July 15, 1958 E. BÜHRER 2,842,817

METHOD AND MEANS FOR THE MECHANICAL PREPARATION OF MOLDS FROM COMPRESSED GRANULAR MATERIAL

Filed Oct. 14, 1953 3 Sheets-Sheet 1

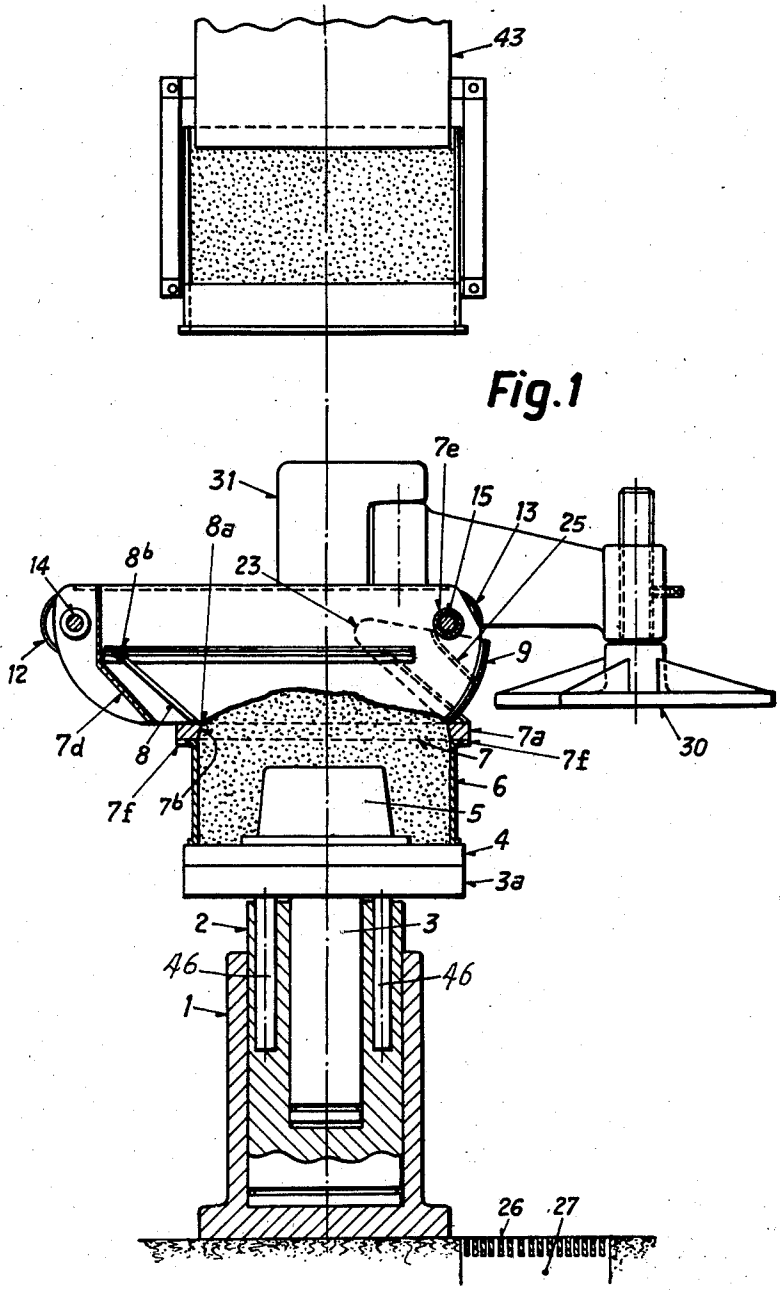

Fig. 1

INVENTOR:
ERWIN BÜHRER
BY Leon M. Strauss
AGT.

