United States Patent [19]   [11] **3,765,653**

Morse et al.   [45] **Oct. 16, 1973**

[54] **REACTOR FOR PREPARING AN EASILY COMPACTABLE MATERIAL**

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[22] Filed: **Dec. 17, 1971**

[21] Appl. No.: **209,104**

[52] **U.S. Cl.** **259/3**, 259/DIG. 18, 259/50
[51] **Int. Cl.** **B01f 9/06**
[58] **Field of Search** .... 259/3, 14, 30, 50, 259/81 R, 89, 90, 175, 176, 177 R, 177 A, DIG. 18

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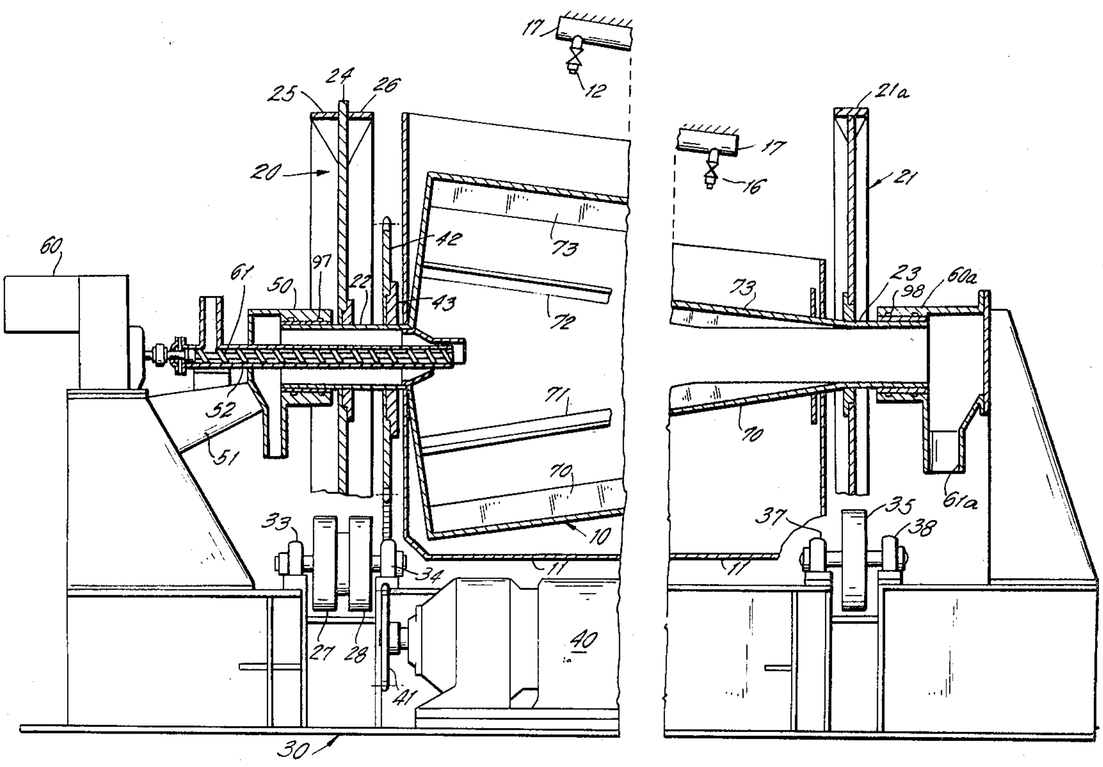
[57] **ABSTRACT**

A conical chamber having its longitudinal axis disposed horizontally has input connections at the center of the larger diameter end of the cone shape. The smaller diameter end of the cone is truncated to define a discharge outlet. The cone is mounted for rotation, and the interior surface of the conical chamber contains lifting vanes of short height which extend longitudinally along the inner surface of the cone and act to mix or tumble material loaded into the chamber from the input connections without applying an undue compacting force to such material. A cooling spray is applied to the exterior surface of the chamber and the cooling fluid is collected by a pan which encloses the bottom region beneath the chamber.

