# United States Patent [19]

**Boenisch**

[11] **3,871,623**

[45] **Mar. 18, 1975**


[54] **APPARATUS FOR MIXING MATERIALS**


[76] Inventor: **Dietmar Boenisch,** 45, Morillenhang, Aachen, Germany



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[21] Appl. No.: **274,762**

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July 26, 1971 Germany............................ 2137277

[52] **U.S. Cl.**........................... **259/2,** 259/54, 259/72
[51] **Int. Cl.**................................................ **B01f 5/10**
[58] **Field of Search**............... 259/2, 12, 17, 29, 35, 259/54, 59, 72, 91, 173, 1 R


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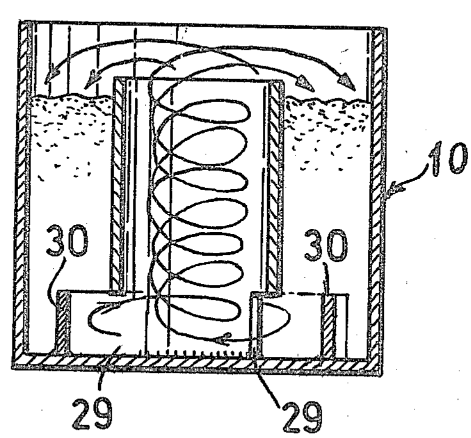
*Assistant Examiner*—Philip R. Coe
*Attorney, Agent, or Firm*—Philip D. Golrick


[57] **ABSTRACT**


A method for mixing fluent materials, especially such as components for foundry molding compositions, by establishing at least two circularly moving regions of material, preferably more or less parallel streams advancing with respective vortex-like motions, with transfer of material between the regions or streams; and as basic apparatus therefor, a container driven with an orbital type oscillation, and having internal vertical partitioning to define said regions or vertical paths for the vortex streams, with communication between the defined paths or regions. Apparatus elaborations afford pluralities of containers feeding serially one to another or in parallel discharging to a common acceptor, for batch or continuous operations, permitting simultaneous mixing of all components, either all brought together at once or, as for reactive component mixing, in parallel diverse component group mixing flows, joined for final mixing bringing the reactive components together.


**31 Claims, 31 Drawing Figures**



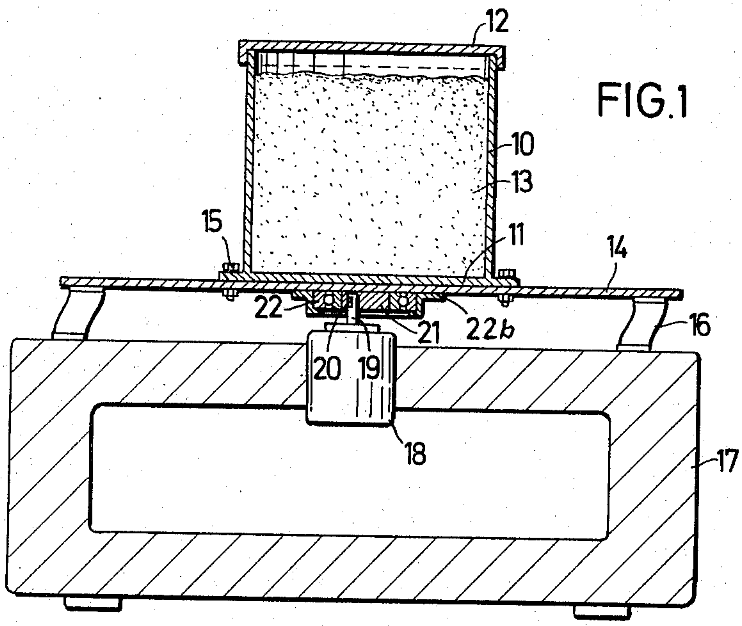

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FIG.1

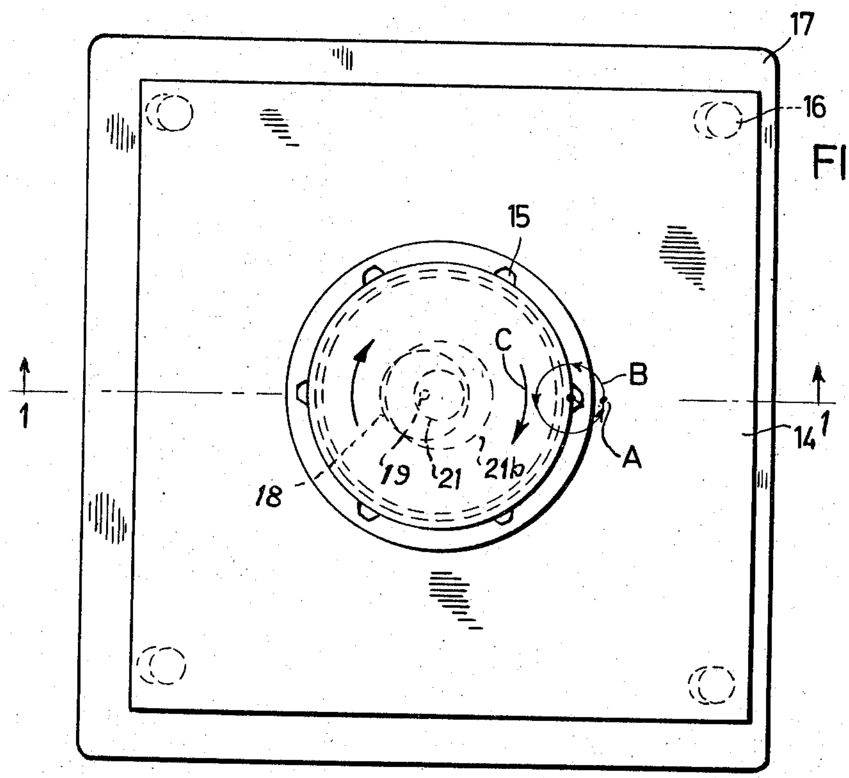
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FIG.2

FIG.3

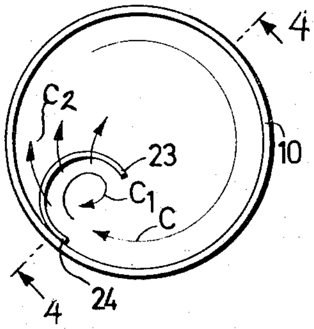



FIG.4

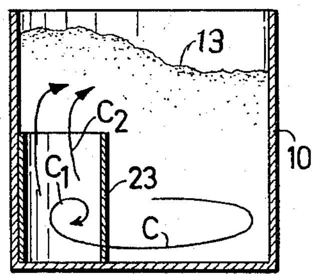



FIG.5

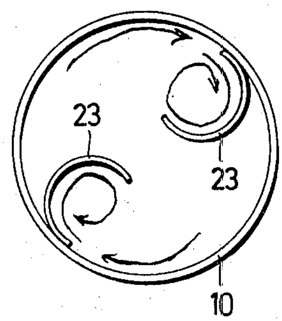



FIG.6

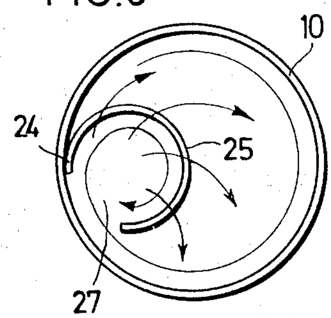



FIG.7

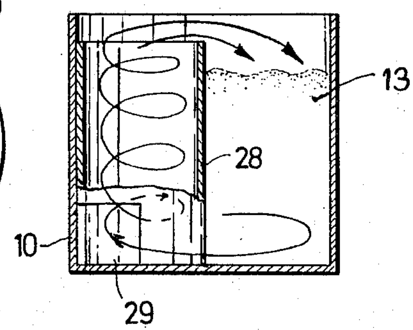



FIG.8

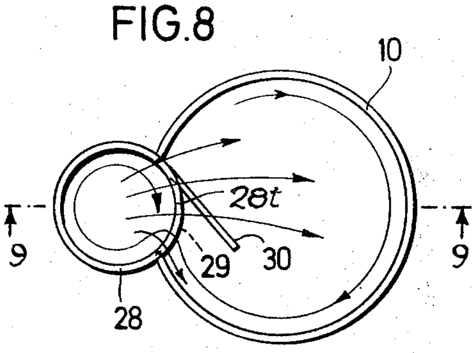



FIG.9

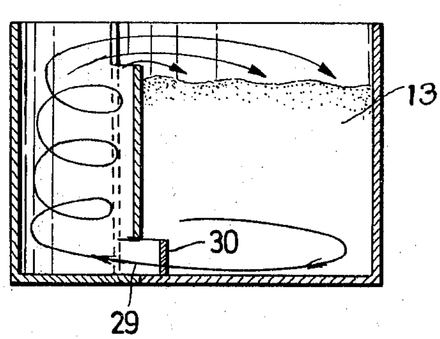


FIG.10

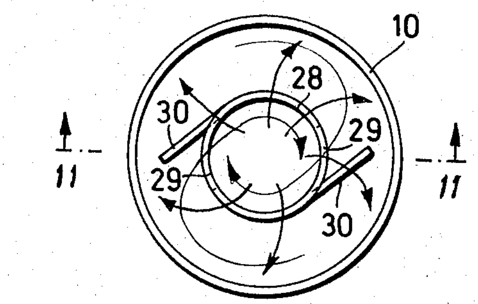



FIG.11

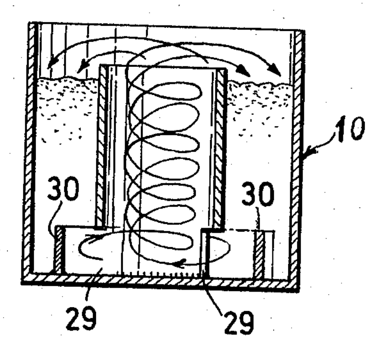
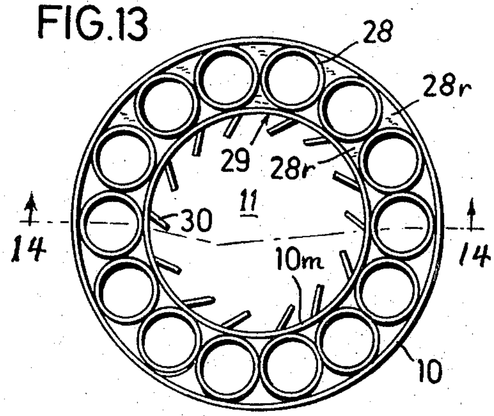