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Fig. 2

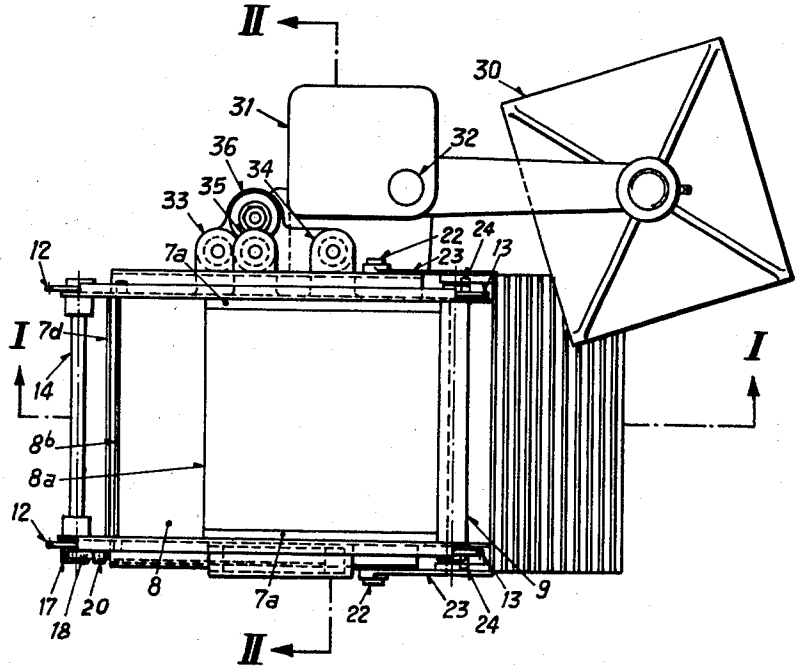
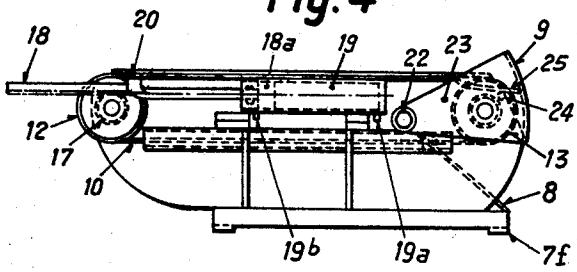


Fig. 4



INVENTOR:
ERWIN BÜHRER
BY Leon M. Straus
ATT.

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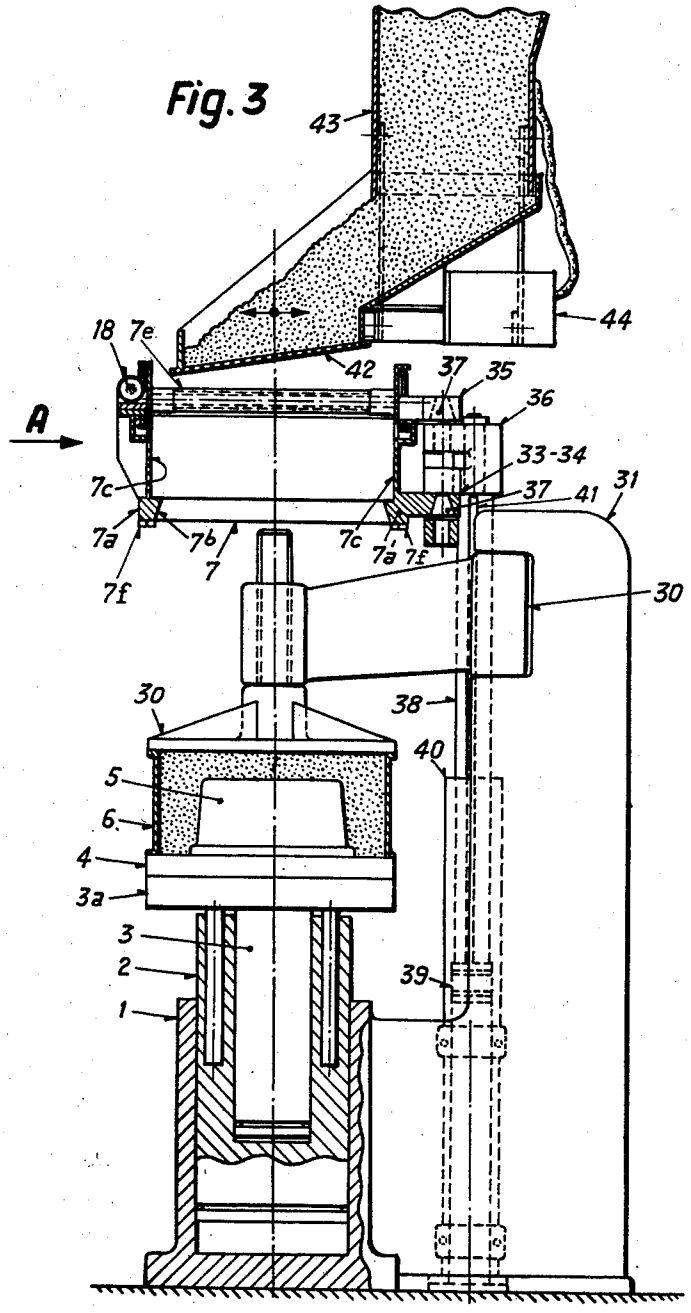
Fig. 3



INVENTOR:
ERWIN BÜHRER
BY Glenn M. Strauss
ATT.

