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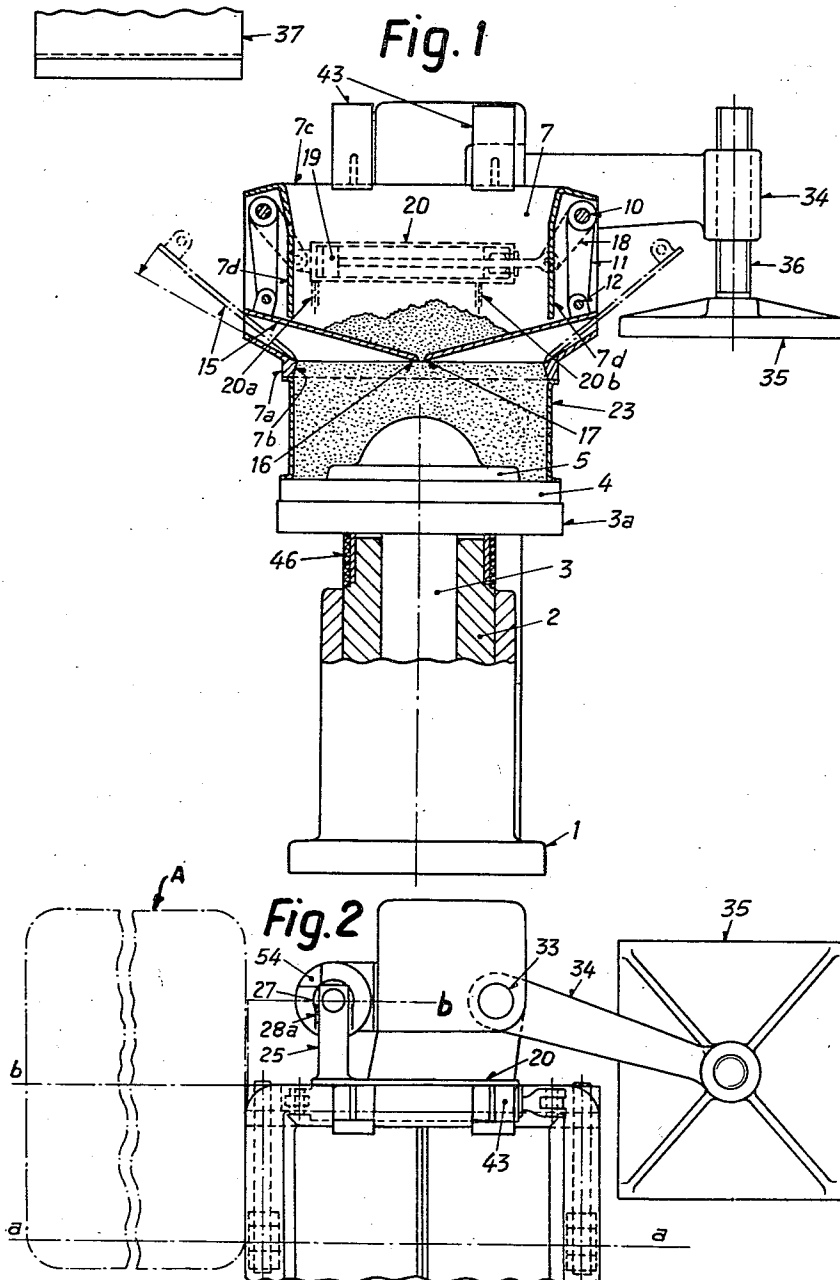
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2,792,601