9 Claims, 7 Drawing Figures



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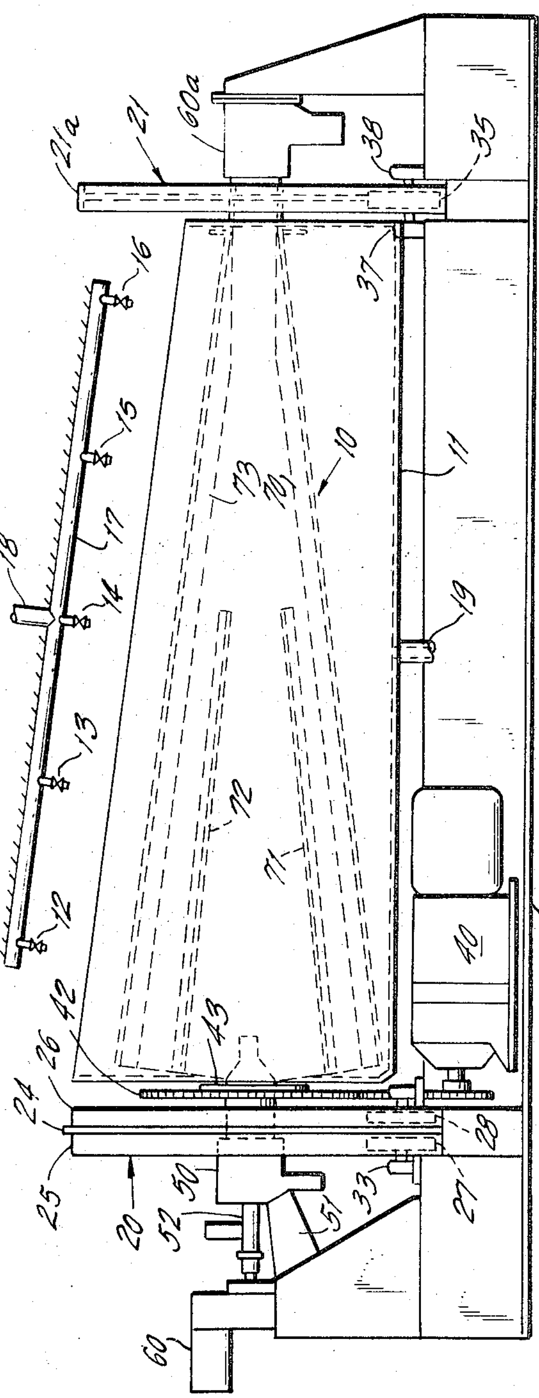