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METHOD AND MEANS FOR THE MECHANICAL PREPARATION OF MOLDS FROM COMPRESSED GRANULAR MATERIAL

Erwin Bührer, Schaffhausen, Switzerland

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Claims priority, application Switzerland October 22, 1952

10 Claims. (Cl. 22—43)

This invention relates to methods of and means for producing molds from compressed, granular sand or like material.

It is well known that if granular sand, poured over a pattern on which a molding box is placed, is squeezed with a plate for the purpose of compressing it, it becomes extremely compressed over the high parts of the pattern, while the degree of compression is considerably less over the other parts. This phenomenon is aggravated still more in practice by the fact that the granular sand, on being poured, as generally happens, from silos arranged on a higher level, impinges directly upon the pattern in a dense "stream," and thus is already during the pouring in stage intensely pre-compressed over the higher parts of the pattern in particular, but also primarily in the middle of the molding box. Neither by jolting nor by attaching a filling frame can the resultant lack of uniformity in the compression be eliminated by a final compression process effected by squeezing. Also, the application of horizontal or spatial oscillations or of other means which have been used in practice, proves ineffective. In the case of higher patterns, one is therefore compelled either to use profiled pressure blocks or, between the preliminary compression by jolting and the final compression by squeezing, to remove the granular sand by hand from over the middle and upper parts of the patterns and to place it along the edge of the molding box, in order to reduce at least to within tolerable limits the lack of uniformity in compression which results after the sand has undergone the final compressing process by squeezing. A uniform compression, however, can also not be achieved for the reason that during pouring it has not proved possible successfully to place over the pattern a predetermined filling of granular sand, which is quantitatively always of the same weight, while simultaneously distributing it horizontally.

The suggestion has also already been made to fill the molding box with more sand than is required for the manufacture of the mold and to remove this surplus sand after the preliminary compression process. This suggestion, however, does not solve the problem, because the sand only accumulates to form a surplus in the middle of the molding box, while at those places which have to be subjected to a particularly accurate compression, no superfluous sand can be found. This is especially applicable to the edge of the molding box where the loosely filled sand slides off during the pouring process.

The purpose of the method envisaged in the invention is to eliminate, at least to a very great extent, the various disadvantages above set forth in order thereby to improve the precision and the surface quality of the mold and to contribute substantially to meeting the requirements for an automatically operating molding machine.

The method according to the invention for the manufacture of molds from granular sand, wherein said sand is subjected to a preliminary and a final compression process, is characterized primarily by an amount of granular sand being poured over the pattern in excess of

a predetermined amount necessary for the manufacture of the complete mold, this surplus being removed again between the preliminary and the final compression process. It is further characterized by the fact that the required amout of such granular sand surplus is supported by means which increase the height of the molding box in such a way that a surplus of granular sand can be poured over the whole surface of the pattern. The pouring in of the granular sand is advantageously effected by strewing or sieving. The method yields, after the preliminary compression and the removal of the surplus granular sand, a pre-compressed mold in which the granular sand projects high enough above the top edge of the molding box to enable the final compression process to be carried out; that is to say, there is, in respect of weight, less granular sand over the heightened parts of the pattern, but, on the other hand, more granular sand over the other parts of the said pattern, than with the methods usual hitherto. This improved horizontal distribution of the granular sand over the pattern before the final compression, which has, at least in part, to be effected by squeezing, enables a compression operating transversely to the direction of the squeeze to be dispensed with. This is all the more essential since tests have established that in the squeezing of granular sand the effect of a compression operating transversely to the direction of the squeeze is insignificant and cannot be increased, even at maximum squeeze power, on account of the internal resistance of the granular sand itself. Another consequence of this method, however, is that the amount of granular sand lying pre-compressed over the pattern has in proportion to its weight a definite, extremely regular size.

After the preliminary compression of the total quantity of granular material, composed of the predetermined quantity required for the complete mold plus the excess quantity, the elevation of the top surface of the mold over the pattern therein is lowered, and the elevation is again lowered when the excess material is removed and lowered further when the final compression takes place.

