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CHANGE-CAN MIXING TECHNOLOGY

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ABSTRACT

Change-can mixing and handling technology has changed dramatically during the past few years. Today, change-can mixing systems are available with up to three different mixers to handle formulations having viscosities up to several million centipoise. These systems incorporate low and high shear and low and high speed mixers that are independently driven and controlled. This permits processors to fine-tune the equipment for single or multiple tasks including emulsification, particle size reduction, dispersion and suspension.

Because of the high viscosity mixing capability of modern change-can mixers, a Follower Plate Discharge System has been specially designed. This discharge system pushes the viscous mixture out of the can into product cartridges, moulds or hoppers of packaging machinery. The development of new mixing and discharging systems and their integration open fresh opportunities to streamline processing operations and substantially lower production costs.

INTRODUCTION

Mixing equipment may be classified in terms of its shear intensity (low or high shear) and in terms of its general design configuration (fixed-tank or change-can).

Fixed-tank mixers such as sigma blade mixers, turbine, cone screw and ribbon mixers were developed many years ago. Change-can mixing equipment such as planetary dispersers and multi-shaft mixers, however, have surfaced only in recent years.

Change-can mixers have a number of advantages over fixed-tank mixing equipment. These advantages include ease of cleaning and low possibility of batch contamination due to the absence of seals or stuffing boxes in the mixing zone. Another advantage is higher productivity because the

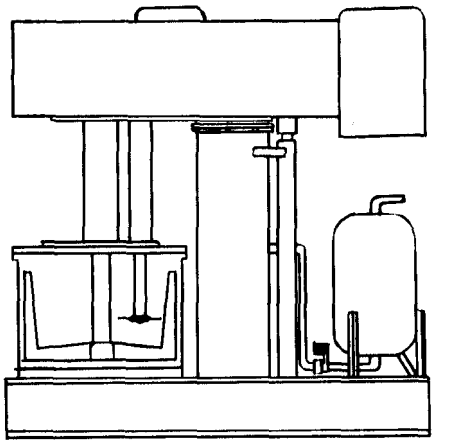


FIGURE 1

ROSS VERSAMIX WITH ANCHOR AND DISPERSER

change-can concept allows the mixer do its job while additional cans are being loaded or unloaded. Fixed-tank mixers are unproductive while the tanks are being loaded or unloaded.

The decision to use fixed-tank or change-can mixing equipment for a given application can be reached quite easily. Deeper evaluation, however, is required to select the most suitable among the many mixer blade designs. In an effort to assist processors in the evaluation, an analysis of various types of modern change-can mixers is presented as follows:

ANALYSIS

Multi-shaft Mixers.

A popular change-can mixing system is one where both a low speed anchor agitator and a high speed disperser are combined to operate in the same mix can (Fig. 1).

The Three-Wing Anchor Agitator is designed to induce maximum movement to the formulation components under low shear conditions. It moves the components in both radial and axial directions thereby maximizing component-interchange.

The Anchor can be provided with Teflon wipers to constantly scrape formulation components from the interior walls of the can. These wipers not only eliminate undispersed components that normally stick on the walls but they also improve heat transfer from the heating jacket of the can to the batch.

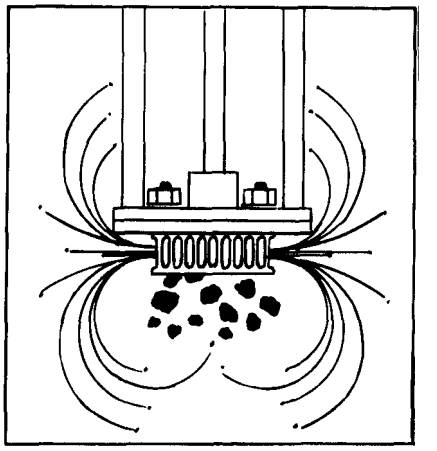


FIGURE 2

MIXING PATTERN OF A ROSS MIXER EMULSIFIER

An important consideration regarding the Anchor is its design configuration. Ideally, all the arms and wings must be of a triangular profile and completely closed. A properly pitched triangular profile optimizes movement of the formulation components at minimum motor power draw. Completely closed arms and wings prevent accumulation of minute formulation particles that can cause premature curing of subsequent batches or can result in cross contamination between batches.

The High Speed Disperser with a modified saw tooth blade is commonly used to disperse solids into viscous liquid vehicles. This mixer when applied by itself functions best in formulations having a viscosity range of up to 50,000 cps, and in conjunction with the Anchor Agitator, up to several hundred thousand centipoise.

A dual-shaft mixing system consisting of the Anchor and the Disperser is suitable for many liquid/liquid and liquid/solids mixing applications. However, when finer emulsification or more efficient particle size reduction is required, a specialized high shear mixer should be added to the system.