METHOD AND APPARATUS FOR CHARGING AND JOLTING FOR THE
PURPOSE OF PRE-COMPACTING GRANULAR MATERIALS

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Fig. 3

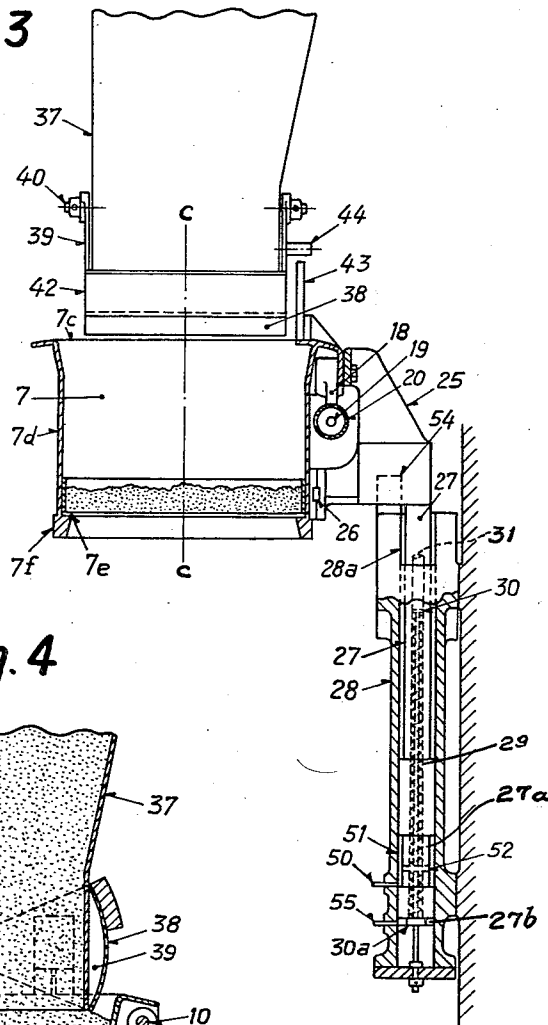
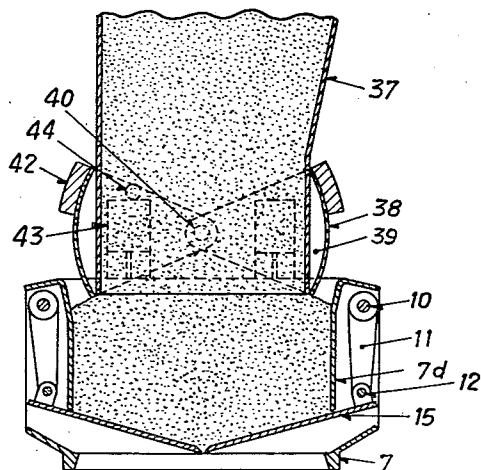


Fig. 4



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METHOD AND APPARATUS FOR CHARGING AND JOLTING FOR THE PURPOSE OF PRE-COMPACTING GRANULAR MATERIALS

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This invention relates to a novel method for pre-compacting granular materials in the preparation of foundry moulds and ceramic products and to a novel apparatus for effecting the pre-compaction.

In compacting granular materials for the production of foundry moulds and ceramic products, etc., it is known to work with filling frames which are placed on the pattern plates to be moulded from. These filling frames should prevent as far as possible any overflow of the granular material during the charging thereof, or, when deep moulds are being made, should enable a sufficient quantity of the granular material to be accommodated. Also known are charging hoppers, with bottom gates, into which the quantity of granular material necessary for the production of moulds is charged and which, when they have been maneuvered over the patterns or the moulding flask, discharge the granular material without mutual contact. Owing to the fact that the granular material has a considerably larger volume when not rammed or compacted than when compacted, it forms a tapering heap a portion of which slides off over the edge of the flask, and owing to the fact that on the impact of the granular material the latter pre-compacts mainly over the raised areas of the pattern, the total quantity is not exact, and the horizontal distribution in particular is unsatisfactory (too much in the middle, too little at the edge of the flask). The use has also been proposed of charging hoppers with drop bottoms kept closed by springs, which hoppers, after having been placed on a moulding flask supported by a pattern plate, are so loaded with a weight bearing on the charge, i. e., pressing the charge forward, that the drop bottom flaps held closed by the action of springs are compelled to release the charge, so that the charge and the weight bearing upon it fall on to the pattern plate. The result of this is an even worse horizontal distribution, because pre-compacting immediately takes place over the raised parts of the pattern, the deleterious effect of which pre-compacting cannot be materially remedied by the subsequent jolting process.