FIG.13



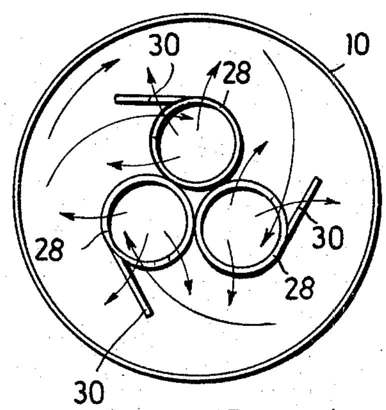




FIG.12

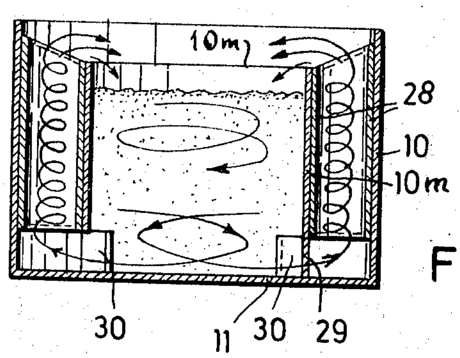



FIG.14

FIG. 30

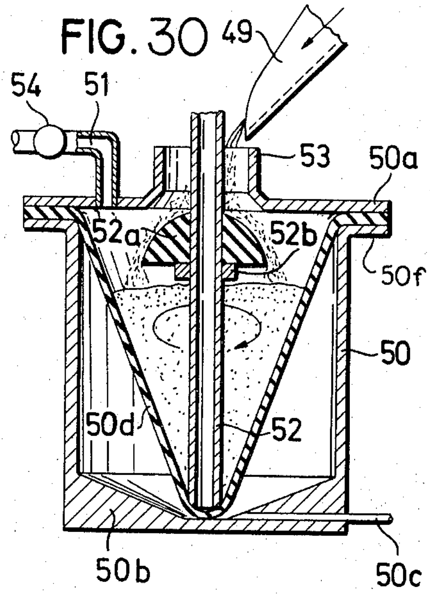



FIG. 31

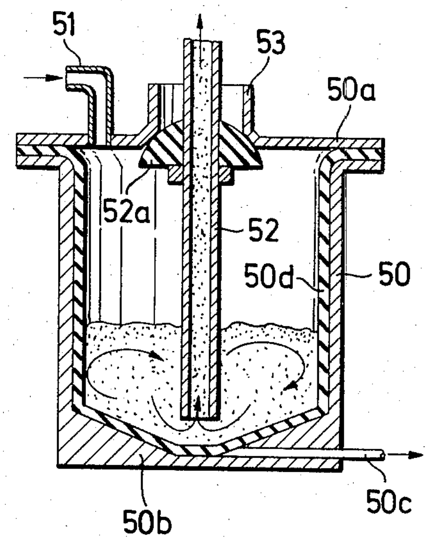



FIG. 15

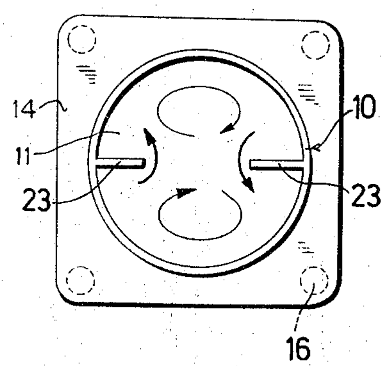



FIG. 16

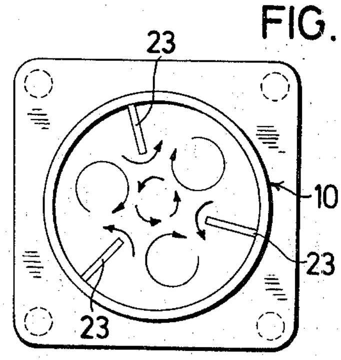



FIG. 17

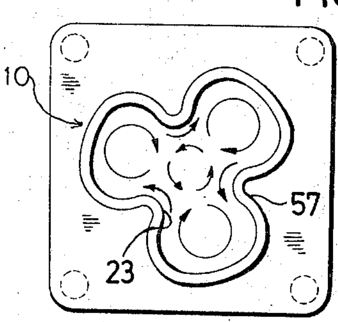
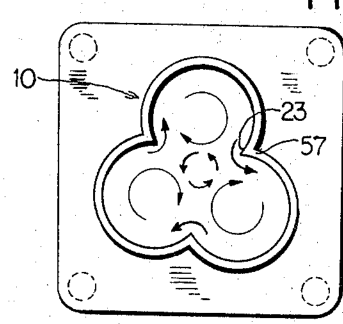



FIG. 18



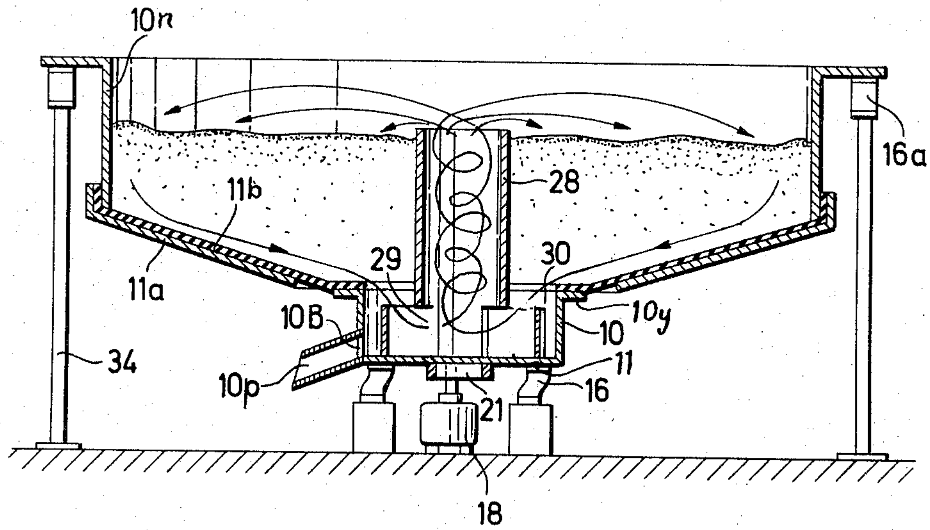

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FIG. 19

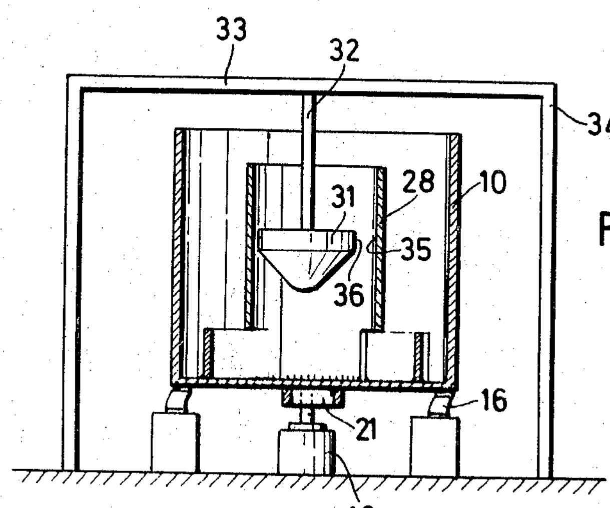
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FIG. 20

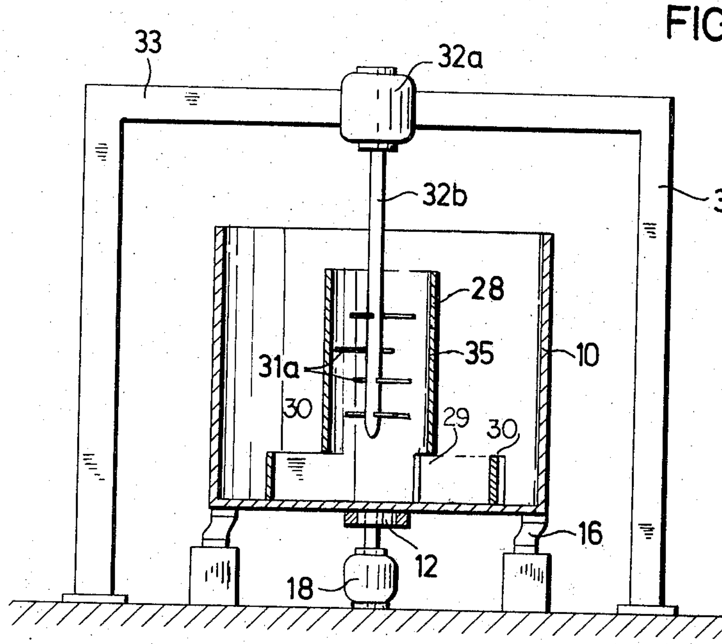
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FIG. 21

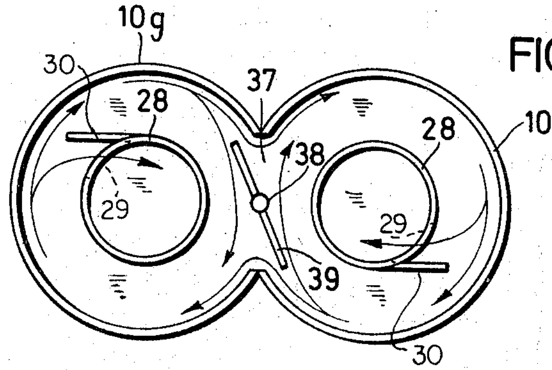
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FIG. 22