FIG. 1

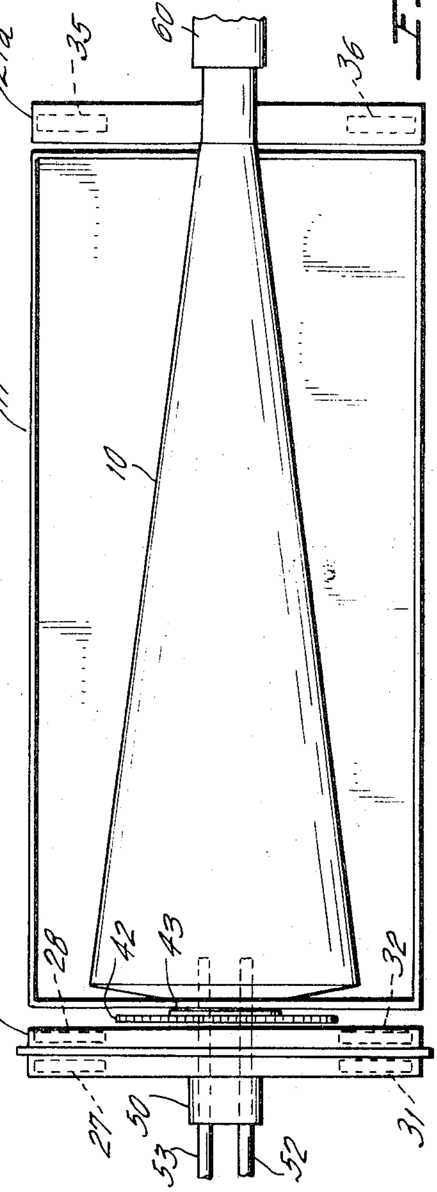

FIG. 2

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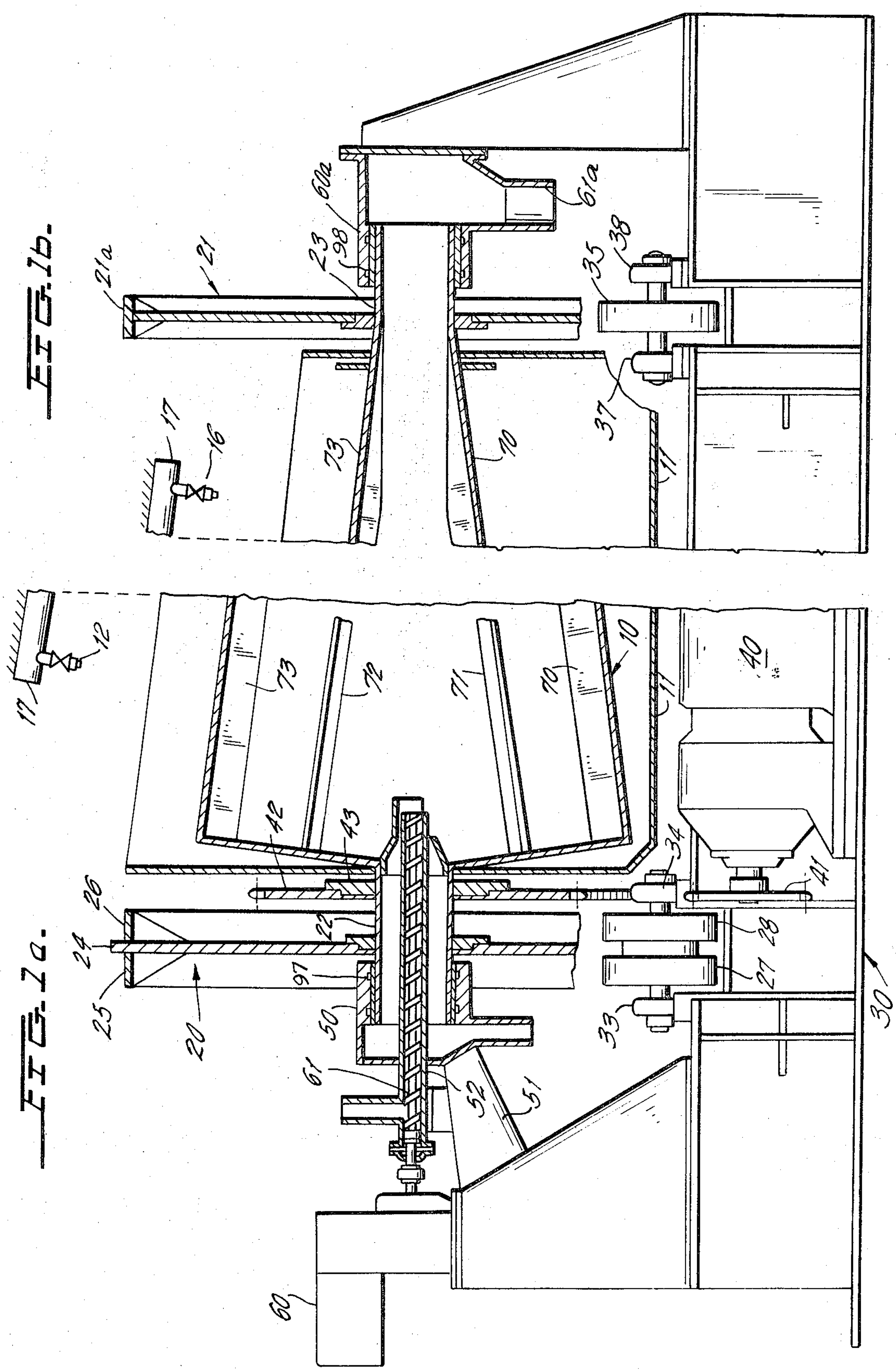


FIG. 4.