It is a fact that has long been known in the art that in the process of compacting a granular material the compacting takes place mainly in the direction of application of force, whilst perpendicularly to that direction the compacting effect is insignificant and dwindles away the more rapidly, the more intense the compacting and the shallower the mass of granular material to be compacted. This proves that during squeezing the granular material over the elevated areas of the pattern is too strongly compacted, and is not sufficiently compacted over the lower-lying parts of the pattern assembly. Many attempts at least partly to eliminate this phenomenon, which is an obstacle to uniform compacting, by the application of horizontally acting jolting or vibratory movements have completely failed. Nor has the use of squeezing boards shaped to match the pattern yielded satisfactory results, as the success achieved was only partial and the method

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inadmissably complicated the change of the pattern assemblies; and both on this ground and on account of the extension of the pattern assemblies the method added to the cost of producing moulds.

It is therefore an object of the present invention at least partially to overcome the drawbacks described, and thereby to provide the conditions essential to the development of a reliable automatic moulding machine. According to the method, a container or hopper filled with a quantity of granular mass at least sufficient for the production of the mould but not materially exceeding that quantity, said hopper being provided with a bottom closure and having a cross-section of discharge approximately equivalent to the internal cross-section of the moulding flask, is placed on the moulding flask. After the opening of the bottom closure of the hopper and completion of the charging process, the granular material pouring in over the pattern assembly is pre-compacted exclusively by the generation within the granular material itself of inertial forces acting preferably in a direction perpendicular to the plane of the pattern, final compacting then taking place supplementarily when the charging hopper has been lifted away.

By the present invention the use of a high drop or of pressing forward by weights, and in consequence the undesirable area-wise compacting of the granular material when charging, is eliminated, so that the said material lays itself loosely and, kept to the sides by the container, largely levelled out on the pattern assembly, and is only compacted by the inertial forces of the granular material itself, said forces acting preferably in a perpendicular direction, and a sufficient quantity of granular material being able to settle into the moulding flask at all points. Of the three known methods of compacting, viz. 1) by forces acting on the granular material from the exterior (e. g. squeezing); 2) by hurling the granular material on to the pattern assembly by means of sand slingers or compressed air; and 3) by releasing inertial forces within the charged granular material itself by sudden changes of velocity, the present invention uses only the third for the purposes of pre-compacting, on account of its particular suitability. The first method is discarded because its properties are demonstrably such as to impair the uniformity of compacting, and the second is not applicable in accordance with the invention. The closer the preliminary compacting approaches the full compacting to be striven for by finish-compacting, the more uniform will the finish-compacted mould be, and for this reason the invention provides that the intensity of pre-compacting shall be so selected that the lowermost parts of the uppermost layers of the granular material shall be fully compacted by the pre-compacting process.

Both experiments and calculations show that by preferably perpendicular jolting alone much more intense compacting is attainable than by the use of vibrators or eccentric weights alone. For this reason, and because jolting produces the most intense compacting only in the parts of the granular material adjoining the plane of the pattern and the patterns themselves, and the degree of compaction declines in the upward direction, jolting plays a special part in the process of pre-compacting. If a moulding table is so supported that it can lift up from its support, and if sufficiently large masses are caused to strike against the table with the necessary velocity from below, adequate pre-compacting can be achieved. This embodiment is, however, in general more complicated in design. In order, however, finally to achieve as uniformly compacted a mould as possible, the pre-compacted mould should, after pre-compacting, be compacted substantially more intensely in the lower-lying parts by jolting than