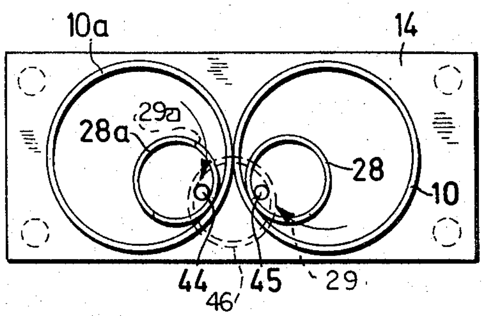



FIG. 23

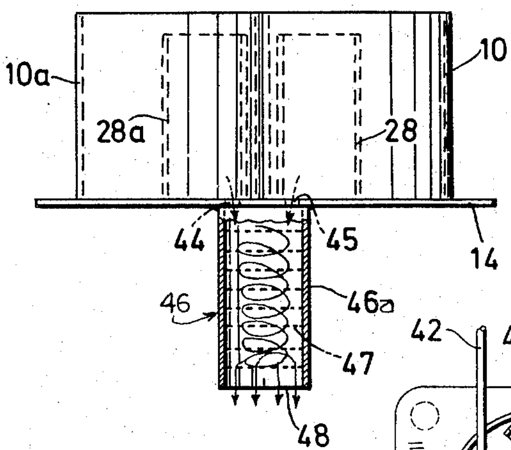



FIG. 24

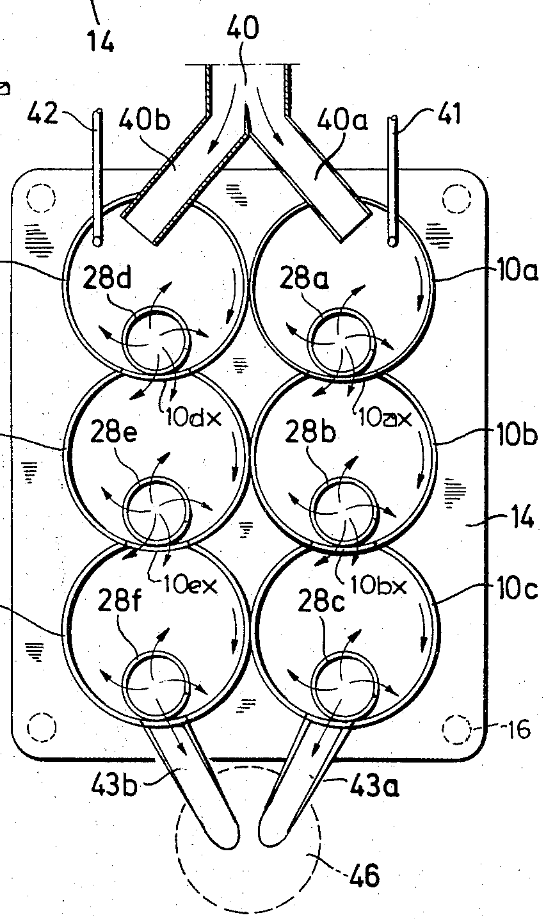



FIG. 28

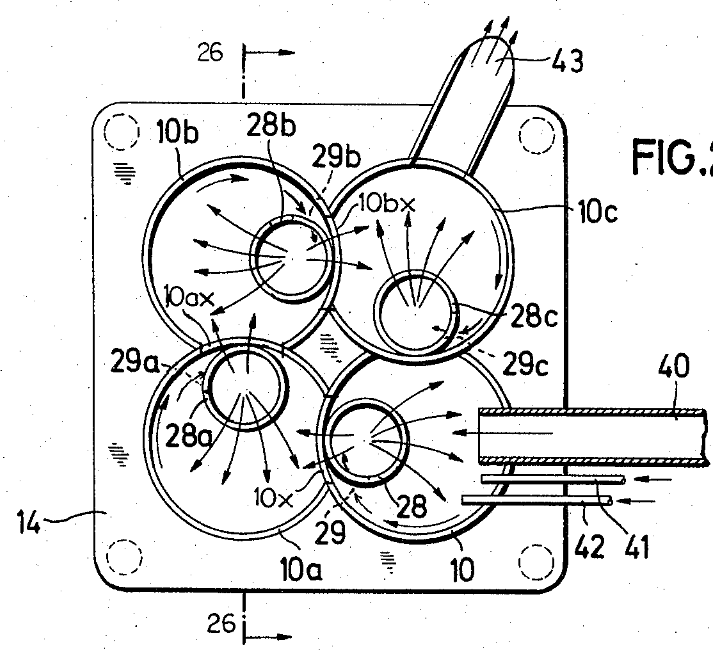



FIG.25

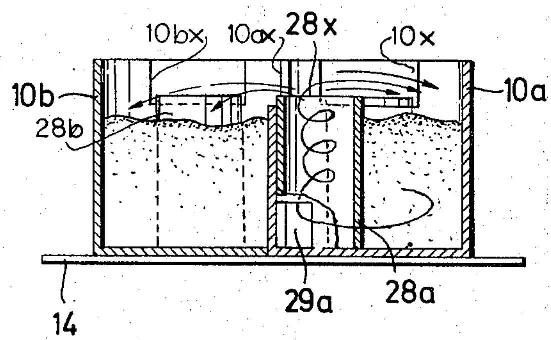



FIG. 26

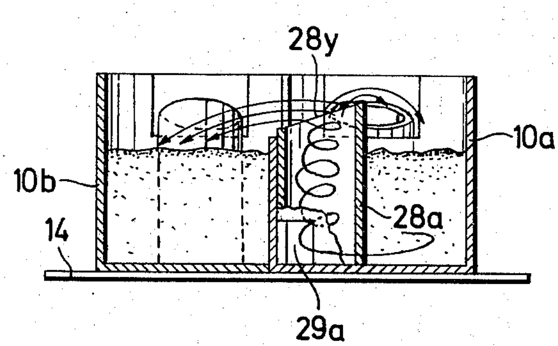
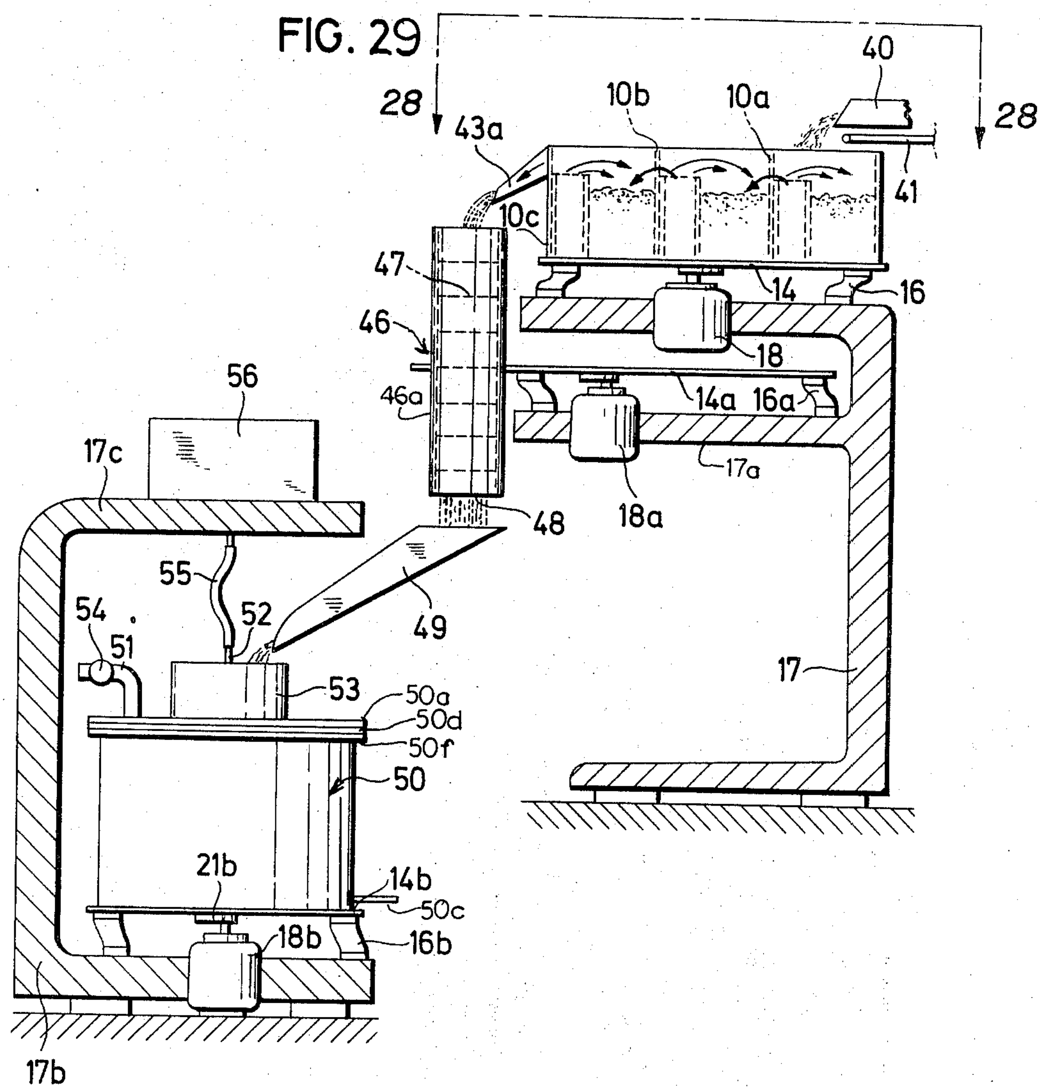



FIG. 27

FIG. 29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## APPARATUS FOR MIXING MATERIALS

The present invention is concerned with a method and apparatus for mixing of materials, particularly the constitutents for foundry molding compositions, by means of a mixing apparatus, subjected to oscillation involving motion in a circular sense about a substantially vertical axis, not what is usually called rotational oscillation, but what is here termed an orbital oscillation as hereinafter defined, to establish a circular movement of material to be mixed in at least two more or less vertical parallel regions, preferably in more or less parallel or vertical streams, in which respectively there is a circular motion about the axis or line of advance of the stream, with exchange of the material between the said regions or streams in diverse manners.

By orbital vibration or oscillation, here is meant the movement of a body, wherein each point thereof tends to move about a closed curved path about its respective distinct axis, without any rotation of the body as a whole with all points thereof swinging coaxially about a common center or axis; the particular type of which motion will appear from the apparatus hereinafter disclosed.

There is a continually increasing demand in various industrial processing technologies for short mixing times for materials involved in the processes. This is true in foundry industries for the mixing of molding compositions, where, for example, quartz sands are bonded with a synthetic resin to which are added activators, catalysts or hardeners, the reaction of which, leading to a setting of the molding composition, should take place first in the molding flask rather then in the mixing apparatus.

To meet this need, especially with foundry molding compositions, by the present invention, it is proposed to use an orbitally oscillating or vibrating mixing container having therein certain partitions, material guides, baffles or the like to establish two or more comparatively distinct vertical regions of circular or rotating movement of the material to be mixed, preferably essentially vertical vortex type streams, between which there occurs a constant exchange of material, to generate further mixing action in addition to that occurring within each region or stream.

