Sept. 29, 1970 G. H. PRASCHAK ET AL 3,531,092

ROTARY BATCH MIXER AND METHOD

Filed Oct. 22, 1968 3 Sheets-Sheet 1

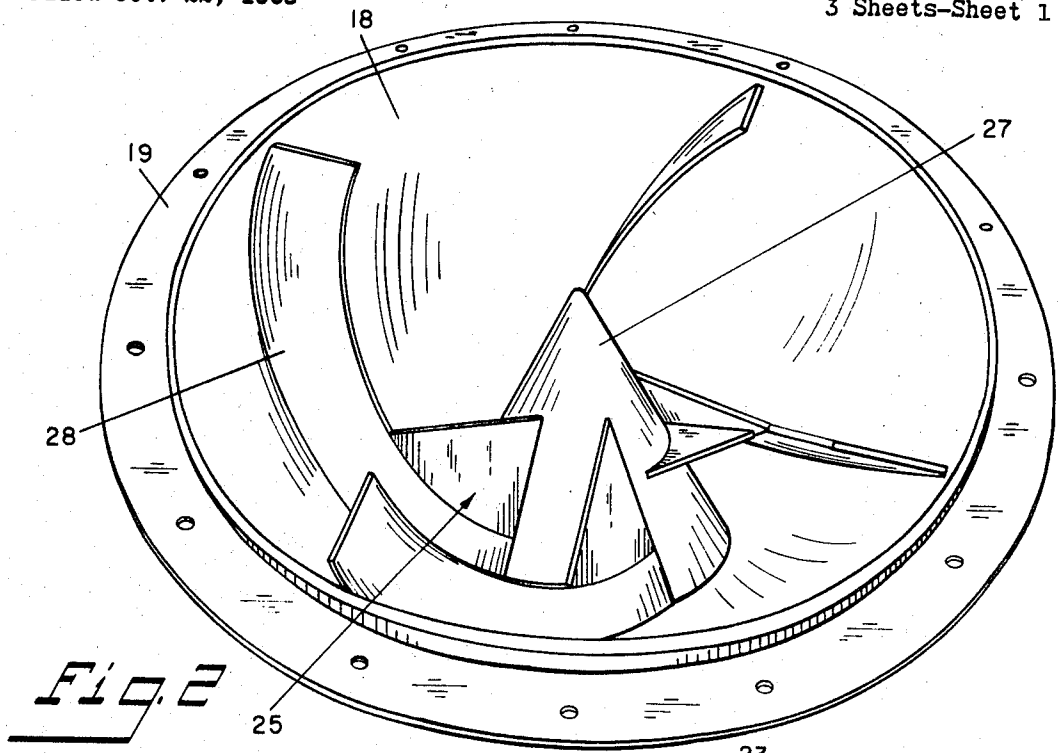


Fig. 2

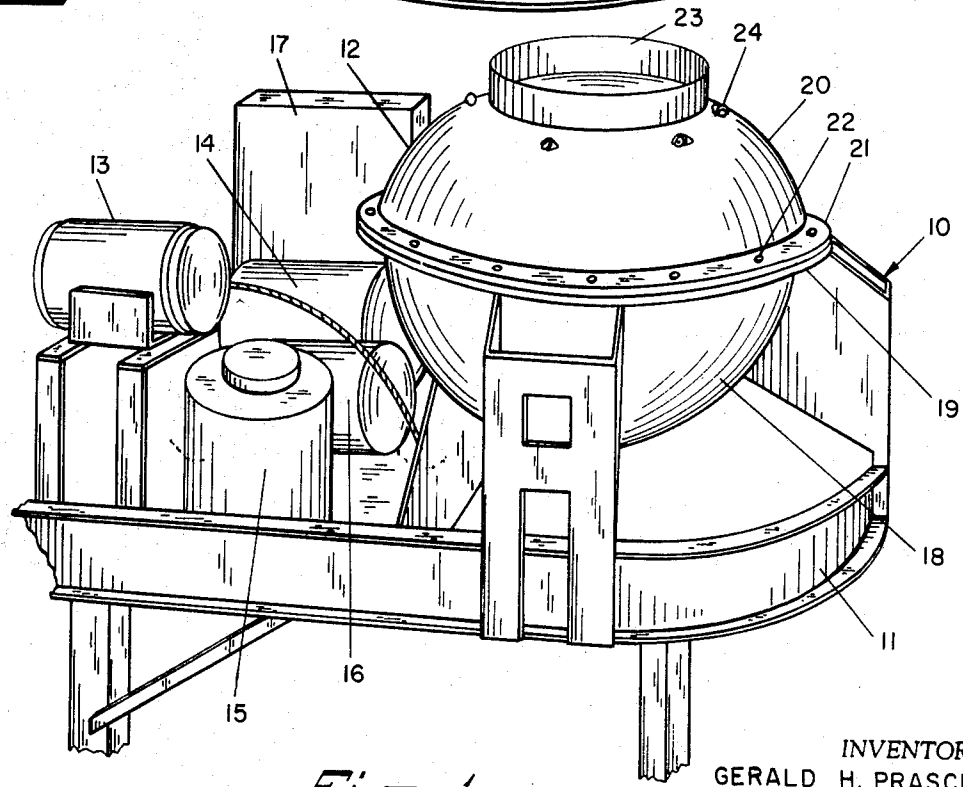


Fig. 1

INVENTORS
GERALD H. PRASCHAK
DWIGHT E. HOWDEN, JR
BY Joseph G. Werner
John M. Winter
ATTORNEYS