over the higher-lying parts above the patterns. This is not the case with the jolting apparatus so far known, because the modulus of elasticity of granular material permeated with clayey binders is only about 500 kg./cm.² and the granular material undergoes considerable elastic deformation. For this reason the present invention, in order to achieve the desired condition, additionally provides that the jolting mass shall strike against a body whose material permits of high compressive stress, has as low as possible a modulus of elasticity, and is shaped long and with thin walls similarly to a bushing, i. e., is able to store a high potential energy. Both calculations and tests confirm the correctness of this hypothesis. It is true that proposals have been put forward for the insertion of underpackings between the jolting mass and the anvil, or for the use of steel plates of membrane-like resiliency, but the effect of these packings is too small to produce the height-dependent differential degree of compacting. Apart from these considerations, when a loose granular material is charged, because the topmost layer is not compacted and therefore the internal friction of the granular material in said layer is very small, a relatively pronounced levelling of the surface is a peculiarity of the shaking process if the granular material is, as is provided for by the present invention, prevented from sliding off at the sides by side walls.

In order still further to improve the preliminary compacting so achieved and favourable to subsequent final compacting, such improvement in the case of moulds of granular material to be compacted consisting in enhanced uniformity of compacting, the invention also provides that more granular material shall be furnished to the charging hopper than is necessary to produce the mould, the surplus being after preliminary compacting, so strickled off or separated in a plane suited to the subsequent final compacting and located above the top edge of the moulding flask that that part of the pre-compacted granular moulding material which projects above the top edge of the moulding flask forms a truncated body tapering off in the upward direction. This arrangement is beneficial because with granular materials even small compacting forces already cause a substantial increase in the weight per unit volume, and because elevations of the granular material caused by considerable elevations of the pattern and remaining after preliminary compacting are removed before final compacting.

For performing the method an apparatus is used which is characterized by a container placeable upon the moulding flask and containing a quantity of granular material in excess but not substantially in excess, of the quantity necessary for the production of the mould, said container having an openable bottom closure and having a cross-sectional area of discharge approximately corresponding to the internal cross-sectional area of the moulding flask, and further characterized by the fact that means are provided which are adapted to produce within the granular material itself inertial forces preferably acting perpendicularly to the plane of the pattern, and finally by the fact that means adapted to finish-compact the moulding material after the removal of the charging container are provided.

In the accompanying drawings the method is illustrated by reference to an embodiment of an apparatus for performing the same, a moulding machine with charging hopper.

In the drawings:

Fig. 1 is a sectional elevation view on the line *a-a* of Fig. 2;

Fig. 2 is a plan view;

Fig. 3 is a sectional view through the charging hopper or container on the line *b-b* of Fig. 2; and

Fig. 4 is a sectional view of the hopper or container on the line *c-c* of Fig. 3.

A moulding machine comprising a stand or frame 1, a squeezing ram 2 and a jolting ram 3 which in the known

manner is lifted by a pressure medium and on the release of the pressure medium drops back on to the squeezing ram by the effect of gravity, which squeezing ram bears, during the jolting process, in its lowermost position against the bottom of the machine frame 1. The jolting ram 3 carries the jolting table 3*a*, on which a pattern plate 4 with a pattern 5 is mounted. All controls and compressed-air pipes are, for the sake of clarity, omitted from the drawing.