These regions or vortical streams can be disposed or directed adjacently to one another but also one region or stream may be located or moved within another, in the simplest case when one is disposed and moving coaxially within a second.

Further in accordance with the invention, where the vertical regions or streams have a like rotational direction, especially when adjacent one another, there occurs particularly heavy exchange between the two streams or regions at what might be loosely called their "interface," that is area of contact.

Basically, an apparatus for mixing of materials in accordance with the invention comprises an orbitally oscillating vessel or main container within which are disposed vertically extended guide elements, e.g., tubular or baffle-like in form, which open toward and are adapted to receive a generated main flow or stream of material in the container, and so set up a circular motion in a distinct local vertical region or an upwardly moving stream of material.

Such guide elements or means, disposed within the mix charge receiving main vessel or container, here at times are referred to as mixing devices.

In one type of embodiment of the invention these mixing devices take the form of vertically extending elements, which in cross section may vary from a trough-like to a tubular shape; and thus, in a sense, locally at each of the devices, there is formed a shaft-like structure, that is, a vertical material passage, in practical sense a second mixing container internal of the main vessel.

In a preferred mixing apparatus embodiments of the invention the mixing container is driven with an oscillation amplitude which is independent of the load and also of acceleration and decelleration, so that dangerous resonance motion and over-drive or whipping motions are avoided.

Further in a preferred embodiment, there is used a positive eccentric drive affording adjustability of oscillation, which is constant over the cycle of the mixing process, but also enables variation of the oscillation rate at will. By appropriate choice of the eccentric shape, and of its drive motor rotational rate, optimal mixing conditions can be obtained, indeed with comparatively small mixing vessels, nonetheless a large through-put rate. The drive rotational speed may be advantageously used of from 1,500 to 5,000 rpm, and can also run as high as 10,000 rpm; through 3,000 rpm is convenient. Thus for either batch or continuous operations, within a few seconds, very intensive through mixing can be obtained with small mixing apparatus.

It is the general object of the present invention to provide an improved method for mixing of various fluent components, at least part of which are or may be made particulate or granular, whereby good mixing may be achieved in a comparatively brief time.

A further object of the invention is to provide a method of mixing fluent components of the character described, wherein the charge or body of materials to be mixed is subjected to orbital oscillation, and at least a portion of the charge is deflected from a circularly streaming motion of the main body of the charge to developed a rather distinct vertical region of another circular motion or a vertically directed vortical stream of the material, thus establishing at least two parallel gross movements of material in distinct paths between which the constant exchange of the material is occurring.

A still further object of the invention is to provide a basically simple orbitally oscillating apparatus for carrying out the method, either as a batch or continuous through-put operation.

A still further object is the provision of apparatus operating on the prinicples described, which enables simultaneous premixing of distinct mix or charge portions containing different components, for example, components of a final total composition desired to be kept as long as possible from reactive contact, and finally brining together the pre-mixed portions or streams for a final mixing and discharge to a point of use.

A still further object of the invention is the provision of apparatus in which the basic mixing functional operation or motion with modification may be included within a projection type molding machine.

Other objects and advantages will appear from the following description and drawings wherein:

FIG. 1 is generally a vertical section, taken as indicated by the line 1—1 in FIG. 2, of the overall organization for a simple form of machine embodying the present invention, certain important details, however, of mixing elements not there appearing;

FIG. 2 is a top plan view of the apparatus shown in FIG. 1;

FIG. 3 is a simplified top plan view of the mixing vessel in FIGS. 1 and 2, with cover removed, and empty to show a trough-shaped, mixing-shaft defining element or mixing device;

FIG. 4 is a vertical section at the line 4—4 in FIG. 3;

FIG. 5 is a plan view similar to and showing a modification of FIG. 3, by inclusion of two mixing elements;

FIG. 6 is a top plan view of a still further modification of the FIG. 3 mixing container, having rather a more tubularly-shaped mixing element;

FIG. 7 shows in vertical section a further modification with a tubular mixing element;

FIG. 8 is a top plan view of a mixing container with a laterally merged mixing device;

FIG. 9 is a vertical section taken at the line 9—9 in FIG. 8;

FIG. 10 is a top plan view similar to and showing a further modification of the FIG. 3 mixing container and elements;

FIG. 11 is a vertical section taken as indicated by the line 11—11 in FIG. 10;

FIG. 12 is a top plan view of another modification, somewhat analogous to that of FIGS. 10 and 11;

FIG. 13 is a top plan view of a still further modification with a multiplicity of the mixing shaft type elements;

FIG. 14 is a vertical section at line 14—14 in FIG. 13;

FIG. 15–18 are outline top plan views of still further mixing container modifications;

FIG. 19 is a still further embodiment of the invention in mixing apparatus shown essentially in vertical section;

FIG. 20 shows in vertical section a further embodiment utilizing a mixing container generally of the type appearing in FIG. 10;

FIG. 21 is a modification of FIG. 20;

FIG. 22 is a top plan view of a double mixing apparatus in which basically two similar mixing containers are adjacent and merging into another;

FIG. 23 is a top plan view of an apparatus with two adjacent simultaneously oscillated independent mixing containers for mixing portions containing respective components which are to be kept distinct to a final point in a mixing cycle;

FIG. 24 is a view generally in side elevation but partially in vertical section corresponding to FIG. 23;

FIG. 25 is a top plan view of mixing apparatus comprising four mixing containers simultaneously oscillated and arranged for a serial flow from one to another;

FIG. 26 is a vertical sectional view taken as indicated by the line 26—26 in FIG. 25;

FIG. 27 is a view similar to and showing a modification of FIG. 26;

FIG. 28 is a top plan view of a mixing apparatus comprising two rows or sets of respectively serially connected mixing containers simultaneously mixing two portions of components and discharging through a common final mixing chamber;

FIG. 29 shows, partially in section and partially in elevation, a combination of the apparatus of FIG. 28 with a further foundry molding composition mixing type projection machine, such as a mold blowing or core shooter machine;

FIG. 30 is a vertical axial sectional detail view of the molding composition projector machine, as shown in FIG. 29, shown in open condition for charging;

FIG. 31 is similar to FIG. 30, but showing the apparatus as in its discharge operation.

In the following descriptions like numerals will be used for like parts, or parts of analogous function through appearing in somewhat different form and in various modifications or embodiments.

## GENERAL DESCRIPTION — ORBITAL OSCILLATION MECHANISM (FIGS. 1-4)

FIGS. 1 and 2 of the drawings show mechanism for producing the characteristic or essential form of oscillation or vibration used in this invention, and which may be used for example for oscillation of various main mixing vessels or other mechanisms as shown in the remaining figures of the drawings.

The generally cylindrical mixing vessel or container 10, provided with a flat externally flanged bottom 11 and a lid or cover 12, for mixing of the mix batch or charge of material 13, is releasably secured on a steel base plate or orbitally oscillated table plate 14, by flange bolts 15, in turn swingably or horizontally oscillatably supported and secured on a heavy base or pedestal 17 through a plurality of three of more resilient elements 16. With a round table, for example, three equi-spaced, with a rectangular table four corner-located, elements 16 may be used. Resilient elements 16 preferably are comprised of rubber-like resilient elastomeric blocks or cylinders, having the opposite ends adapted for screwed or bolted connections to the plate and pedestal; for example, such as are marketed in Germany under the trademark "Schwingmetall;" but helical springs of appropriate size and strength may also be used; there expedients being preferred to gliding mounts.

The preferably cast iron base or pedestal 17, has sufficient mass to obtain immobility and stability in 17 without need to anchor to the floor or other underbase.

As a mechanical oscillator drive, the electric motor 18, secured in the base 17, has a vertical shaft 19 extending into, and by a key 20, secured in an eccentric element 21, which runs in a ball-bearing 22 secured on the under side of table plate 14 by a flanged retaining and supporting ring 22*b*.

The oscillation of the table 14, hence of vessel 10 thereon, which is generated by this eccentric drive with the described resilient restraint and support by the elements 16, is here termed "orbital oscillation." As schematically indicated by the arrows in FIG. 2, upon a counterclockwise rotation of the eccentric, (which is assumed for the drive of all the hereinafter described apparatus), the table, or the container, as a whole does not rotate about a common axis, but each point of the oscillatable assembly moves substantially in a horizontal plane in a small circle about a respective vertical axis, e.g., in FIG. 2, the point A in the circle B, the radius of which, therefore the amplitude, equals the eccentricity of the eccentric 21. Although only a single point is thus represented in motion, obviously each point in the entire table and container table and container assembly will similarly be so moving about a respective axis.

Accordingly, with continual drive by the motor 18, the material of the charge 13 as a whole undergoes a circular motion, in a clockwise direction as indicated by arrow C, absent the mixing elements or devices next to be described, which then also is the assumed main direction of material transport or movement generated by the oscillation in the various mixers, designs and structures disclosed. Plural phased drives may be used.

Mixing vessels or containers 10, having different internal mixing elements or vessel forms readily applicable to or in the arrangement of FIGS. 1–2, are shown and described with respect to FIGS. 4–18, for example.

In FIGS. 3 and 4, the cylindrical container 10 has one interior baffling mixing device 23, a roughly semi-cylindrical, half-tubular trough-shaped element extending vertically about half the height of and parallel to the axis of the container; being connected along one longitudinal edge 24, as by welding to the container inside cylindrical wall surface and endwise on the flat container bottom. The open longitudinal trough side faces the main stream or charge flow (in the arrow direction C) developed in the container as it is orbitally oscillated.

Consequently the element 23 locally changes the motion direction of part of the charge into a circular path as indicated by the curved arrow C-1. An upward vortical or spiral motion, in the region of the element acting as a shaft defining an upward flow path, is developed through the blocking and deflecting action of the element resulting also in an upper component in the motion, with the vertical stream then discharging over the top edge (as indicated by the arrow C-2) into the upper levels of the charge, or when vessel 10 is not filled above the top of element 23, fanning or scattering out over and settling on top of the main batch of material. An intimate and rapid thorough mixing of the charged components is thus obtained, both within the local votical region established by element 23, also by the exchange between the moving main body of the charge and the more localized vortex, both along the length of the element 23 and at its top discharge region.

## FIGS. 5 and 6

In FIG. 5 a pair of the trough-like elements are disposed in diametrically opposed relation with the trough openings facing oppositely across the diameter, for developing in two regions an action similar to that described in FIGS. 3 and 4.