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3 Sheets-Sheet 2

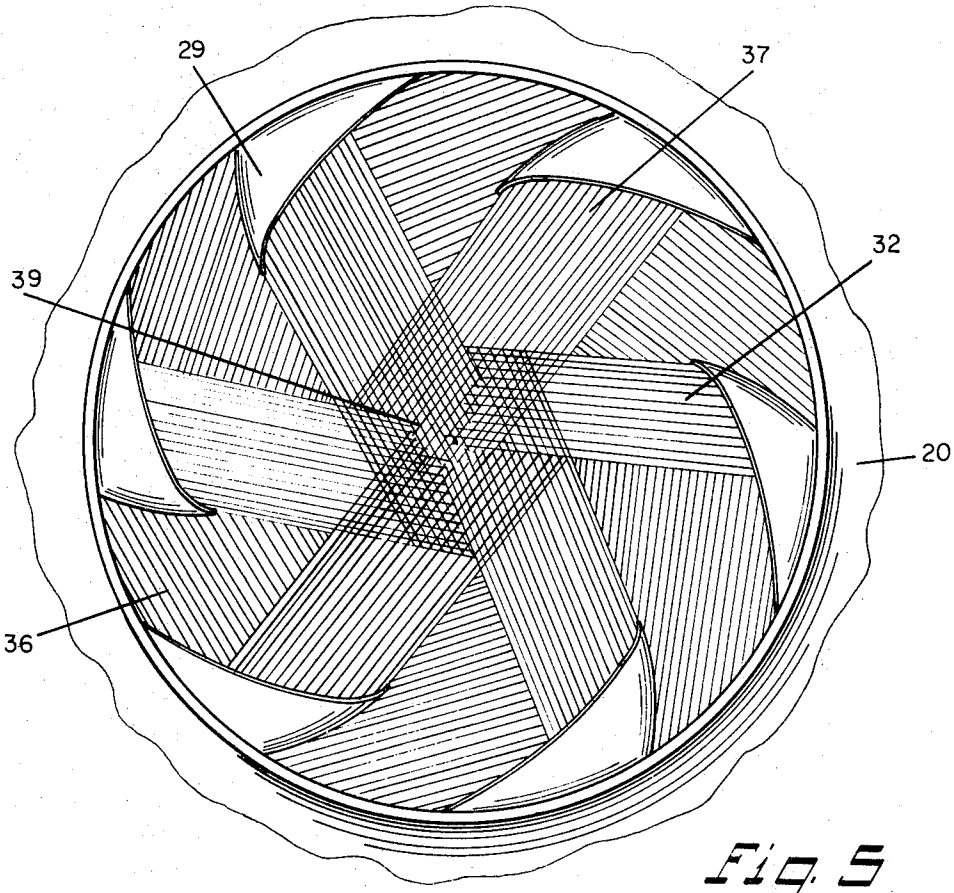


Fig. 5

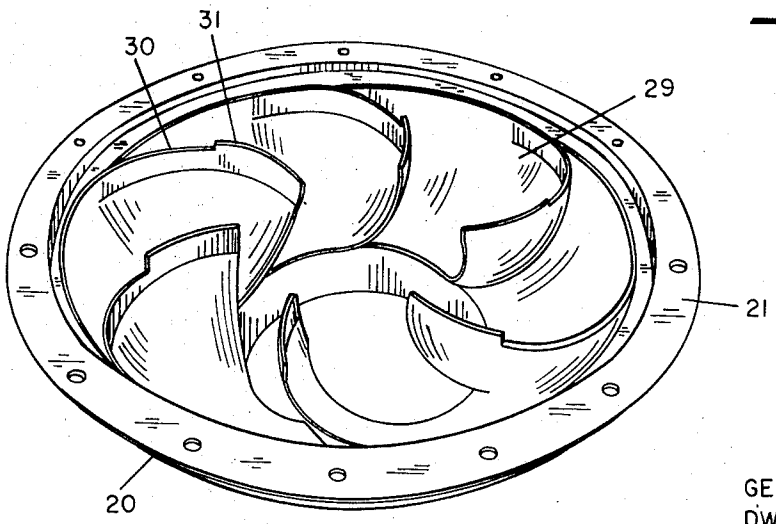


Fig. 3

INVENTORS
GERALD H. PRASCHAK
DWIGHT E. HOWDEN, JR
BY Joseph G. Werner
John M. Winter
ATTORNEYS