Mounted on the pattern plate 4 is the moulding flask 23, and the charging container or hopper 7 is placed on the upper edge of said moulding flask. The charging hopper 7 is provided at the bottom with a thickened edge 7*a* having, on its inner side, faces 7*b* inclined downwards and outwards the purpose of which is to shape the sand into a truncated pyramidal form and to facilitate the lifting off of the charging hopper from the moulding flask. The opposing end walls 7*c* of the hopper are interconnected by two parallel walls 7*d*, the walls 7*d* being set back in relation to the vertical edges of the walls 7*c*. The upper parts of the walls 7*d* are bent outwards and form a roof for the spindles or shafts 10 mounted in the side walls 7*c*. Rigidly keyed to each of the spindles or shafts 10 between the walls 7*c* are two levers 11 at whose lever ends a strickling plate 15 is pivotally mounted on a pivot 12, said strickling plates resting by their edges 16 on the faces 7*e* (Fig. 3) of the thickened edge 7*a* of the hopper 7. Outside one of the hopper walls 7*c* a lever 18 is secured to each of the shafts 10, one of said levers 18 being articulated to the piston 19 and the other to the casing 20 of a hydraulically or pneumatically operated cylinder. Pipes 20*a* and 20*b* for the pressure medium are connected to the casing 20. By means of this press, the two strickling plates 15 can be rapidly moved from the position shown in continuous outline to the position shown in discontinuous outline in Fig. 1. Fig. 1 shows the respective positions of the strickler plates after preliminary compacting and Fig. 4 their respective positions when the new charge of granular material is being received in the hopper 7. The charging hopper is bolted to an arm 25 and secured in the bolted position by means of a wedge or key 26 (Fig. 3). The arm 25 is mounted on the piston rod 27, which in turn seats in the cylinder 28 bolted to the machine frame 1. The cylinder 28 is provided at its upper extremity with a recess 28*a* into which the arm 25 slides when the hopper lowers on to the moulding flask, so that said hopper is secured in its position. The piston rod 27 has a bore in which a coiled helical spring 29 is located which bears against a collar 30 of the rod 31 at the upper end of the rod and at 30*a* in the bottom 27*b* of the piston 27. The rod 31 is screwed fast to the bottom of the cylinder 28. The helical spring draws the piston 27, and with it the hopper 7, against the moulding flask 23 during the jolting operation. An arm 34 is pivotally mounted on the pivot 33 of the frame 1, said arm carrying the squeezer plate 35 which is mounted by means of a screwed spindle 36 in the arm 34 and is thereby adjustable for height. Above the extended position A, Fig. 2, of the hopper 7 is a storage hopper 37 (Figs. 1 and 4) whose outlet can be opened and closed by means of slide gates 38 (Fig. 4). The slide gates are pivotally secured to the storage hopper by segments 39 swivelling on the pivots 40, and may for example be provided with weights 42 so that they can close of their own accord. Two stops or abutments 43, which push against the pivots 44 secured to the segments 39 and keep the storage hopper closure open when the container 7 rises, are secured to the charging hopper 7. The stops 43 are exchangeable or are adjustable for height, so that by the use of stops of different height or by adjusting the height of the stops the height of the container 7 in relation to the storage hopper 37 can be determined, because the lifting movement is stopped by the slide gates 38 encountering the walls 37 of the storage hopper.

As the elastic impact member which absorbs the verti-

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cal blows during the jolting process a bushing-type intermediate packing 46 placed on the ram 2 is used, said intermediate packing being made of a highly elastic material such as synthetic resins reinforced with fabric or paper.

