

Considering all of the motors 51, 59 and 74 as being of substantially-identical speed, the drive-connections are such that the vibrator-weights 48—48 will revolve fastest, the vibrator-weights 56—56 will revolve at a lesser speed, while the vertical vibrator-shaft 63 will, in turn, rotate at a still slower speed. The three speeds referred to should, for best results, be materially different, namely, that the speed of a higher speed-vibrator should be not less than five percent over the speed of a lower speed-vibrator and be, if desired, many times as fast, and it has been found in large-scale commercial production work that the respective speeds referred to may be respectively 7200 R. P. M., 5400 R. P. M., and 3600 R. P. M., preferably with the vibrations out-of-phase so as to cause a minimum number of one set of vibrations to be canceled out by vibrations of another set. Other suitable relative speeds may, for instance, be as follows: 6065, 5775 and 5500; 2194, 1995 and 1900; 6535, 5940 and 5400; and 7500, 3000 and 1100.

As the off-center vibrator-weights 48—48 swing around under the driving force supplied by the motor 51, in addition to causing alternate compression and stretching forces on the adjacent stud 38, there will be created also forces tending to cause the yoke 43 to pivot about its studs 42—42, which pivotal action will be cushioned and restricted by the resilient pad 45. The vibratory effect, however, will be such as to give a perceptible vertical component to the stud 38 and also to the mold-box 37.

The vibrator-weights 56—56 will also function in the manner just described in connection with the vibrator-weights 48—48, although having a markedly different periodicity.

The combined vibratory effects of the weights 48—48, 56—56 and the elements 66—67—68 will be such as to impart to the mold-box 37 and its contents a heterogeneous commingling of vibrations. The said sommingled vibrations apparently apply to the aggregate multi-directional vibratory forces as may be observed by observing the surface of the concrete mix in the mold-box 37 prior to the lowering of the pressure-member 34.

The commingling of vibrations as above described, avoids the stratification of the concrete mix and effects its uniform consolidation in a manner markedly superior to what has been achieved by vibrations of substantially-uniform periodicity. The vibratory effects referred to result in not only the production of molded building-blocks with much greater rapidity, but in building-blocks which are free of stratification, voids, and which possess an ultimate strength, when cured, far above that achieved by the average building-block casting machine with standard vibratory systems.

After the lapse of a suitable brief period, the concrete mix in the mold-box 37 will be thoroughly compacted and formed, whereupon water, air, or other fluid may be introduced beneath the piston 22 thereby causing the same to lift the entire carriage comprising the elements 16, 17 and 18, together with the mold-box 37, while the pressure-member 34 remains in its previously-described depressed position.

The raising of the mold-box 37 as above described will strip the newly-molded cement blocks from the said mold-box, which latter will move completely clear of the said blocks into substantially the position in which it is shown in Fig. 6.

Shortly after the initiation of the lifting of the carriage as just above described, the wheels 47 and 55 will respectively lose engagement with their drive-wheels 49 and 57, thereby automatically stopping (after a short coasting period) the swinging of the vibrator-weights 48—48 and 56—56. However, during the raising of the mold-box as above described, and the stripping of the newly-molded building-blocks therefrom, the vibrator-unit comprising the elements 66, 67 and 68 will continue to vibrate to such a degree as will

readily free the newly-cast building-blocks from the cavities 36 in the mold-box 37.

The pressure-member 34 may now be lifted into its retired position (Fig. 6) by supplying water, air or the like under pressure beneath the piston 29.

The pallet 76 upon which the newly-cast building-blocks are resting may now be removed and a fresh pallet moved forwardly into proper position from the platform 75.

The entire carriage, comprising the elements 16, 17 and 18, may now be lowered until its stop-screws 27—27 engage with the crosshead 13 of the frame, whereupon the mold-box 37 will again be restored to the position in which it is shown in Fig. 1, preparatory to being recharged with a suitable mix in any suitable manner such, for instance, as by the actuation of the feeder 77.

The lowering of the carriage as above described, will automatically re-engage the wheels 47 and 55 respectively with the drive-wheels 49 and 57, thereby subjecting the mix to the simultaneous action of three vibratory forces of different frequencies respectively.