The method according to the invention provides, in addition, for the preliminary compression to be effected by forces resulting from the inertia of the sand, said forces acting, preferably at right angles to the surface of the pattern, in the granular sand itself, and further, for said forces to be produced by jolting. This increases the preliminary compression in the deep parts of the granular sand and decreases it in the parts above. Both these measures improve the pre-compressed mold as the starting material for final compression. So that, at the end, a compressed mold with the maximum degree of uniformity may be obtained from the granular sand, the method provides for the jolting blow to be elastically so strongly damped that in the preliminary compression process a deliberately more intense compression is produced in the lower part of the higher layers of the granular sand filling than in the bottom part of the lower layers of the said sand. In addition, the intensity of the preliminary compression is made so strong that the full compression sought after is already achieved in the lowest part of the highest layers of the granular sand filling. In this way, as calculations and tests show, the uniformity of compression is still further improved. It has, indeed, been further suggested that soft base plates be inserted between the jolting mass and the anvil, or that membrane-like spring plates be used. The effect of these base plates, however, is too slight to produce the difference in compression which depends on height. These well-known suggestions had the aim of reducing the pressure which the jolt blow produces on the anvil. It must be emphasized here that the damping of the jolt blow for the purpose of producing different degrees of compression intensity at different heights of the granular

sand only assumes significance when the present method is applied. The suggested strewing process increases the plasticity of the granular sand and thus the possibility of subsequently forming types, for instance, on patterns etc. Furthermore, in this process the preliminary compression of the granular sand on its being poured in is reduced and the distribution of the granular sand over the whole surface of the box becomes more even.

For applying the method a device is used which is characterized by the fact that a filling frame which can be set up on the molding box and a means for removing the surplus granular sand are provided.

A typical example of the device for applying the method according to the invention is illustrated in the attached drawings, in which:

Fig. 1 is an upright section of the device along line I—I in Fig. 2,

Fig. 2 is a horizontal projection of the device as shown in Fig. 1.

Fig. 3 is a side projection of Fig. 1, partly along line II—II in Fig. 2, and

Fig. 4 is a view of the filling frame seen in the direction of arrow A in Fig. 3.

Referring more particularly to Figs. 1 and 3 of the attached drawings, there is illustrated a molding machine, comprising a machine or base column 1, a press piston 2 and a jolt piston 3, the latter being raised by a pressure medium in a manner already familiar, and, after this pressure medium is released, falling back by its own weight on to press piston 2 which rests on the bottom of column 1 during the ramming process. All the control members and pipe lines are, for reasons of clarity, omitted from the figures. Jolt piston 3 carries a jolting table 3*a* on which lies a patern plate 4 with a pattern 5. On pattern plate 4 is supported the molding box 6 on the upper edge of which lies a filling frame 7. Said frame has on its lower side a downwardly depending reinforced, circumferential edge 7*a* which on its inner sides exhibits surfaces 7*b* running obliquely downwards and outwards and which serve to shape the sand into a blunt or truncated pyramid, facilitate the lifting of the filling frame 7 from the molding box 6, and prevent the granular sand from falling over the edge of the molding box in the final compression process.

On the reinforced edge 7*a* are arranged parallel walls 7*c* lying opposite one another and connected to said edge. To another section of the edge a blade 8 is attached, and to the remaining section a flap 9. The two walls 7*c* are connected with one another by wall 7*d* and tube 7*e*. The sand container of the filling frame 7 is consequently bounded by the side walls 7*c*, the blade 8 and the flap 9. The blade 8 is arranged with the ends of its bottom edge 8*a* lying on the edge 7*a* and projecting inwards past the walls 7*c*, while the opposite sides of the ends of its top edge 8*b* are connected by two endless chains 10. These chains run over sprocket wheels 12 and 13 which are arranged on shafts 14 and 15, journalled in the walls 7*c*. On shaft 14 there is furthermore a gear 17 which engages a piston rod 18 designed as a rack. Piston 18*a* of said rod is moved in both directions in a cylinder 19 by compressed air. The piston rod 18 slides in guide piece 20. Outside the chains, sectors 23 are swivelly arranged on pivots 22 and flap 9 is fixed to said sectors. In the sprocket wheels 13 there are, arranged like crank pins, pins 24 which at intervals work in beneath the ribs 25 of the sectors 23. In one direction of travel blade 8 is moved towards flap 9 which is at the same time raised by the pins 24 so that the sand pushed out of the filling frame 7 by the blade 8 can fall into the sand return passage 27 which is covered with a grate 26.