The following is a description of the functioning of the device: Assuming that a moulding flask is charged and the moulding material pre-compacted, then first the strickling plates 15 are operated, so that the container, or charging hopper, as shown in Fig. 1, is closed at the bottom. As a result, only a truncated pyramid of moulding material remains above the upper edge of the moulding flask, whilst the surplus passes above the strickling plates 15 into the container. After the separation of the heap of surplus, the charging hopper 7 is lifted by the inflow of compressed air into the cylinder 28. The said compressed air is conducted through the opening 50 and the space 51 formed by the cavity 27a of the piston 27, and on through the communicating bores 52 provided in the part 27a of the piston, to the central bore of the piston 27 in which the spring is seated, so that the pressure medium arrives below the face 27b of the piston. The piston 27 is raised until the container 7 reaches the extended position. This position corresponds to that height of the piston 27 in which the latter just closes the opening 50. In this suspended position the charging hopper 7 is swivelled into abutment with a stop 54 (Fig. 2) under the storage hopper 37. Now compressed air is also admitted through the opening 55, so that the piston 27, and with it the charging hopper 7, lifts still further, stops 43, which are exchangeably or adjustably secured to the charging hopper, pressing against the pivots 44 of the storage hopper flaps 38 and fully opening the latter. According to the length of the exchangeable or adjustable abutments 43, the charge of granular material is larger or smaller. During the swivelling of the charging hopper below the storage hopper, the squeezer plate 35 is swivelled over the moulding flask. Simultaneously with the lifting of the charging hopper 7 and the opening of the storage hopper flaps 38, the squeezing of the already filled and preliminarily compacted mould takes place by the lifting of the squeezing ram 2, this being effected by a combined compressed-air control member, not shown in the drawing. By means of the same control member, the lowering of the squeezer ram 2 is subsequently initiated and at the same time the opening 55 of the cylinder is set to exhaust, whilst the opening 50 still remains closed. The now filled charging hopper lowers again to the suspended position shown in Fig. 3, the storage hopper flaps 38 being automatically closed by the loading weights 42. The squeezing plate 35 is now swivelled aside and the moulding flask lifted off. A new moulding flask is placed in position and the filled charging hopper swivelled back over the moulding flask. The opening 50 is set at exhaust, whereupon the charging hopper lowers on to the moulding flask. The supply of compressed air through the opening 20a to the cylinders 20 is opened, so that the bottom closure is opened, whereby the granular material is discharged over the pattern plate into the moulding flask 23. In the course of the jolting action now coming into play, the spring force of the spring 29 ensures secure seating of the charging hopper on the moulding flask, so that the said charging hopper and the moulding flask remain constantly in contact with one another. The jolts of the jolting table are absorbed by the bushing-type spacer, whereby preliminary compacting, to an extent dependent on the height of the granular material, takes place in those parts which are above the pattern assembly. After a few jolts, pre-compacting is completed and, by reversal of the compressed air at the opening to the cylinder 20, the strickling plates are caused to strickle off the surplus of granular material above the moulding flask and at the same time to close the bottom of the charging hopper. With the lifting of the charging hopper, the cycle of operations recommences.

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The inventive idea can also be put into practice with other shapes of storage or supply hopper and other storage hopper bottom closures. More particularly, the bottom closure of the charging hopper is not bound to take the form of the strickling plates shown. These strickling plates have, however, produced more satisfactory results than strickling plates moved rectilinearly or performing pivotal movements about axes, as they do not jam through the trapping of granular material, and in the course of strickling off the surplus granular material they loosen the same again by breaking it up. Needless to say, large storage bins or hoppers can also be opened and closed by the charging hopper controlling a compressed-air or hydraulic slide valve which in turn controls a hydraulic or compressed-air cylinder actuating the storage hopper bottom closure. Still more particularly it is stressed that the use of the idea is not limited to specific types of moulding machines; the inventive idea can be applied both to flask-lift and rollover-type moulding machines. The application of the inventive idea is subject only to the provision of suitable means for the preliminary compacting described and for subsequent final compacting.

Instead of producing a level cut-off of the moulding material above the moulding flask by means of rectilinearly moved, flat strickling plates, the cut-off surface may also be produced three-dimensionally uneven, whereby a further adaptation is possible of the depth of the moulding material, above extreme shapes of patterns, to the requirements of compacting. This can be done by making the guide faces 7e (Fig. 2) not straight, but shaped to suit the purpose, and by the strickling plates being of an irregular shape adapted to the mould.