After the cavities 36 in the mold-box 37 have been recharged with mix, the pressure-member 34 may be lowered and kept under downward pressure by supplying water, air, or the like into the cylinder 28 at a point above the piston 29.

To achieve the optimum results, it is important to maintain the mold-box 37 out of contact with the pallet 76 or its equivalent during the vibrating action referred to. Furthermore, it is of great importance to continue the vibration of the mold-box 37 during the stripping of the newly-cast building-blocks therefrom, since, by means of the present apparatus and method, the aggregate is so firmly consolidated and packed as to be very difficult to strip in the absence of the continued vibratory force referred to.

The invention may be carried out in other specific ways than those herein set forth without departing from the spirt and essential characteristics of the invention, and the present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

I claim:

1. An apparatus for molding building-blocks, including in combination: a frame having means designed and adapted to support a wet concrete mix; a drive-wheel associated with the said frame; a carriage movable with respect to the said frame, support-means and drive-wheel; a mold-box carried by the said carriage and movable therewith toward and away from the said support-means; a vibrator also carried by the said carriage and connected to the said mold-box to vibrate the same; and a wheel connected to the said vibrator to operate the same, the said wheel being carried by the said carriage and constructed and arranged to engage with the said drive-wheel when the said movable carriage is in an advanced position and to disengage from the said drive-wheel when the said carriage is retired.

2. An apparatus for molding building-blocks, including in combination: a frame having means designed and adapted to support a wet concrete mix; a drive-wheel associated with the said frame; a carriage movable with respect to the said frame, support-means and drive-wheel; a mold-box carried by the said carriage and movable therewith toward and away from the said support-means; adjustable stop-means holding the said mold-box spaced from the said support-means when the said carriage is advanced; a vibrator also carried by the said carriage and connected to the said mold-box to vibrate the same; and a wheel connected to the said vibrator to operate the same, the said wheel being carried by the said carriage and constructed and arranged to engage with the said drive-wheel when the said movable carriage is in an advanced position and to disengage from the said drive-wheel when the said carriage is retired.

3. An apparatus for molding building-blocks, including in combination: a frame having means designed and adapted to support a wet concrete mix; a plurality of drive-wheels associated with the said frame; a carriage movable with respect to the said frame, support-means and drive-wheels; a mold-box carried by the said carriage and movable therewith toward and away from the said support-means; a plurality of vibrators also carried by the said carriage and connected to the said mold-box to vibrate the same; and a plurality of wheels respectively connected to the said vibrators to operate the same, the said wheels being carried by the said carriage and constructed and arranged to respectively engage with the said drive-wheels when the said movable carriage is in an advanced position and to disengage from the said drive-wheels when the said carriage is retired.

4. An apparatus for molding building-blocks, including in combination: a frame having means designed and adapted to support a wet concrete mix; a plurality of drive-wheels associated with the said frame; a carriage movable with respect to the said frame, support-means and drive-wheels; a mold-box carried by the said carriage and movable therewith toward and away from the said support-means; adjustable stop-means holding the said mold-box spaced from the said support-means when the said carriage is advanced; a plurality of vibrators also carried by the said carriage and connected to the said mold-box to vibrate the same; and a plurality of wheels respectively connected to the said vibrators to operate the same, the said wheels being carried by the said carriage and constructed and arranged to respectively engage with the said drive-wheels when the said movable carriage is in an advanced position and to disengage from the said drive-wheels when the said carriage is retired.

5. An apparatus for molding building-blocks, including in combination: a frame having means designed and adapted to support a wet concrete mix; a pair of drive-wheels associated with the said frame respectively adjacent the opposite ends of the said support-means; a carriage movable with respect to the said frame, support-means and drive-wheels; a mold-box carried by the said carriage and movable therewith toward and away from the said support-means; a pair of vibrators also carried by the said carriage and respectively connected to the opposite ends of the said mold-box to vibrate the same; and a pair of wheels respectively connected to the said vibrators to operate the same, the said wheels being carried by the said carriage adjacent the respective opposite ends of the said mold-box and constructed and arranged to respectively engage with the said drive-wheels when the said movable carriage is in an advanced position and to disengage from the said drive-wheels when the said carriage is retired.