The frame 7 is lowered onto the molding box by means of a pneumatic lifting and lowering device. When the box has been filled and the granular sand subjected to the preliminary compression process, the frame is lifted high enough from the molding box to enable the squeezer board 30 which is used for the final compression, to be swung over the mold. The lifting and lowering device is arranged on a column 31, on which also the squeezer board 30 can be swivelled about axis 32. On edge or lower rim 7*a* of filling frame 7 there are two eyes 33 and 34 and, on the upper edge of the appurtenant frame wall 7*c*, an eye 35. The inner surface of lower rim 7*a* defines a space of truncated pyramidal configuration. These eyes are provided with tapered bores into which the tapered centering pins 37 fixed to head 36 engage. Head 36 is fixed to a piston rod 38 whose piston 39 is arranged in a cylinder 40, which is fixed to column 31. The piston rod 38 which is kept from twisting or rotating by wedge or key 41, moves downwards until the tapered pins 37 emerge from the bores in said eyes, when the filling frame 7 lies on the molding box, so that the frame can follow without hindrance the jolting movements of the molding box 6 during the preliminary compression process. Above the uppermost position of the filling frame 7 there is a shaking or oscillating screen 42 arranged at the bottom end of a molding sand silo 43; the shaking movement of the said screen is produced by an electromagnet 44 and its oscillation period is controlled by a time switch (not shown). The electromagnet can be switched on by hand or by means of a contact, not shown or described in detail, which is closed after the frame is resting on the molding box. This contact is advantageously actuated by the piston rod 38 moving still further downwards.

The device operates as follows: Let it be assumed that a finished mold, which has just undergone final compression by squeezing, as is shown in Fig. 3, is on the machine. Now, by the actuation of a control member, which is not illustrated, the pressure medium is released under the press piston 2, and said press piston and with it the jolting table 3*a* with the pattern 4 or 5 and the finished mold are lowered. The squeezer board 30 is moved into the swung-out or inoperative position, as is shown in Fig. 2, and the finished mold is lifted off in a conventional manner. After a fresh molding box 6 has been set up, by actuating another control member, likewise not illustrated, which can be combined with the one already mentioned, the pressure medium is released under piston 39, which drops together with the filling frame 7 until the latter rests on the molding box 6 where, as Fig. 1 shows, it is guided by stops 7*f* in a horizontal direction on the molding box 6, whereupon by a further lowering of the piston 39 until it reaches the bottom of the cylinder 40, the tapered pins 37 are drawn out of the eyes 35, so that the filling frame 7 has no physical contact with the pins 37 and thus with the piston rod 38 etc. At the same time electric current is supplied to the electromagnet 44 by the actuation of a contact and the shaking screen 42 is thus set in motion.

The granular sand is now strewn onto the pattern 5 and the pattern plate 4, pouring down from the silo 43 in a continuous stream. After the required amount has been sieved through screen 42, said amount being adjusted or regulated by means of a time switch, the electric current is automatically stopped by the said switch, the electromagnet 44 comes to a standstill and the sieving of the granular sand ceases. The preliminary compression by jolting which now begins is carried out in a conventional manner by actuating the already mentioned control member.

The jolting, as is well known, compacts the sand by making use of the inertia thereof. In other words, upon upward movement of jolting table 3*a*, the lower sand particles are propelled up against the entire weight of the overlying sand particles, while during downward movement of said table the upper sand strata fall heavily onto the lower sand strata. This results in a compres-