In FIG. 6 also, the construction and mixing is generally similar to FIG. 3, but the mixing element or shaft structure 25 assumes a more tubular form, enclosing about 4/5 of the circumference of a hollow cylinder or tube, the free longitudinal edge approaching more closely the container side wall to define therewith a narrower longitudinal inlet opening 27. Here, in even more marked fashion than in the preceding figures, the inside of the container curved side wall serves as a guide surface toward the longitudinal inlet over the entire shaft height.

## FIGS. 7, 8 and 9

In FIG. 7 the interior mixing device is actually a tube 28, somewhat shorter than, and about half the diameter of, the main container, again being secured longitudinally against the vessel side wall and endwise to the container bottom, at which the tube has a cut out forming a window-like inlet opening 29 extending from the line of tangency and attachment to the side wall over a portion of the bottom circumference, again on the side of the shaft approached by the moving charge material 13, with the adjacent part of the side wall again serving as a guide surface directing part of the charge moving in the bottom of the container to enter opening 29.

The material entering the shaft tube rises very quickly in a vertical path as a helical stream where mixing is occurring to discharge from the open upper end of the shaft, and with the preferred charging of the container 10 short of the tube top, the material discharges in a fan-wise scattering upon the top of the major part of charge, for mixing both by the larger circular streaming outside the tube 28, and also recirculation downwardly to the inlet 29.

Thus in FIG. 7 there is established a constant movement in both horizontal and vertical directions substantially as generally indicated by the arrows and curved lines.

In FIG. 7, and so also in FIG. 6, since the inside diameter of the mixing element 28 or 25 is smaller than that of the main vessel, the material in the shaft region rotates much more rapidly then in the main space of the container vessel. Consequently, the material present in the oscillating mixing shaft element is particularly readily movable and, by the material being moved in the main container and pushing into the mixing shaft element under the continual orbital oscillation, it is vortically advanced upwardly to the cast from the top opening fanning out to be scattered in a finely divided condition.

In consequence of the high rotational rate of the drive motor 18, preferably from 2,000 to 10,000 rpm, especially at 3,000 rpm, the constant circulation of the mixer charge is so rapid that a thorough, homogeneous mixing is obtained in a few seconds. Thus in experiments with a laboratory mixer charged with 4 kg of foundry molding sand composition and a binder agent, even at 3,000 rpm a completely homogeneous thorough mixing was obtained in only 6 seconds.

For very intensive thorough quick mixing, mixer vessels with inner diameters between 10 and 30 and shaft-like inner mixing elements with inside diameters of from ⅓ to ½ that of the main vessel diameter, have proven themselves to be very good in operations as above described. With larger main vessel diameters, the mixing action diminishes markedly, because the rotation movement of the mix charge becomes slower; but this can be compensated for through higher oscillation rates and by arrangement of several mixing devices within the vessel.

A particular advantage of the type of mixing apparatus here disclosed is the markedly porous or loose condition of, and an extensive air penetration and ventilation of, the charge during the mixing process, so that in spite of the intense work of mixing, heating of the charge is counter-acted, with charged material remaining cool, and no unwanted heat-induced reaction occurs.

In FIGS. 8–9, the mixing element or shaft 28, again of tubular form, for a major part of its circumference, laterally projects outside of the cylindrical main vessel 10 which it equals in height, the main vessel side wall being interrupted in its cylindrical form by tube 28, to which the opposed vertical edges of the interrupted cylindrical vessel wall are welded. A small portion of the circumference of the shaft located within the vessel main cylindrical space and serving also as a reentrant part of the main vessel wall, is cut down at **28***t* below the level of the vessel rim to provide a discharge opening into the main space of the vessel while its bottom has a similar circumferential cut out between the opposed vertical edges of the vessel forming inlet opening **29.** Outboard of this opening, a straight blade **30,** sloping away from the shaft tube inwardly into the vessel, cooperates with the adjacent vessel wall portion, as a guide structure opening towards the direction from which the bottom part of the vessel charge is flowing, for directing material through inlet **29** into the shaft bottom, where again as previously described there is generated the upwardly votically moving column or stream of material, fanning out through the opening **28***t* as a finely divided discharge scattered on the top of the charge portion in the main vessel as shown in FIG. **9.**

The blade **30** may be in effect the portion of the tube wall sheared out to form the opening **29,** but remaining attached at one end and straightened to provide a guide surface tangential to or merging into the interior wall surface of the bottom of the shaft **28.**

Because of the large volume provided in the mixing vessel or container **10** in this arrangement of FIGS. **8** and **9,** it is particularly well suited for inclusion therein of an additional arrangement of mixing elements particularly of the trough-like form **23** in FIG. **3.** Such an arrangement is particularly well suited for most mixtures with higher viscosity components or with dry substances which are difficult to divide and disperse.

## FIGS. 10 to 14

A rapid mixing vessel with particularly high mixing capacity is shown in FIGS. **10–11,** wherein the tubular mixing element **28** is co-axially disposed in the mixing vessel or container **10,** and has at diametric bottom locations two window-like inlet openings **29** with respectively associated guide blades **30,** providing dual shaft inlet and guide arrangements each similar to that described for FIGS. **8—9.** The action is similar to that in say FIG. **8.**

FIGS. **12** to **14** and **19** show particular constructions embodying the invention for rapid mixers intended especially for mixer containers with larger diameters and corresponding higher capacities, while nonetheless assuring high mixing performance.

The design of FIG. **12,** in effect an elaboration or variation of the FIG. **10** form, in place of the single coaxial tubular mixing shaft **28,** comprises a group of several such tubes, here three smaller diameter tubes **28,** each having a respective bottom inlet opening and associated guide blade **29–30** similarly disposed about the vessel axis in three-fold rotational symmetry. The mixing work accordingly is performed simultaneously by a plurality of tubular mixing elements each having a relatively small diameter and a correspondingly high conveying and mixing speed or velocity for the portions of the charge moved in their individual tubes.

The large volume mixer seen in plan in FIG. **13** and in vertical section in FIG. **14** has a relatively large number of like tubular mixing elements **28** disposed serially in the annular cylindrical space between the side wall of the cylindrical vessel **10** and the co-axial cylindrical inner wall **10***m*, down to the top edge of which the top ends of the respective tubes slope inwardly at similar angle to the vessel axis. The open straight lower tube ends are spaced from the vessel bottom wall **11**; and preferably the vertical spaces as at **28***r*—**28***r*, residual between the successive tubes **28** and the inner and the outer walls **10***m*, are closed at least at the bottom and top ends by means as welded plates or by filling say with cast plastic, thus first providing an annular channel running entirely around the inner wall **10***n* beneath the bottom of the tubes and secondly eliminating corresponding dead spaces in the mixing apparatus, which also might become filled with sand mixture.



At the location of each tube **28,** from the bottom wall **11** up to the level of the tube bottoms, the inner wall **10***m* is sheared out to form an inlet opening **29** and a respectively associated straight guide blade **30,** into the annular channel; each of the several inlet openings thus provided being in effect associated with a respective shaft tube **28.** Again the several blades **30** are each directly obliquely to a respective radius inwardly into the vessel central space within the wall **10***a*, which receives the mix batch or charge; the blade-defined passages opening toward the direction from which approaches charge material flowing generally circularly in the central space.

In and at each of the tubes **28,** there takes place previously described rapid mixing rotation with a vertical ascent in a vortical stream flow and the fanning scattered top discharge towards the center space for repeated recirculation. A mixing container or vessel, which has this FIGS. **13–14** construction provides an excellent mixing performance and capacity even with rather large vessel or container diameters.

## FIGS. 15 to 19

FIGS. **15–19** show somewhat schematically in plan further modification of simple oscillatable mixing container structures, as further elaborations or modifications of FIG. **3** and the aforegoing types.

In FIG. **15,** the cylindrical main vessel or mixing container **10** has as mixing or guide elements **23,** simple straight vertical plate baffles running up from the bottom **11** and projecting radially inwardly from the vessel side wall each for about one-half the vessel radius and in diametrically opposed alignment. This arrangement in practical sense approaches a sub-division of the vessel **10** into two mixing sub-chambers with central region communication over their entire heights. As indicated by the arrow-headed curved lines, in each of these sub-chambers there again results a circular flow and mixing motion of and in corresponding portions of the charge, between which moving portions there is a continual material exchange and mixing transfer at what might be loosely called the area of tangency, of the oppositely rotating or circulating streams, at the space between the baffle edges. Preferably, the top ends of the elements **23** terminate below the top rim of the main vessel wall.

The arrangement and mixing motion action of FIG. **16** is similar to that of FIG. **15,** but has three of the baffle type mixing elements **23,** equi-spaced about the inner circumference of the vessel cylindrical wall **10,** thereby in effect forming three sub-chambers with respective rotationally moving vertically portions of the charge. Additionally here, in the very central axial core, a further fourth rotating vertical portion generally tends to arise, so that there is constant material exchange between the central core and the respective chambers, as well as between adjacent chambers around the element 23.

FIGS. 18 and 19 both show the vessel circumferential upright wall as varying from cylindrical, by having inward or reentrant curvatures of cusps as at 57 resulting in a symmetric trefoil type form as seen in plan, where at re-entrant regions, the inward projections 23 act similarly to the baffles in FIG, 16 in vessel spaces dividing and mixing motion directing action.

In FIG. 18, the vessel side wall is obtained, as it were, by successively joining the edges of three like incomplete tubular sections each comprising about ⅔–¾ the circumference of a complete cylindrical tube; in contrast with FIG. 17, where in effect the wall may be considered as derived from a cylinder by inwardly forming longitudinally at equi-spaced locations.

It may be noted here that the type of mixing vessel construction represented in FIGS. 15–19 is particularly advantageous for orbitally oscillating mixing type sand projection or mold blowing cylinders 50 as hereafter described relative to and in the system of FIGS. 29–31 to the extent that, because a very intimate thorough mixing is attained, the separate and special rapid mixing chamber 46, therein described relative to say FIG. 29, can be dispensed with.

The mixing containers of FIGS. 17 and 18 are particularly suitable and useful in combination with an elastic rubber or elastomeric lining sheet 50*d* to the described relative to the mixing vessel of FIG. 30, even where the vessel is not to serve as part of a mold blowing apparatus. For this presently discussed use, the conforming of the elastic sheeting on the vessel walls then is achieved by application of vacuum merely by a vaccum pump connected conduit opening to the bottom of the vessel, such as the pipe 50*c* appearing in FIG. 30.