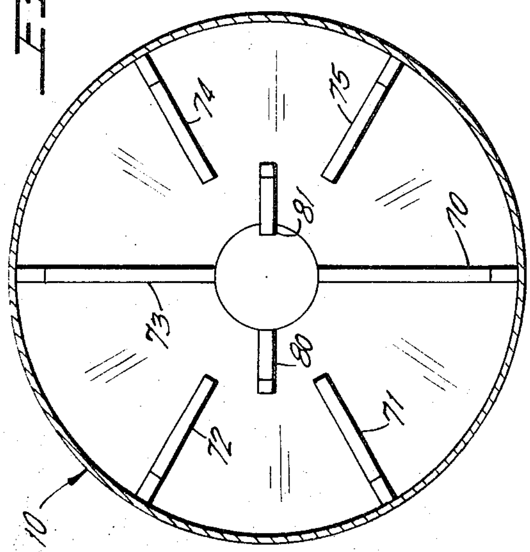


FIG. 5.

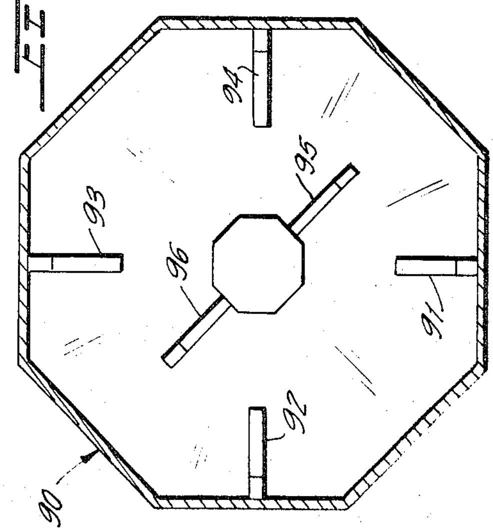
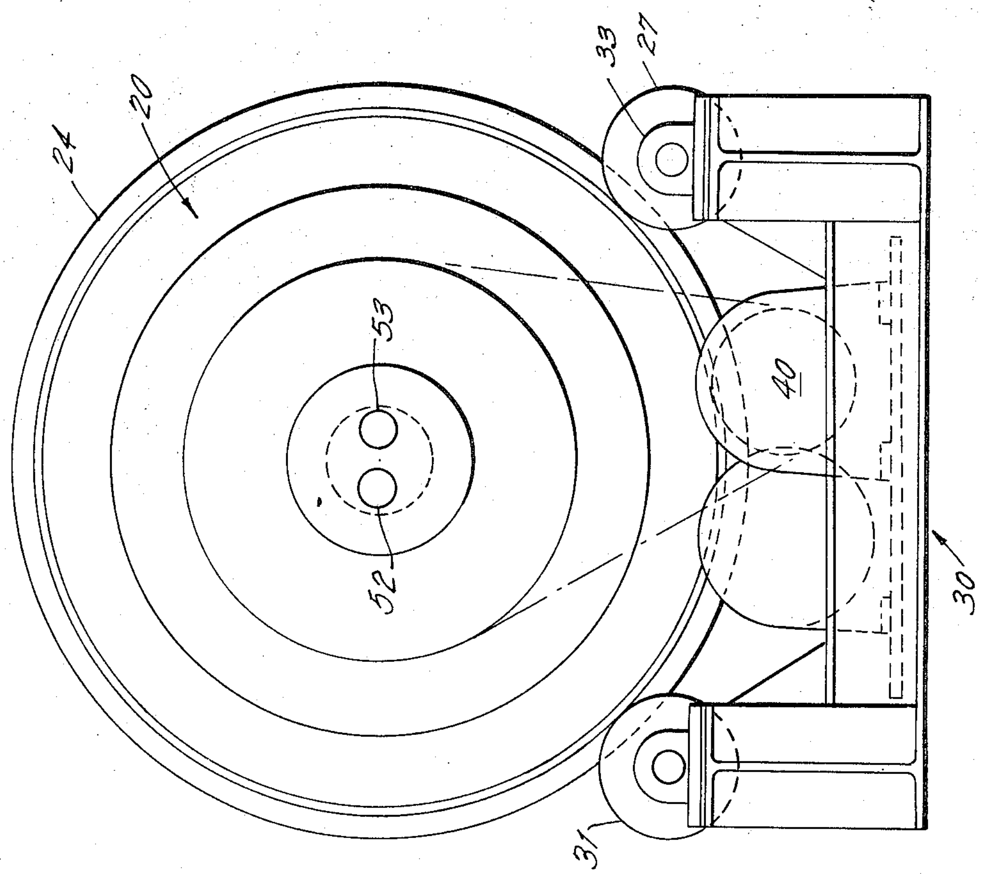