6. An apparatus for molding building-blocks,

including in combination: a frame having means designed and adapted to support a wet concrete mix; a pair of drive-wheels associated with the said frame respectively adjacent the opposite ends of the said support means; a carriage movable with respect to the said frame, support-means and drive-wheels; a mold-box carried by the said carriage and movable therewith toward and away from the said support-means; adjustable stop-means holding the said mold-box spaced from the said support-means when the said carriage is advanced; a pair of vibrators also carried by the said carriage and respectively connected to the opposite ends of the said mold-box to vibrate the same; and a plurality of wheels respectively connected to the said vibrators to operate the same, the said wheels being carried by the said carriage adjacent the respective opposite ends of the said mold-box and constructed and arranged to respectively engage with the said drive-wheels when the said movable carriage is in an advanced position and to disengage from the said drive-wheels when the said carriage is retired.

7. An apparatus for molding building-blocks, including in combination: a frame having means designed and adapted to support a wet concrete mix; a drive-wheel associated with the said frame; a carriage movable with respect to the said frame, support-means and drive-wheel; a mold-box carried by the said carriage and movable therewith toward and away from the said support-means; a first vibrator also carried by the said carriage and connected to the said mold-box to vibrate the same; a wheel connected to the said first vibrator to operate the same, the said wheel being carried by the said carriage and constructed and arranged to respectively engage with the said drive-wheel when the said movable carriage is in an advanced position and to disengage from the said drive-wheel when the said carriage is retired; and a second vibrator connected to the said support-means and constructed and arranged to continuously vibrate the same when the mold-box is in both its advanced and retired position with respect to the said support-means.

8. An apparatus for molding building-blocks, including in combination: a frame having means designed and adapted to support a wet concrete mix; a pair of drive-wheels associated with the said frame; a carriage movable with respect to the said frame, support-means and drive-wheels; a mold-box carried by the said carriage and movable therewith toward and away from the said support-means; a pair of vibrators also carried by the said carriage and respectively connected to the opposite ends of the said mold-box to vibrate the same; a pair of wheels respectively connected to the said vibrators to operate the same, the said wheels being carried by the said carriage and constructed and arranged to respectively engage with the said drive-wheels when the said movable carriage is in an advanced position and to disengage from the said drive-wheels when the said carriage is retired; and a third vibrator connected to the said support-means and constructed and arranged to continuously vibrate the same when the mold-box is in both its advanced and retired position with respect to the said support-means.

9. An apparatus for molding building-blocks,

including in combination: a frame having means designed and adapted to support a wet concrete mix; a pair of drive-wheels associated with the said frame; a carriage movable with respect to the said frame, support-means and drive-wheels; a mold-box carried by the said carriage and movable therewith toward and away from the said support-means; a pair of vibrators also carried by the said carriage and respectively connected to the opposite ends of the said mold-box to vibrate the same; a pair of wheels respectively connected to the said vibrators to operate the same, the said wheels being carried by the said carriage and constructed and arranged to respectively engage with the said drive-wheels when the said movable carriage is in an advanced position and to disengage from the said drive-wheels when the said carriage is retired; and a third vibrator connected to the said support-means and constructed and arranged to continuously vibrate the same when the mold-box is in both its advanced and retired position with respect to the said support-means; the vibrating speed of the one of the said vibrators being more than five percent greater than the vibrating speed of the other vibrator.

10. An apparatus for molding building-blocks, including in combination: a frame having means designed and adapted to support a wet concrete mix; a pair of drive-wheels associated with the said frame; a carriage movable with respect to the said frame, support-means and drive-wheels; a mold-box carried by the said carriage and movable therewith toward and away from the said support-means; a first and second vibrator also carried by the said carriage and respectively connected to the opposite ends of the said mold-box to vibrate the same; a pair of wheels respectively connected to the said vibrators to operate the same, the said wheels being carried by the said carriage and constructed and arranged to respectively engage with the said drive-wheels when the said movable carriage is in an advanced position and to disengage from the said drive-wheels when the said carriage is retired; and a third vibrator connected to the said support-means and constructed and arranged to continuously vibrate the same when the mold-box is in both its advanced and retired position with respect to the said support-means; the respective vibratory speeds of the said three vibrators differing by at least five percent.

FREDERICK H. JACKMAN.

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