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3 Sheets-Sheet 3

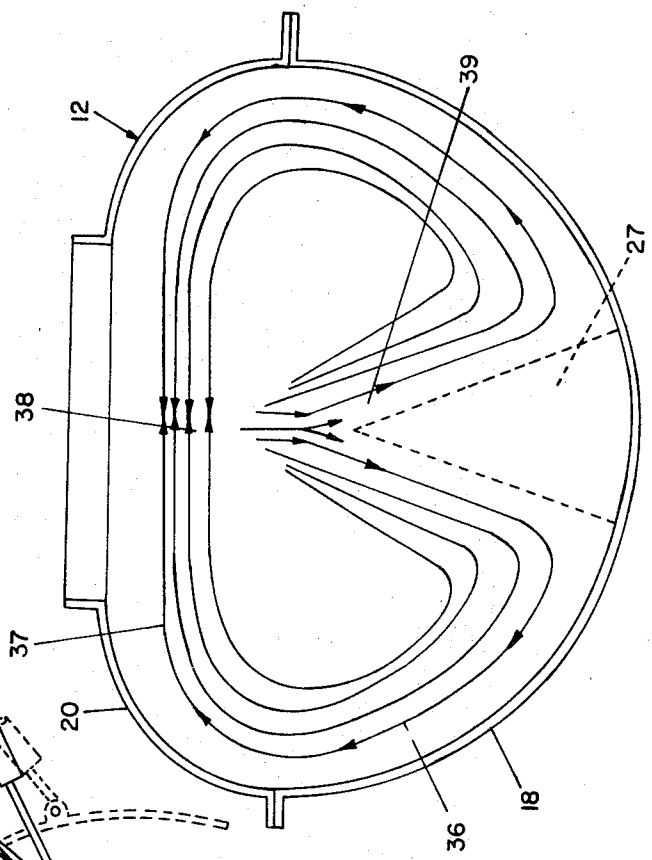


Fig. 6

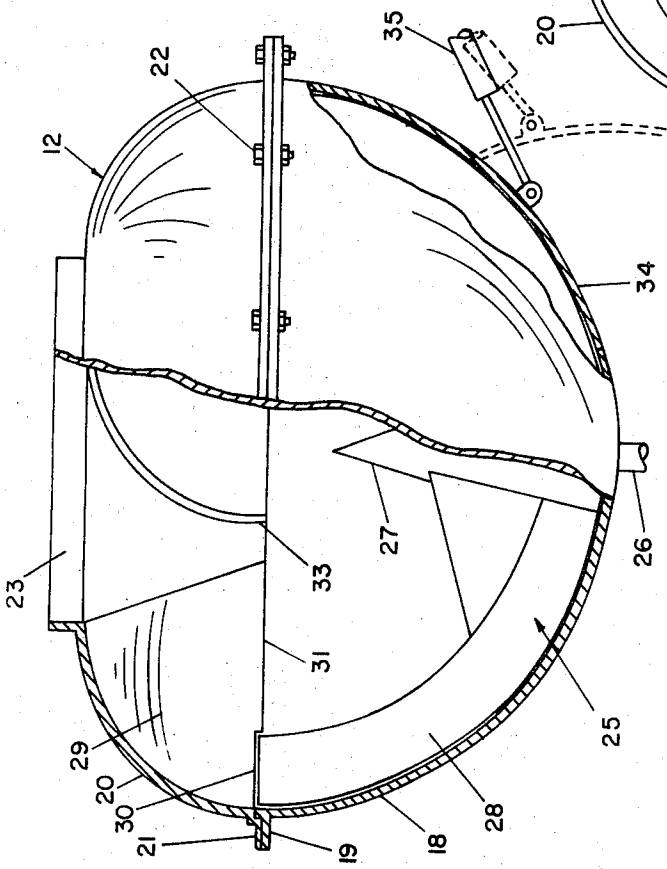


Fig. 4

INVENTORS
GERALD H. PRASCHAK
DWIGHT E. HOWDEN, JR.
BY Joseph G. Werner
John M. Winter
ATTORNEYS

United States Patent Office 3,531,092
Patented Sept. 29, 1970

3,531,092

ROTARY BATCH MIXER AND METHOD

Gerald H. Praschak and Dwight E. Howden, Jr., Marshfield, Wis., assignors to Praschak Machine Co., Inc., Marshfield, Wis., a corporation of Wisconsin

Filed Oct. 22, 1968, Ser. No. 769,522
Int. Cl. B01f 7/16
U.S. Cl. 259—8 11 Claims

ABSTRACT OF THE DISCLOSURE

A batch mixer having a mixing chamber wherein the upper portion has a first inlet for introducing particulate material into the mixing chamber and a series of inlets circumferentially spaced about the top portion for rapid introduction of liquid material under pressure. A rotary impeller assembly is mounted in the bottom portion of the mixing chamber. A plurality of stationary curved baffle ducts are provided on the underside of the top portion of the mixing chamber.

The impeller blades impart an upward spiral flow to the mass of material. The baffles divide the upwardly spiraling mass into a plurality of converging flow streams directed at one another in opposed intermixing relation wherein the materials bombard one another. The intermixed material then falls by gravity and the conical hub of the impeller assembly imparts a deflected separation flow to the material.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to a new and improved method and apparatus for mixing batches of dry or liquid materials and combinations of such materials.

Discussion of the prior art