sion or compaction of the lower sand strata. As pointed out above, the jolting blows may be elastically or resiliently damped, as by interposition of a suitable resilient or spring member **46** disposed between the jolting piston **3** and press piston **2**, in order to reduce the magnitude of the effect of the jolting blows. After the mold has been pre-compressed, a pressure medium is supplied by actuating a further control member, which can also be combined with the one already mentioned, to the cylinder **19** via the opening **19***a*, while the pressure medium on the other side can escape via the opening **19***b*. The blade **8** is thus pushed by the movement of the piston **18***a* via the piston rod **18**, gear wheel **17**, sprocket wheels **12** and chains **10** from the position illustrated in Fig. 1 into that illustrated in Fig. 4, while at the same time the flap **9** is raised by the pins **24** into the position illustrated in Fig. 4. Thereby, the surplus granular sand above the molding box **6** is scraped off down to the height of the inwardly projecting edge **7***a* of the filling frame **7**, and falls through the grate **26** into the sand return passage **27**. By reversing the appropriate control member the cylinder **19** is supplied with a pressure medium via the opening **19***b*, while the pressure medium at the opposite end can escape via the opening **19***a*, whereby inversely to the already mentioned process the blade **8** is withdrawn into the position illustrated in Fig. 1 and the flap **9** is lowered into the position illustrated in Fig. 1. At the same time, cylinder **40** is supplied with pressure to raise piston **39** and piston rod **38**, and therewith head **36** with the centering pins **37** engaged in it. During this operation the filling frame **7**, after the pins have entered the tapered bores in the eyes **33**, **34** and **35**, is also raised into the position illustrated in Fig. 3, said position being predetermined by the stepped or shouldered bore of cylinder **40** which defines the limit of lift of the piston **39**. After the squeezer board **30** has been swung from the position shown in Fig. 2 to that shown in Fig. 3, a pressure medium is supplied below the press piston **2** by actuating a control member, whereupon said press piston and with it the jolting table **3***a*, the pattern plate **4**, the pattern **5** and the molding box **6** are raised, and the pre-compressed mold is pressed against the squeezer board **30** in such a way that the granular sand, which in the pre-compressed state projects above the molding box like a blunted or truncated pyramid, is compressed as far as the top edge of the molding box. After the final compression the series of operations begins anew.

It will be noted that the above-described method of preparing a complete mold of predetermined volume and configuration having at the termination of the mold preparation an upper face located at a predetermined elevation above a pattern in the mold includes the steps of placing over the suface of the pattern a total quantity of granular material equal to a predetermined quantity of the granular material required by the complete mold and in addition thereto an excess quantity of the granular material, while laterally confining the total quantity of material to provide the same with a top surface at a first elevation above the pattern greater than the above predetermined elevation. At this time the total quantity of material occupies a lower space equal to the predetermined volume of the complete mold, an intermediate space of the configuration of a truncated pyramid forming a continuation of the lower space and having a base coincident with the top of the lower space, and an upper space directly above the intermediate space. This total quantity of granular material which is laterally confined in the above fashion is preliminarily compressed until the top surface of the total quantity of material is lowered to a second elevation between the above-mentioned first and predetermined elevations above the pattern to thereby attain a preliminary compressed material, and this preliminary compressed material fills the lower and intermediate spaces and part of the upper space. At this time the predetermined quantity of material required for the complete mold exactly fills the lower and intermediate spaces, and the excess quantity of material remaining in the upper space is removed to leave the predetermined quantity of granular material with an upper face coincident with the top of the intermediate, truncated pyramidal space which is at a third elevation between the above-mentioned second and predetermined elevations above the pattern. The granular material is now finally compressed so that the predetermined quantity of material is compacted out of the intermediate space into the lower space of predetermined volume to form the complete mold, and it will be noted that during this step the upper face of the granular material is lowered from the above-mentioned third elevation until this upper face has the above-mentioned predetermined elevation above the pattern.

The principle of the invention is not limited to the device described, nor exclusively to the operational sequence described. The preliminary compression by jolting, for instance, can be introduced even while the granular sand is being poured in. Furthermore, it must be pointed out in particular that the method is restricted neither to the form of silo illustrated nor to the system of strewing. The method can be applied to all types of molding machines, both to "flask-lift-type molding machines" and to "turn-over-table molding machines"; the method is merely committed to the presence of suitable means for the preliminary and final compression processes. Instead of removing the surplus granular sand above the molding box evenly with flat blades guided in a straight line, the surface of this section can also be produced unevenly in two or three dimensions. In addition, it is not necessary to combine the blades for the removal of the surplus granular sand with the molding box. The latter can be designed in several sections, so that the means for the removal of the surplus sand may be arranged independently and separately.