FIG. 3.



REACTOR FOR PREPARING AN EASILY COMPACTABLE MATERIAL

RELATED APPLICATIONS

This application describes a reactor which is particularly useful in carrying out portions of the process of copending application Ser. No. 209,094, filed Dec. 17, 1971, entitled METHOD FOR PRODUCING REFRACTORY METALS, and assigned to the assignee of the present invention.

SUMMARY OF THE INVENTION

When two or more products are to be mixed and partially reacted and form an easily compactable material, it is necessary that the mixer be constructed so that it will not apply any appreciable force to the mix, as would occur in a paddle or dough mixer. If compacting would take place, it is apparent that the mixture would compact and eventually jam the mixer, particularly where a continuous process is desired in which products to be mixed are continuously introduced into the mixer inlet and the compactable mixture is continuously withdrawn from the mixer outlet.

One typical process which requires mixing without the application of substantial compacting force to the mixture is the process described in the above-noted application in which titanium tetrachloride is mixed with liquid sodium to produce a partially reduced material (reducer product) corresponding to a $TiCl_4$ - Na mixture in which about 45–55 percent of the stoichmetric reduction of the $TiCl_4$ to the metal has occurred. The partially reduced material is subsequently mixed in a mixer with additional sodium to produce an intermediate material corresponding to a mixture of $TiCl_4$ and sodium in which about 55–95 percent of the stoichmetric reduction to the metal has occurred which subsequently produces metallic titanium. The intermediate material is a product which has the consistency of wet snow and is easily compactable. Thus, when using conventional mixers, the product will be compacted, eventually to jam the mixer to prevent continuous processing.

In accordance with the invention, a generally conical tumbler is provided to tumble and thereby mix and cause to react materials to form an easily compactable material without applying substantial compacting force to the material while continuously moving the tumbling material from an inlet region adjacent the large diameter end of the conical tumbler to an outlet region at the small diameter end of the tumbler. The conical tumbler is, therefore, mounted for rotation, and has its longitudinal axis disposed generally horizontally but slightly lower at the exit end. A plurality of shallow longitudinal ribs are secured to the interior of the tumbler where these ribs have a height, for example, of three inches for a forty-five inch diameter tumbler, to insure effective tumbling action of the mix without compacting the mixture.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view through a vertical plane extending through the center of the mixer of the invention.

FIGS. *1a* and *1b* show enlarged views of the inlet and outlet regions of the mixer of FIG. **1.**

FIG. **2** is a top plan view of the mixer of FIG. **1.**

FIG. **3** is an end plan view of the apparatus of FIGS. **1** and **2,** shown schematically and with the end support structure removed, for clarity.

FIG. **4** is a cross-sectional view of the tumbler drum of FIGS. **1** and **2** to more clearly show the lifting rods within the rotating cone or tumbler.

FIG. **5** shows another form which can be taken for the cone of FIGS. **1** to **4.**

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the figures, and particularly FIGS. *1a* and *1b*, there is shown a rotatable conically shaped tumbler or drum **10,** which is supported for rotation within a pan **11,** which receives the collected fluid of a cooling spray directed toward drum **10** from overhead spray nozzles **12** to **16.** Spray nozzles **12** to **16** may be operated by suitable solenoid valves, and are connected to a common header **17** which is suitably mounted above drum **10** in any desired manner. A suitable spray cooling fluid is water, which may be connected to inlet duct **18** of header **17.** Water collected in pan **11** may be withdrawn from outlet tube **19** and recirculated or discharged, as desired.