Due to the variations of size, density, viscosity, weight, moisture content, and other physical characteristics of the many materials, both liquid and dry, to be blended, a great variety of blending and mixing apparatus and methods have been developed to handle the broad range of materials. In the past, it has been common to mix materials primarily by stirring, tumbling, compressing, folding, and agitating the materials in various patterns and manners. These presently known blending methods generally require a comparatively long mixing time to obtain the desired mix, if, in fact, the desired mix is actually attainable at all by these methods.

For example, in mixing cement with aggregate and water, the typical mixing period is about three minutes dry (cement and aggregate), and then three minutes wet (water added). When including the time for charging and discharging the typical cement mixer, the total elapsed batch time is commonly about eight minutes.

Basically, the approach to meet the increasing volume demand for mixed materials, such as cement, has been by the employment of additional and larger size mixers. There have been few, if any, really new techniques developed to improve the mixing of cement or to reduce the relatively long mixing time.

For many years virtually all cement mixing has been done by a tumbling action in the well-known egg-shaped type batch mixer wherein the entire mixing chamber is rotated slowly about an inclined axis. The materials to be mixed are repeatedly lifted by and dropped from inwardly protruding fins attached to the inside wall of the mixing chamber.

On the other hand, in the chemical industry, the emphasis has been placed primarily on a folding action obtained

by very high speed rotary blenders. U.S. Pat. No. 2,436,-767 (1948) is typical of this type of mixer which generally comprises a concave bowl with an inverted annular cover mounted thereon. The mass is swirled around and carried up the concave wall of the mixing chamber by a high speed agitator. The annular under surface of the cover folds the material inwardly and downwardly, returning it to the agitator at the bottom of the mixing chamber.