Various changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

1. Means for preparing a mold from granular material, comprising a mold box including pattern means, base means supporting said box and including means adapted to transmit preliminary compressive forces to said material to preliminarily compress said material when placed in said box, a filling frame attachable to and removable from said box, whereby said material may be supplied to said box when said filling frame is attached to said box, means operatively connected to said frame for selectively moving the latter to and from said box, means movably connected to said frame for removing excess of said material from said box, pressure exerting means on said base means operable to finally compress said material in said box to complete said mold on said pattern means, and a pneumatic system comprising a piston and a cylinder, said piston being provided with means disengageable from said frame to lower the latter onto said mold box when said piston moves in one direction and engageable with said frame to raise said frame from said box when said piston moves in another direction, said disengageable and engageable means on said piston comprising tapered pins, said frame being provided with tapered holes into which said pins fit, said pins being disengaged from said holes as soon as said filling frame rests on the molding box so that said piston has no longer any physical contact with said filling frame.

2. Means for preparing a mold from granular material, comprising a mold box including pattern means, base means supporting said box and including means adapted

to transmit preliminary compressive forces to said material to preliminarily compress said material when placed in said box, a filling frame attachable to and removable from said box, whereby said material may be supplied to said box when said filling frame is attached to said box, means operatively connected to said frame for selectively moving the latter to and from said box, means movably connected to said frame for removing excess of said material from said box, pressure exerting means on said base means operable to finally compress said material in said box to complete said mold on said pattern means, a pneumatic system comprising a piston and a cylinder, said piston being provided with means disengageable from said frame to lower the latter onto said mold box when said piston moves in one direction and engageable with said frame to raise said frame from said box when said piston moves in another direction, and stops on the lower edges of said filling frame, whereby said filling frame in the lowered position rests on said box and is prevented from horizontal displacement thereon by said stops.

3. In a process for mechanically producing a mold by means of foundry machinery; the steps of strewing upon pattern means in loose manner a quantity of molding sand in predetermined excess of the quantity contained in the finished mold, supporting the entire quantity of said molding sand laterally substantially adjacent the marginal edges of said pattern means, then subjecting said entire quantity of molding sand to jolting action to thereby precompact said entire quantity of sand, whereby an improved distribution of said sand over the entire pattern means results due to the presence of said predetermined excess sand quantity, removing the excess sand and leaving in the mold the thus precompacted quantity of sand required for the finished mold, to thereby attain more even compression of the sand throughout the mold and on and about said pattern means, and then subjecting said latter quantity of sand in said mold to final compaction.

4. A machine for producing a mold made of molding sand comprising a pattern plate with a pattern thereon, a molding box on said pattern plate, a filling frame on said molding box and separable therefrom, means extending above said filling frame, said molding box, said filling frame and said extending means being adapted to enclose together a total quantity of molding sand composed of a predetermined excess quantity of molding sand and the quantity of molding sand required for the finished mold, means located below said pattern plate for imparting a jolting action to said total quantity of molding sand, said extending means including a plurality of operable means arranged for movement relative to each other for removing said excess quantity of sand from above said molding box, and pressure exerting means arranged for movement above said molding box to apply final compaction to the quantity of molding sand required for the finished mold after said filling frame and said extending means with said operable means have been separated from said molding box.

5. The process according to claim 3 further including the step of elastically damping the jolting action.

6. A machine according to claim 4, said operable means being mounted on said extending means and including at least one blade having a cutting edge for removing said excess quantity of sand from above said molding box.

7. A machine according to claim 4, said filling frame being provided with a downwardly and outwardly projecting circumferential edge having an inner surface which is substantially in the form of a pyramid.

8. A machine according to claim 7, wherein a blade having a cutting edge for removing said excess quantity of sand is movably arranged on said inclined inner surface and adapted to remove sand extending above said box and beyond said edge.

9. A machine according to claim 8 including means providing with a compressed air cylinder and a piston for movement of said blade along said edge, said blade forming an acute angle with respect to the top surface of said filling frame, said filling frame being provided with guide surfaces for said blade.

10. Means for preparing a mold from granular material, comprising a mold box including pattern means, base means supporting said box and including means adapted to transmit preliminary compressive forces to said material to preliminarily compress said material when placed in said box, a filling frame attachable to and removable from said box, whereby said material may be supplied to said box when said filling frame is attached to said box, means movably connected to said frame for removing excess of said material from said box, said movably connected means including two elements forming in one position closure means for said filling frame and in another position at least one of said elements being movable across said filling frame to remove said excess of said material, while the other element is adapted to release said excess material from said filling frame, pressure exerting means on said base means operable to finally compress said material in said box to complete said mold on said pattern means, and actuating means connected to said base means and provided with means disengageable from said frame when the latter has been lowered onto said mold box and engageable with said frame to raise said frame from said box, respectively.

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