It should be noted that the water cooling system is arranged such that the water spray density is controllable along the length of drum **10.** The temperature at the larger end of the drum, where the products are being mixed and reacted, will be higher than at the small end. This will be more fully understood later. Note that other cooling patterns could be used, depending on the configuration and disposition of the spray cooling nozzles **12** to **16.**

In order to rotatably support drum **10,** drive wheels **20** and **21** (FIGS. **1, 2** and **3**) are connected to drum hubs **22** and **23,** respectively, at the large and small diameter ends, respectively, of drum **10,** shown in FIG. **1.**

Drive wheel **20** contains an extending central rib **24** which divides its outer periphery into two axially spaced halves **25** and **26.** The drive wheel **20** is then supported on two radially displaced pairs of wheels **27–28** and **31–32,** respectively (FIGS. **2** and **3**), which receive surfaces **25** and **26,** respectively. Wheels **27** and **28,** as shown in FIG. **1,** are spaced from one another, and receive rib **24** between them, and are mounted by suitable ball bearing mounts **33** and **34,** respectively, which are mounted on a suitable support frame **30.** A similar support is provided for wheels **31** and **32.** It will be apparent that drive wheel **20** is now rotatably mounted relative to frame **30** by bearing-mounted wheels **27, 28, 31** and **32.** Note that rib **24** prevents axial movement of drive wheel **20** relative to wheels **27** and **28.**

The small diameter end of hub **23** of drum **10** is similarly rotatably mounted by radially displaced wheels **35** and **36** (FIGS. **1** and **2**) which are bearing-mounted on frame **30.** Thus, as shown in FIG. **1,** wheel **35** is mounted in bearings **37** and **38** which are fixed to frame **30.** Thus, wheel **21** is rotatably carried on wheels **35** and **36** which roll relative to its surface ***21a*.**

In order to rotate drum **10,** a drive motor **40,** having a suitable speed control means, is provided with an output sprocket **41** (FIG. *1a*) which drives a suitable chain which is connected to sprocket **42.** Sprocket **42** is then mechanically connected to flange **43** which is, in turn, connected to hub **22.**

The inlet structure, for introducing products to be mixed in drum **10**, includes a sealed collar **50** which surrounds hub 22 and is stationarily supported with respect to hub 22 by support web **51** fastened to frame **30.** Collar **50** then receives two input channels **52** and **53** (FIGS. **1, 2** and **3**) where channel **52** may consist of a screw feed means. By way of example, the reducer product can be injected into drum **10** through the screw feed in channel **52.** The second channel **53** can be connected to a source of liquid sodium which is to be mixed with the reducer product within drum **10** in accordance with the description of previously identified copending application Ser. No. 209,094.

Where the conduit **52** contains a screw feed, the motor for driving the screw can be arranged as shown in FIG. **1** for the motor **60,** mounted on frame **30,** which motor **60** drives screw **61** in channel **52.** It will also be noted that the collar **50** has an overflow outlet in communication with the interior of drum **10.** This permits overflow of the contents of the drum when it inadvertently rises above the level of the bottom of the opening in hub **22.** Note further that the bottom of the opening in hub **22** is intentionally higher than the bottom of the opening in hub **23.**

The outlet structure for the drum **10** is best shown in FIG. **1** and consists of a collar **60*a*** supported from frame **30,** which has an outlet opening **61*a*** through which mixed material is discharged from the drum **10** as its level within the drum is higher than the bottom of the opening in hub **23.**

Suitable rotating seals (**97** and **98**) may be provided, for example, at collars **50** and **60*a*** which permit drum **10** to be filled with a controlled atmosphere if desired.

In order to assure the desired mixing, without compacting, the drum **10** has longitudinally extending lifters or vanes therein which can be hollow and fluid cooled when required, shown in FIGS. **1** and **4** as vanes **70** to **75.** Note that vanes **70** and **73** extend the full length of drum **10** while vanes **71, 72, 74** and **75** extend only a part of its length in the large diameter end of conical drum **10.** Any number of vanes can be used so long as they have a relatively low height. By way of example, for a drum having a large end diameter of about 3 feet and small end diameter of about 1 foot, the vanes may have a height of about from 1 to 3 inches and a width of about ½ inch. The vanes may have any desired length. By way of example, vanes **70** and **73** may have a length of about 12 feet. Additional vanes can be added, as shown in FIG. **4,** for vanes **80** and **81** which extend for about half the length of the drum from its small diameter end.