FIG. 19

Because of their rather great weight and large charges, large volume mixers require sturdy and powerful drive systems, and further have mechanical components, particularly the resilient oscillating support elements 16, which are rather heavily stressed. To overcome or at least diminish these disadvantages, in the mixer construction shown in vertical cross section in FIG. 19, in contrast with the previously described constructions, the charge receiving vessel comprises a large outside upper container structure which is not directly and rigidly connected with the eccentric drive system 21; being formed by the generally cylindrical circumferentially top flanged container wall 10*n*, supported upon a plurality of circumferentially spaced fixed columns 34 preferably through support elements 16*a* similar to elements 16 previously described, and a shallow funnel-shaped bottom provided by a centrally apertured resilient rubber diaphragm 11*b* or similar elastomeric tough sheet, supported by a similarly shaped conical metal wall 11*a* with larger central opening and also an upwardly turned rim circumferentially embracing, and capturing the diaphragm about, the bottom of the wall 10*n*, being secured by suitable known means (not shown).

Beneath the bottom aperture, there is disposed an oscillating mixer, in effect a mixer vessel structure as shown in FIGS. 10–11, but with cylindrical wall 10 cut down to just above the level of inlet openings 29 and blades 30 and circumferentially top-flanged at 10*y* for securing to the inner margin of the elastic bottom wall 11*b* with the mixing shaft tube 28 projecting up through the central opening.

Vessel 10 is supported by resilient elements 16 suitably secured to the floor or rigid base on which is secured the drive motor 18 operating the eccentric mechanism 21 on the bottom wall 11. The side wall bottom outlet 10*B* opens through a discharge tube 10*p*.

In FIG. 19, the primary driving effect arises from the orbital oscillation of the lower vessel portion 10 and its upwardly extending tubular mixing shaft 28 and the blades 30 associated with the shaft inlets 29. Comparatively free oscillation in 10 is permitted by the resilient character of the bottom lining sheet 11*b*, and the gap between the flange 10*y* and the surrounding inner edge of the bottom wall 11*a*.

Basically the mixing flows and action is that described for preceeding figures, especially FIGS. 10–11 as indicated by the various curved arrow lines.

To some degree the oscillating motion of the bottom container 10 and shaft 28 is communicated to the large top vessel portion through the charge and, to a slight degree, through the elastomeric wall 11*b* as permitted by the preferably used elements 16*a* at the top of the respective columns 34. This vibration of the top container wall portions assures a constant, ready flow down the funnel-like bottom into the lower active vessel portion 10, and thus contributes even in this large space to a quite intensive mixing.

But in such motion, the upper vessel portion is not directly driven by the eccentric mechanism, so that it is not required that the motor-eccentric mechanism substantially move the entire upper vessel structure with the full mass of its charge with the characteristic oscillation and with the amplitude imparted to the vessel 10 and mixing tube 28. Obviously this lessens the power and structural demands on this drive mechanism and as well on the upper resilient supports 16*a*.

The mixing intensity or activity with a large volume mixer can further be increased through disposition therein of several of the mixing elements as shown for example in FIG. 12.

FIGS. 20–21

FIG. 20 shows a further elaboration of the construction of FIGS. 10–11 for the main mixing vessel or container 10. The latter is again supported by the resilient elements 16 on a rigid sturdy base surface, which also mounts the drive motor 18 operating the eccentric device indicated generally at 21. Here a simple rectangular stationary frame, provided by base-anchored columns 34 topped by a transverse horizontal beam 33, supports a beam-centered vertically depending, preferably rigid rod 32, carrying a conical element 31 disposed within and partially downward along the length of the central mixing shaft tube 28. Between the external periphery of a short cylindrical top portion 36 of element 31 and the tube inner wall surface 35 there is defined a circumferential gap of size locally varying the eccentric oscillation of the vessel 10 and its shaft tube 28 fixed therein.

With the high rate of oscillation, from point to point the gap is continually rapidly widening and narrowing to subject the mix material passing up through the gap to a further crushing or at least lump breaking action. This arrangement of the FIG. 20 is especially well suited for the comminution and mixing of difficulty dividible charge mixture components.

In general arrangement, the apparatus of FIG. **21** is similar to FIG. **20**; but in place of the fixed conical crushing element, there is provided a rotary agitator type device comprising a set of vanes or bars **31***a* carried within the middle region of mixing tube **28** by the depending drive shaft **32***b* of a high speed electric motor **32***a* mounted on beam **33.** The elements **31** preferably are knife blades, which break up felting, balling or agglomorations of the charge material being transported upwardly in tube **28** by the characteristic oscillating mixing action.

Also, for example, granulated or powdery material can be uniformly coated or tinted with extremely small quantities of coloring substances or can be quite rapidly and evenly dampened with wetting materials or agents. A rapidly rotating cutting tool in the form of a knife head works very effectively within the mixing tube of a rapidly oscillating mixer, because the entire mixing charge, within a very short time is repeatedly exposed continually to the knife head action.

FIGS. **22** and **23–24**

The double mixer in FIG. **22** is comprised of a single vessel affording right and left main mixing containers **10** and **10***a*, each generally of the form shown in FIG. **10** except that its co-axial mixing tube **28** has only a single bottom inlet opening **29** and associated guide plate **30**; and that the two cylindrical wall portions intersect and leave a wide vertical opening **37,** which is fully closable or partially opened by a flap or shutter-like closure **39** supported by a vertical shaft **38.**

With the flap **39** closed, mixing can proceed simultaneously and independently in the respective containers; or, with the flap opened, on entire charge can be mixed, not only by the characteristic motions and action in each of the containers as previously described, but also with transfer of material from one another to the other as indicated by the several arrows in FIG. **22.**

In a first part of the mixing cycle, with the flap **39** closed, in each container simultaneously mixing of respective charge portions may be carried on, for example "pre-mixing" with sand, but keeping separate, certain reactive components; and in the second part of the mixing cycle, with flap open, to carry out a rapid complete final mixing of the total charge in both containers, as a finished batch of mixed product.

The necessary dwell time of the reactive mix in the apparatus can advantageously be further shortened by use of double or multiple mixers in a single overall apparatus.

FIGS. **23** and **24** two independent mixing vessels **10** and **10***a*, each having respective tubular mixing shaft elements **28** and generally the form and disposition represented in FIG. **7,** are mounted adjacently on a base or oscillating table **14** as a common bottom wall but without a direct inter-connection between their cylindrical spaces as in FIG. **22.**

Controllable respective discharge apertures **44** and **45** open from the respective tube structures **28***a* and **28** through the bottom wall into the top region of a rapid finish mixing chamber **46** secured to the bottom of plate **14** to oscillate therewith. Apertures **44–45** are provided with appropriate stoppers or shutter means (not shown). Chamber **46** is comprised of the vertical cylinder or tube **46***a*, sub-divided above its discharge end **48** into smaller vertically successive mixing chamber by apertured horizontal inserts **47,** in the form of perforated or slotted plates or rigid sieve screens.

Accordingly in each of the respective mix vessels **10,** 10*a*, mixing of diverse and separate charges of components simultaneously may proceed to a thorough mixing; and, as soon as these preliminary mixings are completed, the respective charges are released to the top of chamber **46,** and with the continuing oscillation of the apparatus, the pre-mixed batches flow in steady streams onto the first partition **47,** thence descending through and finally mixed in the successive chambers during the dwell time which it takes to advance to discharge at the bottom end **48.**

Thus for example, in this arrangement of FIGS. **23–24,** sand and a binder resin can be mixed in one vessel **10,** sand and resin hardener or activator in the other **10***a*, so that the respective sub-mixtures of the total batch can be retained in the two vessels unaltered as far as the reaction is concerned for a very long time.

The final mix reaching the bottom opening **48** is ready for discharge or acceptance directly into a mold flask or core box or other suitable receptor for further use. By appropriate timing of the duration of the opening of the respective controlled outlets **44** and **45,** quite accurately dispensed amounts of the premixed materials can be taken from respective container vessels **10** and **10***a* and mixed in chamber **46,** to provide a final mix of such quantity as might be required for immediate use. This apparatus of FIGS. **23** and **24** is suited to mixing equipment feeding into mold and core making machines.

FIGS. **25, 26** and **27**

Because of the larger quantities of molding compositions required for the cold hardening process, where several tons per hour are required, continuous throughput mixers are obviously especially advantageous.

FIGS. **25–26** show various ones of the structures, features, and principals of the invention above disclosed applied in a continuous mixer, of comparatively small dimensions, with which a considerably through-put of several tons per hour is obtainable. On the oscillatingly supported square table **14** (driven with the characteristic orbital oscillation previously described) there is mounted, in generally symmetric fashion, a plurality of four mixing vessels, each having respective tubular mixing shaft devices with bottom window type inlet openings (**10, 28, 29**) (**10***a*, **28***a*, **29***a*,) and (**10***c*, **28***c*, and **29***c*), arranged in serial order for material flow from a point of continual in-feed of separate components at vessel **10** by supply means **40, 41, 42,** to a point for continuous discharge at vessel **10***c* by discharge trough **43.** The structure of each mixing vessel is generally similar to that of FIG. **7** in having a vertical shaft with bottom inlet opening, adjacent to a cylindrical vessel main wall, extending upwardly from the bottom to terminate below the vessel top rim.

The supply devices, here a vibratary conveyor **40** for solids and two pipes **41** and **42** for liquids, are appropriately selected for suitability to individual components to be delivered, and provided according to the number of the mix components to be individually supplied. It is also feasbile to add further components at subsequent points in the other mixing containers especially **10***a* and **10***b*.

As seen in overall plan FIG. **25,** and more particularly in the FIG. **26** vertical section for the two successive intermediate mixing vessels **10***a* and **10***b*, each container in effect has a slight portion of its circumferential wall partially projecting into the adjacent next container, and in fact forming a common wall, the top portion of which is recessed or cut out downwardly, as at **10***ax* for the container **10***a* (see FIG. **26**) to a level below the top of and symmetrical to its tube **28***a* to provide a discharge openings to the next container. These discharge openings are designated by the vessel reference character with a suffixed *x*.

Further each vertical tubular mixing device in the last three vessels is located to one side, at 90° spacing, from its inlet opening, i.e., the discharge opening from the preceding container, so that as its mixing movement occurs as previously described, the material discharging from its mixing shaft tube is thrown in part onto the top of the main material mass therein and in part through the adjacent discharge opening into the succeeding container.

The in-feed, of the several components to the first container and of the vessel discharges to subsequent vessels, is made onto the larger top area of the vessel contents remote from its mixing shaft, so that there is immediate mixing with material being discharged in the following vessel out of its shaft back into its main chamber region.