A more recent, but similar folding action blender for pharmaceuticals is shown in U.S. Pat. No. 3,024,010 (1962). This type of mixer for chemicals is designed for rotational speeds in the range of about 400–1500 r.p.m. depending upon the character of the chemicals being mixed and the size of the device.

SUMMARY OF THE INVENTION

Generally, our invention comprises a new method and apparatus for mixing materials in such a thorough and rapid manner that an improved ultimate blend is obtained in a much shorter mixing time than required by known methods in practice today.

The result of an improved blend in a greatly reduced mixing time is accomplished summarily as follows:

A rotary impeller assembly mounted in the bowl-like bottom portion of a mixing chamber imparts a swirling movement to the materials, thus, moving the mass spirally upward along the wall of the mixing chamber. Stationary curved baffle ducts mounted on the underside of the cover portion of the mixing chamber extend forwardly and inwardly in the direction of rotation of the impeller assembly and downwardly adjacent the impeller blades. The baffle ducts divide the upwardly swirling mass into a plurality of substantially radially converging flow streams and direct them at one another in opposed intermixing relation wherein the streams of material bombard one another. The bombarded intermixed materials drop by gravity and the conical hub of the impeller assembly imparts a deflected separation flow to the descending material, whereupon the cycle is repeated until the desired mix is obtained.

Further objects, features and advantages of our invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings showing a preferred embodiment of a cement mixer exemplifying the principles of our invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a somewhat simplified frontal perspective view of a rotary mixer embodying the principles of our invention;

FIG. 2 is a perspective view looking into the bottom portion of the mixing chamber of the mixer shown in FIG. 1;

FIG. 3 is a perspective view of the inverted cover portion of the mixer shown in FIG. 1;

FIG. 4 is a front elevation view of the mixing chamber of the mixer shown in FIG. 1, with portions of the wall of the chamber broken away;

FIG. 5 is a plan view looking into the top of the mixer of FIG. 1 and depicting the bombarding intermixing of the material;

FIG. 6 is a schematic elevation view showing the flow pattern of the material in the blending method of our apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

While we hereinafter describe our method and apparatus in terms of cement mixing, it should be understood that we have done so merely to facilitate the clear un-

derstanding of our invention and not with the intention of limiting the invention to cement mixing which is just one application of our invention.

Referring now specifically to the drawings wherein like numerals refer to like parts throughout the several views, our mixing apparatus is referred to generally at **10** in FIG. 1. The mixer shown has a frame structure **11** supporting the mixing chamber **12**, a starter motor **13**, a drive motor **14**, a gear reducer **15**, a compressor **16**, and a control panel **17**.

The bottom portion of the mixing chamber **12** is comprised of a hemispherical shell **18** having an annular peripheral flange **19** at its upper edge. The top portion of the mixing chamber is comprised of an annular shell **20** having the shape of a section of a torus. The bottom edge of the upper shell has an annular peripheral flange **21** which is secured to flange **19** on the lower shell by a series of bolts **22**.

The upper shell **20** has an inlet **23** in the top thereof for introduction of the particulate dry materials to be mixed, in this case, cement and dry aggregate. These materials are preferably dispensed in desired amounts from a hopper (not shown) automatically controlled from the control panel **17**.

The liquid constituent to be mixed, in this instance water, is introduced from a plurality of inlets **24** circumferentially spaced about the upper shell. In order to get the required amount of water into the mixing chamber as rapidly as possible, the water is preferably injected under substantial pressure and is also automatically controlled from the control panel.

As best shown in FIGS. 2 and 4, an impeller assembly **25** is mounted in the bottom portion of the mixing chamber on a vertically disposed rotatable drive shaft **26** extending through the bottom of the mixing chamber. The impeller assembly comprises a conical hub **27** and a plurality of blades **28** mounted on the hub. The impeller blades conform substantially to the configuration of the inner surface of the bottom portion of the mixing chamber. The blades curve upwardly to the top of shell **18** and are swept backwardly from top to bottom opposite their direction of rotation. The backward curve or pitch to the blades, which is best shown in FIG. 2, assists in moving the material upwardly along the curved wall of the bottom portion of the mixing chamber.