The use of a circular cone for drum **10** was selected for illustrative purposes only, it being apparent that any desired shape could be used. By way of example, an octagonal configuration could be adopted for the drum, as shown for drum **90** in FIG. **5.** Note that drum **90** may contain vanes or lifters **91** to **96,** either solid or hollow for fluid cooling as required.

Although this invention has been described with respect to particular embodiments, it should be understood that many variations and modifications will now be obvious to those skilled in the art and, therefore, the scope of this invention is to be limited, not by the specific disclosure herein, but only by the appended claims.

We claim:

1. A reactor for making compactable material comprising a hollow rotatable conical drum; said conical drum being symmetrically disposed around a longitudinal axis and having a large diameter end and a small diameter end; means for rotatably supporting said conical drum with said longitudinal axis of said conical drum disposed generally horizontally; a first and second input conduit means stationarily mounted relative to the rotation of said conical drum and extending into the large diameter end of said conical drum for depositing a liquid and a solid material, respectively, to be mixed and reacted therein; rotating seal means connected to said large and small diameter ends of said conical drum to permit the interior of said drum to maintain a controlled atmosphere; said small diameter end of said conical drum being truncated to define a discharge opening; output means connected to said small diameter end of said conical drum for receiving a mixed product from said conical drum; elongated lifter members, having a small height relative to the diameter of said drum, secured to the interior surface of said conical drum and longitudinally extending for at least a portion of the length of said interior surface and radially spaced from one another around the interior surface of said conical drum; and rotating means connected to said conical drum for rotating said conical drum.

2. The reactor of claim **1** wherein the discharge end of said input conduit means is disposed at a height greater than the height of the bottom of said discharge opening in said conical drum, and means for continuously introducing products to be mixed into said drum from said input conduit means and for continuously withdrawing mixed products from said output means.

3. The reactor of claim **1** which includes cooling spray means for discharging a cooling spray over substantially the full length of the exterior of said conical drum.

4. The reactor of claim **1** wherein said input conduit means is disposed generally at the axis of said conical drum.

5. The reactor of claim **4** wherein the discharge end of said input conduit means is disposed at a height greater than the height of the bottom of said discharge opening in said conical drum, and means for continuously introducing products to be mixed into said drum from said input conduit means, and for continuously withdrawing mixed products from said output means.

6. The reactor of claim **5** which includes cooling spray means for discharging a cooling spray over substantially the full length of the exterior of said conical drum.

7. The reactor of claim **5** wherein said elongated lifter members have a height of from about 1 to 5 inches, and wherein said conical drum has a diameter at its said large diameter end of more than 1 foot, and has a length of more than 2 feet.

8. The reactor of claim **1** which includes overflow outlet means connected to said large diameter end of said conical drum; said overflow outlet means being stationary relative to said conical drum and having a height greater, by a given amount, than the height of the bottom of said discharge opening.

9. A reactor for making a compactable material comprising a hollow rotatable conical drum, said conical drum being symmetrically disposed around a longitudinal axis and having a large diameter end and a small diameter end; means for rotatably supporting said conical drum with said longitudinal axis of said conical drum disposed generally horizontally; input conduit means extending into said large diameter end of said conical drum for depositing material to be mixed and reacted therein; overflow outlet means connected to said large diameter end of said conical drum, said overflow outlet means being stationary relative to said conical drum and having a height greater, by a given amount, than the height of the bottom of said discharge opening; said small diameter end of said conical drum being truncated to define a discharge opening; output means connected to said small diameter end of said conical drum for receiving a mixed product from said conical drum; elongated lifter members having a small height relative to the diameter of said drum, secured to the inner surface of said conical drum and extending for at least a portion of the length of said interior surface and radially spaced from one another around the interior surface of said conical drum; and rotating means connected to said conical drum for rotating said conical drum.

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