At the final vessel **10***c*, although the wall projects back into the first mixing vessel **10**, there is no discharge wall opening adjacent the shaft **29***c* at this location, but rather at the roughly diametrically opposite location for discharge to the inclined trough **43.**

The size of such discharge openings out of each vessel establishes under given operating conditions the relative quantities of the tube-discharged mixed material passed to a succeeding vessel, or in the final stage vessel **10***c*, to the discharge trough **43.**

Once the apparatus of FIG. **25** is set into continuous through-feeding operation and steady state conditions have been established, the final output at **43** will be limited, of course, by the amount of supplied material.

The through-put velocity or speed of the mixed material, and therewith the mixing intensity, is established first by the eccentric drive motor speed, further by the number of the successive serially connected mixing containers, and also by the amount of material respectively delivered from the vertical mixing shaft devices to the next vessel.

Hence, the through-put capacity or rating can be notably increased for example, by sloping the upper edge of the mixing shaft toward the adjacent discharge window, as indicated by the sloped edge **28***y* in FIG. **27,** as compared with the horizontal upper edge **28***x* of the mixing shaft device **28***a* in FIG. **26.** This, of course, by increasing the amount of the shaft discharge passed on hence, the feed rate, to the succeeding vessel, decreases the amount of shaft discharge fed back into its own vessel, as is signified by the respective numbers of the discharge direction arrows, for discharge and feedback respectively, as appearing in FIG. **27** as compared with FIG. **26.**

## FIGS. 28 to 31

The next described particular arrangements of the mixing apparatus, as is also the case for FIGS. **23–24,** are quite advantageously suited for carrying out of molding methods by the so-called cold resin process to prepare molds and cores for casting production in the foundry industry.

By the process sand, generally quartz sand, is mixed with a resin as a binder agent and certain hardeners, various acids, for setting the resin and thereby solidifying the foundry molding composition. The resin type and the proportion of the resin to acid can be so selected that the setting will occur in a very short time, even in a few seconds, so that by such procedures an economic and automatable molding process is feasible. However, for success with such methods, a prerequisite is the use of mixers which both work extremely rapidly and have a very simple form of construction, with which the strong tendency of the reactive sand-resin-hardener mixture to set up and form incrustations on the mixer surfaces either can be avoided or at least presents no particular problem.

As previously noted in this cold hardening process, large quanitites of molding sand compositions are required, often many tons per hour, for which continuous mixers are particularly advantageous.

The mixing apparatus shown in top plan view in FIG. **28,** and appearing in FIG. **29** also as part of a larger combination, represents a mixer combination suitable for such uses. On a single rectangular base plate **14** supported and by an eccentric motor drive oscillated as previously described, there are two parallel sets of three series-connected mixing vessels each with respective tubular mixing shaft elements, **10***a*–28a, **10***b*–**28***b*, **10***c*–**28***c* in one, **10***d*–**38***d*, **10***e*–**28***e*, **10***f*–**28***f* in the other. To each of these series sets sand is fed at a predetermined rate from a vibratory conveyor **40** or other suitable conveying mechanism, divided into the two streams at **40***a* and **40***b* feeding into the respective first containers **10***a* or **10***b* of the series, along with simultaneous measured delivery of the resin and of the hardener through supply pipes **41** and **42,** so that in one series resin is being pre-mixed with sand, in the other hardener with sand, in two parallel streams finally leaving through the discharge outlet troughs **43***a*, **43***b*, for mixing of the final total composition in a rapid mixer **46** therebelow.

The form of the individual vessels and their respective mixing shaft devices or elements is basically similar in structure and mode of individual operation to the construction shown in FIG. **7.** However, the containers "intersect" one another as described for FIGS. **25** and **26** at a region providing a discharge window or opening from each container to its successor in each series or to the discharge trough **43***a* or **43***b*, but here the respective tubes are disposed roughly at 180° from the point of in-feed to each container.

Again there is a thorough mixing of the resin component with sand and of the hardener component with sand, in flows simultaneously passing through the respective series of mixing vessels; these mixings or submixings, during this important pre-mixing phase of the overall mixing, keeping resin and hardener totally separate so that they can not begin to react until the two mixing flows are brought together in discharging from **43***a* and **43***b* into the rapid mixing chamber **46** previously described relative to and shown in FIGS. **23–24.**

FIG. **29** shows the larger combination of apparatus for the mixing and preparation of the molding composition on through to its use in discharging to a mold flask or a core box. At the upper right, the heavy pedestal **17,** of cast iron or other suitable material, shown in section, at its top surface through the resilient or elastic support elements **16,** supports the mixing section comprising apparatus as described with respect to FIG. **28,** and a drive motor **18** for an eccentric drive of the base plate **14** as in FIGS. **1** and **2.**

Here the rapid mixing chamber **46** is mounted on a separate oscillating plate or base table **14***a*, in turn supported through the elastic support elements **16***a* on a lower shelf portion **17***a* and eccentrically driven by a separate drive motor **18***a*. As previously described, chamber **46** rapidly thoroughly mixes the two streams of separately pre-mixed materials delivered by **43***a*, **43***b* to discharge the final completely mixed molding compositions at **48,** into inclined trough **49** feeding either directly into a mold flask or core box, where the reactive mixture sets up after a few seconds to provide a finished core or mold, or to discharge into the apparatus at the lower left side of FIG. **29** which may be broadly described as a mixing type mold blowing or core shooter machine.

The motors **18** and **18***a* provide separate drives for independent operation of the respectively actuated apparatus sections. Considering operation of the mixing section alone, turning off the motor **18** immediately interrupts the discharge streams from **43***a* and **43***b;* at which time also, of course, the supply of sand at **40** and to the resin and hardener at the supply tubes **41** and **42** is to be cut off, so that abvantageously the power for the component feeding system is normally simultaneously cut off along with power to the motor **18,** as by one main switch or other known controls.

The rapid mixing chamber **46** can be allowed to run on continously or if desired only for a brief time for the thorough mixing of the desired molding composition amount.

Thus, by control of the duration of mixer operation, it is possible to withdraw precisely the molding composition desired to be dispensed, and in amount exactly suited to the molding sand composition requirement for making of respective molds or cores as may be required, so that the apparatus is quite flexible in uses, and quite suited for making successive molds and also cores of quite diverse weight.

Application of the present mixing invention in the continuous mixer described with respect to FIG. **28** has a further very important advantage that no part of the entire machine can be afflicted by incrustations, because the necessary chemical reaction has no opportunity to occur during the swift transit of the mix.

Incrustations in the rapid finish mix chamber **46** to some extend are indeed unavoidable, but through constructional expedients they present little trouble. The basic tube **46***a* can be built up from heavy paper board, synthetic plastic or other suitable low cost stock in individual tubular sections between which are clamped and mounted perforated rubber sheets as the sieves **47**; a structure therefore also to be taken apart and cleaned. But also in consequence of the possible simple construction from cheap materials this chamber can also be a throw-away component intended to be replaced by a new part after incrustations have set in.

This last described mixer combination for carrying out of the cold hardending mold manufacturing method can advantageously be supplemented by an air pressure operated mold blowing or core shooting type mix projecting machine for the making of molds or cores, with the latter machine likewise operated on the oscillation mixing principal. In this way even the compaction of the reactive molding composition in the mold or core box can be essentially accelerated and the preparation time accordingly shortened.

Such larger combination of mixer and molding machine is also shown in FIG. **29** by inclusion of a projection machine of the type described, at the lower left hand side. Details of a basic oscillating vessel **50** are presented in sections FIGS. **30** and **31,** showing conditions for charging and discharging stages of operation. A lower portion of a sturdy rigid pedestal **17***b* mounts a fixed motor **18***b* again through an eccentric connection **21***b* orbitally oscillating the swingable table **41***b*, supported on the pedestal through the previously described type of resilient elements **16***b*, and carrying vessel **50.** The drive of the oscillating table for the swinging mold blowing mixture **50** and the oscillating finish mixer **46** and the larger multiple vessel mixer can be similar in their operating frequencies and amplitudes. The top shelf **17***c* supports a mold flask, core box or the like receptacle **56** to be filled or charged from vessel **50** with a molding sand composition. The vessel **50** comprises a heavy cylinder **50** secured on the oscillating plate **14***b*, through the shallowly conical bottom **50***b* of which there extends an air vent or vacuum application pipe **50***c;* an internal elastomeric rubber sheet or lining **50***a;* a top cover **50***a* circumferentially clamping the lining top margin against the vessel top flange **50***f* in an air sealing relation by bolts or other suitable means not shown and having a central upwardly circumferentially flanged charging opening **53.**

A hollow discharge pipe **52,** co-axially shiftably mounted and extending upwardly through the cover opening **53,** carries an upwardly convey hemispherical rubber-like resilient sealing stopper or plug element **52***a* supported from below by the collar **52***b* which is sealingly seatable against the inside periphery of the cover opening. The discharge or shooting tube **52** is connected in turn by flexible tubular elements **55** with an inlet or nozzle supported in the pedestal top level **17***c* for ultimately directing discharged molding composition into the core box or mold flask **56** of other receiving vessel as shown. An air inlet pipe **51** through the cover provided with a valve **54,** either manual or automatically operated, admits and releases air to an upper chamber defined between the cover **50***a* and the diaphragm sheet **50***d*.

The diaphragm or sheeting **50***d*, held tensioned between the lid and the top flange of the container in airtight relation, in the condition of FIG. **30** is tensioned against the closing the lower or inlet end of the tube **52** when the latter is moved downwardly by appropriate shifting means (not shown in the drawings), thereby opening a circumferential gap between the inlet opening **53** and the stopper **52***a*. On the other hand the elastic tension of the diaphragm normally urges the rod **52** and the stopper element firmly into seated relation, when the latter is raised, to provide an airtight closing of the charging opening.

The now reactable molding sand mixture is supplied from the rapid chamber **46** through the discharge trough **49** into the vessel inlet **53,** in open condition as shown in FIG. **30,** in an amount suited for the mold or the core to be produced. As soon as the requisite amount is charged, and the container closed by raising the plug **52** to seated position, air valve **54** is opened, admitting air from the pressurized supply source into the vessel **50** as in FIG. **31** shown, causing downward extension of the diaphragm **50***d* into the conformity with the inner wall surfaces of the vessel, air being vented from below the diaphragm through **50***c*, or the diaphragm even drawn down by simultaneously applied vacuum, thus carrying the diaphragm away from the discharge tube, through which the charge is suddenly shot upwardly out of tube **52** through **55** into the receptor **56** with compaction assured.