As seen in FIG. 3–5, six curved baffle ducts **29** are mounted inside the upper shell of the mixing chamber. The baffle ducts commence at the wall of the upper shell and curve forwardly and inwardly in the direction of rotation of the impeller assembly **25**. The baffle ducts extend downwardly closely adjacent the impeller blades and the bottom edge of the baffle ducts are notched as shown at **30** to allow the blades to pass therethrough. The lower edge of the inner portion **31** of the baffle ducts extends downwardly below the top edge of the impeller blades. This close association between the baffle ducts and the impeller blades facilitates the interception of the upwardly swirling material from the impeller blades.

As best shown in FIG. 5, the baffle ducts **29** divide the spiraling mass into a plurality of flow streams **32** and direct the flow streams substantially radially inwardly toward the center of the mixing chamber in opposed intermixing relation. The bombardment of materials depicted in FIG. 5 produces rapid and thorough intermixing of the materials.

As best shown at **33** in FIG. 4, the bottom edge of the baffle ducts curve inwardly slightly from the vertical. This helps in keeping the flow streams projected at one another in substantially horizontal opposed relation.

FIG. 4 also shows a discharge door **34** which is hinged at its upper edge and operated by an air cylinder **34** powered from compressor **16**. The operation of the discharge door is automatically controlled from the control panel **17**.

In operation, the desired amounts of the materials to

be mixed are injected into the mixing chamber **12** through inlets **23** and **24** automatically by the controls on panel **17**. In order to get the necessary amount of water into the mixing chamber quickly so as not to unduly extend the batch cycle, the water is injected under pressure through inlets **24**. The inlets are directed somewhat downwardly and in the direction of rotation of the impeller assembly whereby the water jets are directed against the underside of the baffle ducts. The materials introduced drop over the revolving conical hub of the impeller assembly whereby the material is distributed evenly about the base of the hub. The hub deflects the material outwardly into contact with the rotating impeller blades.

In the cement mixer shown, the rotation of the impeller assembly **25** is begun with the starter motor **13** which brings the rotational speed up to about 15 to 20 r.p.m., whereupon the drive motor **14** cuts-in to override the starter motor and bring the impeller assembly up to mixing speed of about 100 to 125 r.p.m.

The revolving impeller blades engage the material to be mixed and impart a swirling action to the material, thus, moving the mass spirally upward around the wall of the mixing chamber. The combination of the swept back curvature of the impeller blades and the centrifugal force acting against the curved wall of the bottom portion of the mixing chamber causes the material to be moved rapidly upward to the top of shell **18**. This phase of the mixing process may be referred to as spiral acceleration flow and is depicted at **36** in FIG. 5 and in the schematic flow diagram of FIG. 6.

As the upwardly spiraling material leaves the top ends of the impeller blades, the material is intercepted by the baffle ducts **29**. The baffle ducts divide the swirling mass into a plurality of substantially radially converging flow streams shown at **32** in FIG. 5. This phase in the mixing process, referred to as multiple dispersed flows, is schematically depicted at **37** in the flow diagram of FIG. 6.

The baffle ducts **29** direct the flow streams **32** at one another in opposed intermixing relation. As the high velocity flow streams **32** leave the inner ends of the baffle ducts the materials in the flow streams bombard one another resulting in minute intermixing of the materials. This bombardment phase of the mixing process is illustrated at **38** in FIG. 6 where it will be noted that the flow streams are moving substantially horizontally at one another to obtain high velocity opposed bombardment of materials.

After bombardment, the material drops by gravity over the spinning conical hub of the impeller assembly which imparts a deflected separation flow to the material as shown at **39** in FIG. 6, whereupon continuous recycling of the flow pattern takes place.

When the predetermined mixing time has run, the drive motor automatically cuts-out and the starter motor cuts-in to rotate the impeller assembly at about 15 to 20 r.p.m. for discharge through door **34**. The discharge door is operated by the air cylinder **35** in response to a signal from the control panel.