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

1. In an apparatus having a support, a flask carried by said support, and a pattern in said flask for charging and compacting granular material about said pattern in said flask in preparing a mould for metal pouring and like operations; hopper means of greater volume than said flask and provided with an outlet in its bottom of substantially the same size as the mouth of said flask, substantially horizontally movable closing means for said outlet of said hopper means, container means for supplying granular material to said hopper means, vertically and rotatably movable piston means operatively connected to said hopper means whereby said hopper means can be moved from a first position directly adjacent said flask to a second position elevated and angularly displaced relative to said first position and under said container means, and vertically displaceable jolting means operatively connected to said support for applying jolting blows to said support and therethrough to said flask, whereby upon filling said flask with granular material from said hopper means in said first position and actuating said jolting means, said granular material is compacted more intensely at points directly overlying said pattern so that upon removal of excess granular material from said flask by said closing means and completion of compacting a more uniform strong mould is produced.

2. In an apparatus according to claim 1, said hopper means including guide surfaces, and said closing means including two inclined complementary plates, the lower edges of the respective plates moving substantially horizontally toward each other along said guide surfaces in closing.

3. In an apparatus according to claim 2, including a first pair of levers pivotally connected to said plates, respectively, a second pair of levers operatively connected to said first pair of levers, respectively, for movement therewith, and means for moving said second pair of levers, whereby upon actuation of said moving means said second pair of levers are moved, carrying said first pair of levers, thereby moving said plates between open and closed position.

4. In an apparatus according to claim 1, said closing means including at least one inclined plate, the lower

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edge of said plate moving substantially horizontally in closing.

5. In an apparatus according to claim 1, wherein said hopper means includes an outwardly flared edge disposed below said closing means for contacting said flask, whereby upon supplying excess granular material to said flask and actuating said closing means, a mass of granular material of substantially truncated pyramidal contour is left above said flask, the height of said flared edge varying with the extent of final compaction so that the volume of said truncated pyramidal mass is approximately equal to the loss in volume of all of said granular material due to compaction.

6. In an apparatus according to claim 1, said jolting means including a sleeve having a high modulus of elasticity for absorbing the shock produced by jolting.

7. In an apparatus according to claim 1, including gate means on said container means for closing same, and adjustable abutting formations disposed on said hopper means and said container means, respectively, whereby upon movement of said hopper means beneath said container means a predetermined charge of granular material is automatically supplied from said container means to said hopper means by opening of said gate means through contact of said abutting formations.

8. The method of charging and compacting granular material about a pattern extending in a plane within a flask in preparing a mould for metal pouring and like operations, which comprises the steps of filling a measured amount of said granular material into a container, which measured amount is greater than that necessary for the formation of said mould, placing said container on said flask, permitting said granular material to fall directly from said container into said flask so that said amount of said granular material necessary to form said mould covers said pattern and fills said flask while excess granular material protrudes into said container, applying jolting force to said granular material in a direction substantially perpendicular to said plane of said pattern while retaining said container on said flask to thereby precompact said granular material, cutting off said excess

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granular material from the amount thereof in said flask and simultaneously enclosing said excess granular material in said container, removing said container with said excess granular material from said flask, and thereafter finally compacting said granular material remaining in said flask to complete said mould.

9. The method of claim 8, further including the step of elastically damping said jolting forces prior to application of the latter to said granular material.

10. The method of claim 8, including the further step of predetermining the intensity of precompaction of said granular material to ensure that, in the lowermost parts of the highest strata of said granular material in said flask, the desired degree of final compaction is attained prior to the initiation of the final compacting step.

11. The method of charging and compacting granular material about a pattern extending in a plane within a flask for preparing a mould for metal pouring and like operations, which comprises the steps of filling a measured amount of said granular material in a container whereby said amount corresponds at least to that required for said mould in final compacted condition, placing said container on said flask, releasing at least a portion of said granular material to fall directly from said container into said flask so as to cover said pattern and fill said flask, jolting said granular material in a direction substantially perpendicular to said plane of said pattern while retaining said container on said flask to thereby precompact said granular material in the latter, removing said container from said flask, and thereafter finally compacting said granular material remaining in said flask to complete said mould.

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