The orbital oscillation of the container **50** during charging and up to the time of complete discharge serves first to continue a mixing action, also to keep the charge loose and porous, and further assures its ready flow down to and into the lower inlet end of discharge tube **52** for a free and ready complete discharge under air pressure into the receptor. To initiate the charging process the air valve **54** is closed, the upper space vented, for example by dropping the rod **52** or by a three-way valve at **54,** and a new charge fed in. All such operations are as aforementioned advantageously carried out with continued oscillation of the machine.

The mixing and sand shooting or mold blowing apparatus as described relative to the FIGS. **28** and **29** has the following important advantages:

1. The combination comprised of a continuous mixer and rapid finish mixing chamber, as shown in FIG. **28** and at the right of FIG. **29,** can simultaneously service several oscillating mixing type mold blower or core shooting apparatuses; and thereby machine idle time which is determined by the time required for the molding composition to set up in flasks or core boxes can quite extensively be avoided.
2. The mixer combination operates without dependence on valves or closures so placed that they can become blocked by setting of molding composition.
3. Incrustation in the oscillating mixer type mold blower machine is avoided, because the reactive molding composition comes in contact for any notable time with only the rubber diaphragm; and because the latter, continually changing shape and tension in shifting between charging and discharging positions, is continually repeatedly strongly stretched and contracted, so that deposits or crusts even at an incipent condition are immediately cast off.
4. Furthermore the constant intense shaking motion of the mixing projecting machine itself provides three important advantages:
   a. During the charging time, the already reacting molding composition is kept loose and porous and incipent adhesion is avoided.
   b. The charge blowing or shooting process, the transfer in the discharge conduits, and the emptying of the vessel are extraordinarily facilitated, in consequence of the marked mobility of the agitated charge and its rotational motion. While conventional sand projector machines, such as core shooting or mold blowing machines, generally work with a projection pressure of from 5 to 6 atmosphere gauge, the apparatus of the present invention, even at about two atmosphere gauge pressure provides cores and molds with a quite sufficient density and compression, Accordingly it is possible to use relatively cheap and simple air seals; and also the pressurized air consumption is low.
   c. Any molding composition left in the machine after the charge projection, in consequence of the shaking motion remains fluent and granular and is taken up by the subsequent fresh charge without detriment.

It should be noted, in summary, that not only the FIGS. **15–19** show the formation of several circular streams, with the streams having a like rotational sense, but also that the other embodiments lead to several circular streams. Thus for example FIG. **10** shows the formation of two circular streams, the one a circular stream in the annular space between the inner surface of the vessel **10** and the other circular stream within the mixing tube **28.** In FIG. **22** are found the two adjacent circular flows (generated as in FIG. **15**) in the respective annular spaces, between the tubes **28** and surrounding vessel walls and additionally the circular, vortical flows in the tubes, therefore axially within the annular flows. Thus there are represented circular flows adjacent one another and disposed one within the other. Of course, in the drawings the flow designations are to be understood as representing principal directions of flow, and that displacements and overlappings occur.

Also be it emphasized that a mixing apparatus in accordance with the invention can be constructed in a simple manner not only as a batch machine, but even as a continuous mixer, and that despite a comparatively very small size there can be obtained even a considerable through-put performance of several tons per hour.

What is claimed is:

**1.** A mixing apparatus for mixing fluent materials, particularly foundry molding materials, comprising:
- a mix vessel having a vertical circumferentially enclosing side wall and resiliently mounted by means permitting an orbital oscillation about a vertical axis located within the confines of the vessel;
- driving means imparting to said vessel and orbital oscillation in a horizontal direction thereby imparting a principally horizontally circular main flow to material contained in the vessel;
- mixing means comprising at least one shaft-like element rigidly connected to and extending longitudinally within the vessel in a vertical direction away from the vessel bottom,
- said mixing means having a horizontally concavely curved vertical surface and providing an opening to said surface facing toward the direction from which said main flow approaches, whereby said element intercepts a portion of the main flow through said opening to develop at least over the height of the element a separate flow with a circular motion.

**2.** A mixing apparatus as described in claim **1,** wherein
- said shaft-like element
  - is a vertical tubular element,
  - having in its bottom end region as said opening an inlet aperture opening to its interior space above the vessel bottom.

**3.** A mixing apparatus as described in claim **2,** wherein
- the upper end of the tubular element is disposed beneath the upper end of the mixing vessel side wall.

**4.** A mixing apparatus as described in claim **2,** wherein the tubular element is secured on a side wall of the mixing vessel and
- said inlet opening starts at said side wall.

**5.** A mixing apparatus as described in claim **2,** wherein said tubular element includes a material conducting deflecting baffle or blade, associated with said inlet aperture and projecting therefrom into the main material flow path in said vessel.

**6.** A mixing apparatus as described in claim **2**, wherein

said tubular element is secured on an inner wall surface of the mixing vessel,

said inlet aperture faces towards the interior of the mixing vessel,

and the upper edge of the tubular element lies below the level of the upper edge of the mixing vessel side wall.

**7.** A mixing apparatus as described in claim **6**, including a series of said tubular elements disposed next to one another successively at the side wall inner surface of the mixing vessel.

**8.** An apparatus as described in claim **6** wherein adjacent the upper end of said tubular element the vessel side wall has a window-like cut-out as a material discharge passage opening into an adjacent mixing container.

**9.** Apparatus as described in claim **2**, wherein said tubular element is located at the middle region of the mixing vessel, has a plurality of said inlet apertures and has in association with said inlet apertures respective material directing blades.

**10.** Apparatus as described in claim **9**, having a plurality of said tubular elements disposed at the middle region of the mixing vessel.

**11.** A mixing apparatus as described in claim **2**, wherein

said mixing vessel is associated with and is in material receiving communication with a relatively fixed larger vessel and has its said mixing means disposed for orbital oscillation of its axis about a substantially vertical axis of the relatively fixed larger vessel.

**12.** A mixing apparatus comprising apparatus as described in claim **2**, and a markedly larger container disposed above said mix vessel and having a comparatively stationary side wall and a centrally apertures bottom wall including an elastic resilient centrally apertures rubber-like inner wall portion with outer periphery connected to the bottom of the container side wall and the top of the vessel side wall connected to the rubber inner wall central aperture periphery as a closure therefor.

**13.** A mixing apparatus as described in claim **1** comprising a plurality of said vessels disposed on a common oscillating base and connected either for series or for parallel flow of material therethrough.

**14.** A mixing apparatus as described in claim **13**, including conveying devices supplying to a first vessel components to be mixed; and a discharge opening from a last mix vessel for the mixed material.

**15.** A mixing apparatus as described in claim **13**, wherein

said plurality is arranged on said common base in two rows of series-connected vessels,

each series row provided with at least two component feed paths to a first vessel of, and a discharge path from a last vessel of, the row,

said discharge paths feeding into an oscillating mixing vessel provided with a drive independent of the drive for said common base.

**16.** A mixing apparatus comprising

a plurality of said mix vessels each as described in claim **1** adjacently mounted on a common orbitally oscillating base, but with independently operating mixing spaces,

and jointly connected through suitably valved discharge openings to an additional conjointly oscillating rapid finish mixing chamber.

**17.** A mixing apparatus for fluent materials, particularly foundry molding materials, comprising

a mix vessel having a vertical circumferentially enclosing side wall and resiliently mounted and driven by means imparting to said vessel an orbital oscillation in a horizontal direction imparting a principally horizontally circular main flow to material contained in the vessel,

mixing means rigidly connected to said vessel and having a vertically extending portion located within the vessel,

said mixing means including a material conducting vertical baffle or blade within the vessel associated with an inlet opening of said mixing means as a projection of said mixing means into the main material flow path in said vessel, directing material into said inlet opening,

whereby material encountering said mixing means develops at least over the height of the said mixing means a separate flow with a circular motion.

**18.** A mixing apparatus as described in claim **17**, wherein the said mix vessel is oscillatable with a constant amplitude independent of the loading.

**19.** A mixing apparatus as described in claim **18**, wherein said vessel is oscillated at a high rate by motor driving at more than 1,000 rpm and preferably from 2,000 to 4,000 rpm.

**20.** A mixing apparatus as described in claim **19**, wherein said vessel is provided with a motor operated eccentric drive.

**21.** A mixing apparatus as described in claim **18**, wherein

said mix vessel is secured to a base plate,

said base plate being oscillatably supported on an immobile support by resilient elements,

and a drive motor fixed on said immobile support drives an eccentric rotatably journalled in a guide member secured on said base plate.

**22.** A mixing apparatus as described in claim **17**, wherein said inlet opening of said mixing means is slot- or window-shaped.

**23.** A mixing apparatus as described in claim **17**, wherein said mixing means is a vertical tubular element, having a closed bottom end, and above its bottom is provided with an aperture as said inlet opening.

**24.** A mixing apparatus as described in claim **17**, with said mixing means

located at the middle of the mixing vessel,

having a plurality of said inlet openings and

having, in association with said inlet openings, respective material directing blades to direct material from the main flow into said mixing means.

**25.** A mixing apparatus as described in claim **24**, having a plurality of said mixing means disposed at the middle of the mixing vessel.

**26.** A mixing apparatus as described in claim **17**, having a plurality of said mixing means, secured on the inner surface of the side wall of the mixing vessel.

**27.** A mixing apparatus as described in claim **17**, comprising a plurality of said vessels disposed on a common oscillating base and connected for either series or parallel flow of material therethrough.

**28.** A mixing apparatus comprising a plurality as described in claim **27,** of said mix vessels jointly connected through discharge openings to an additional conjointly oscillating rapid finish mixing chamber.

**29.** A mixing apparatus as described in claim **27,** wherein said plurality is arranged on said common base in two rows of series-connected vessels;

each series row being provided with at least two component feed paths to a first vessel of, and a discharge path from a last vessel of, the row;



said discharge paths feeding into an oscillating mixing vessel provided with a drive independent of the drive for said common base.

**30.** A mixing apparatus as described in claim **17,** wherein the vessel side wall has a window-like cut out as a material discharge passage opening into an adjacent container.

**31.** A mixing apparatus as described in claim **17,** wherein said mixing means is disposed for orbital oscillation of its axis about a substantially vertical axis in a relatively fixed larger vessel.

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