We claim:

1. A batch mixer comprising:

(a) a mixing chamber having substantially circular top and bottom portions,

(b) inlet means for introducing materials to be mixed in said chamber,

(c) an impeller assembly positioned in the bottom portion of said mixing chamber for rotation about a substantially upright axis,

(d) means for rotating said impeller assembly to move material deposited in the bottom portion of said mixing chamber outwardly and upwardly along the wall of the bottom portion of said mixing chamber,

(e) a plurality of stationary curved baffle ducts mounted inside to top portion of said mixing chamber and curving forwardly and inwardly in the direction of rotation of said impeller assembly and extending

downwardly adjacent said impeller assembly for receiving the upward moving material from said impeller assembly and dividing same into a plurality of flow streams and directing said flow streams inwardly toward the center of said mixing chamber in opposed intermixing relation with one another, and

(f) a discharge door in said mixing chamber.

2. The batch mixer as specified in claim 1 wherein, the bottom portion of said mixing chamber is substantially hemispherical, said impeller assembly has a plurality of impeller blades conforming substantially to the configuration of the inner surface of the bottom portion of said mixing chamber and extending outwardly and upwardly along the inner surface of said bottom portion substantially to the top thereof, and said blades curve backwardly from bottom to top opposite their direction of rotation.

3. The batch mixer as specified in claim 2 wherein said impeller assembly has a substantially conical hub to which said impeller blades are attached.

4. The batch mixer as specified in claim 2 wherein said baffle ducts extend downwardly below the top of said blades and are notched to allow said blades to pass therethrough.

5. The batch mixer as specifie in claim 1 wherein said inlet means comprises a first inlet in the top portion of said mixing chamber for introducing particulate material and a series of inlets circumferentially spaced about the top portion of said mixing chamber between said baffle ducts for introducting of liquid material.

6. The batch mixer as specified in claim 5 wherein said circumferentially spaced liquid inlets are directed downwardly and in the direction of rotation of said impeller assembly for introducing liquid against the underside of said baffle ducts.

7. A batch mixer as specified in claim 1 wherein, the top portion of said mixing chamber is comprise of an upper shell having the shape of a section of a torus, the bottom portion of said mixing chamber is comprised of substantially hemisphercial shaped shell, and said inlet means comprises a first inlet in said upper shell for introducing particulate material and a series of inlets circumferentially spaced about the upper shell between said baffle ducts for introduction of liquid material.

8. The batch mixer as specified in claim 7 wherein said circumferentially spaced liquid inlets are directed downwardly and in the direction of rotation of said impeller assembly for introducing liquid against the underside of said baffle ducts.

9. The batch mixer as specified in claim 1 wherein the bottom portion of said mixing chamber is substantially hemispherical, said inlet means comprises a first inlet in the top portion of said mixing chamber for introduction of particulate material, a series of inlets circumferentially spaced about the top portion of said mixing chamber between said baffle ducts for introduction of liquid material, said impeller assembly comprises a substantially conical hub having a plurality of impeller bades mounted on said hub, said impeller blades conforming substantially to the configuration of the inner surface of the bottom portion of said mixing chamber and extending outwardly and upwardly along the inner surface of the bottom portion of said mixing chamber substantially to the top thereof, and said blades curve backwardly from bottom to top opposite their direction of rotation.

10. A method of mixing flowable materials in a mixing chamber, said method comprising the steps of:

(a) imparting an upward spiral flow to said material,

(b) dividing said upwardly flowing material into a plurality of flow streams,

(c) directing said plurality of flow streams at one another in opposed intermixing relation wherein the streams of material bombard one another, and

(d) imparting a deflected separation flow to said material.

11. The method as specified in claim 10 including the steps of introducing liquid material under pressure to said mixing chamber from a plurality of spaced points about the mixing chamber.

References Cited

UNITED STATES PATENTS

2,436,767	2/1948	Gerlicher	259—107 X
2,945,634	7/1960	Beck	259—107 X
2,964,301	12/1960	Bosse	259—107
3,024,010	3/1962	Sperling	259—107

ROBERT W. JENKINS, Primary Examiner

U.S. Cl. X.R.

259—178

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,531,092 Dated September 2, 1970

Inventor(s) Gerald H. Praschak and Dwight E. Howden, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Claims:

Column 4, line 72, the word "to" should be changed to the word "the";

Column 5, line 25, the word "specifie" should be changed to the word "specified";

Column 5, line 30, the word "introducting" should be changed to the word "introduction";

Column 5, line 37, the word "comprise" should be changed to the word "comprised".

SIGNED AND SEALED DEC 29 1970

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents

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