Specialized high shear mixers are available in a number of design variations. A well-proven design is one where a four-blade rotor rotates at high speed (approximately 4,000 fpm) at close clearance to a stationary stator head. The high speed rotor draws the formulation components from the bottom and then expels the components radially through the openings in the stator (Fig. 2).

Intensive mechanical shearing of formulation components takes place at the rotor/stator interface. Due to the multiple shearing areas and because of the high rotor speed, thousands of shearing actions are generated each mixing minute.

High speed, high shear mixers are ideal in applications calling for fast dissolution of solid polymers or elastomers in a liquid. By reducing the particle size of a solid, the equipment increases the surface area exposure of the solid, thereby accelerating solubilization.

A multi-shaft mixing system is therefore available with up to three distinctly different mixers such as the slow speed Anchor Agitator, the High Speed Disperser and the High Shear Mixer Emulsifier. A system consisting of one Anchor and two Mixer Emulsifiers is also available and is advantageous in applications where the highest rate of particle size reduction is desired, such as in rubber solvation.

Each mixer of a multi-shaft mixing system should be independently driven by either single, two or variable speed motor. Independent control of each mixer enables the processor to fine tune the system to suit his or her specific process requirements.

Multi-shaft mixing systems such as the VersaMix are being used successfully in a number of applications in the adhesives and sealants industry where only fixed-tank mixers were used previously. Today, the VersaMix is used for mixing the components in the production of hot melts, rubber solutions, silicones, pressure sensitive adhesives and many other products.

DOUBLE PLANETARY MIXERS

Another proven change-can mixer design is the Double Planetary Mixer. This equipment has two rectangularly shaped stirrer blades that revolve on a central axis (Fig. 3). Simultaneously, each blade revolves on its own axis. With every revolution on its own axis, each blade advances forward along the tank wall. This stirrer blade movement insures complete homogeneity of the formulation components being mixed within a few minutes. The stirrers do not depend on the flow characteristics of the mix. Instead, they cover every point within the mix can.

The stirrer path patterns of a Double Planetary Mixer can be seen by placing a marker at the bottom end of each vertical bar of the stirrer blades. Fig. 4 shows the path patterns at 1, 3 and 36 revolutions.

Because of its stirrer blade design and the planetary movement, the Double Planetary Mixer presents a wide range of capabilities including mixing, dispersing and kneading. Acceptance of this change-can mixer extends into numerous applications in the process industries. Ross Double Planetary Mixers are currently being used in products areas such as epoxies, caulks, polysulfides, silicone sealants and pipe joint compounds.

Double Planetary Mixers can be used for formulations having a viscosity range of up to several million centipoise. Their only limitation is the inability to masticate large blocks of polymer or resinous solids.

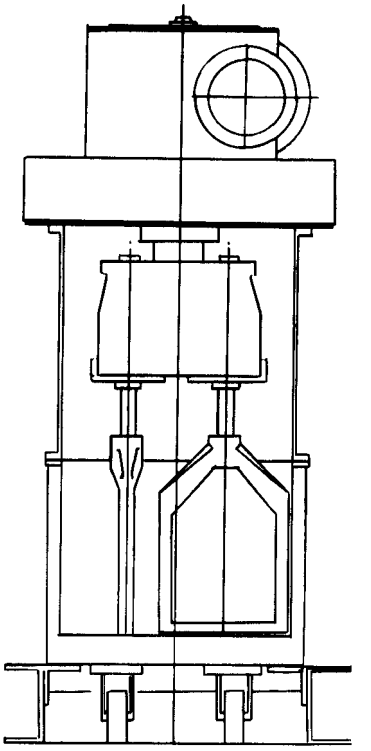
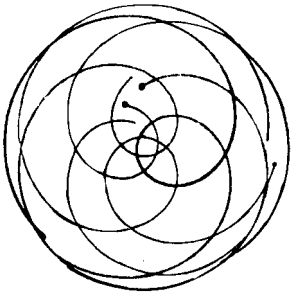


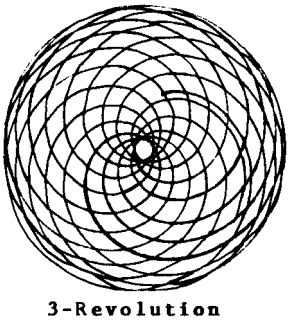
FIGURE 3

ROSS DOUBLE PLANETARY MIXER



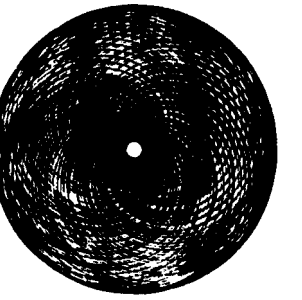
1-Revolution

One complete revolution of the planetary gearbox. Approx. Time-2 seconds.



3-Revolution

Three complete revolutions of the planetary gearbox. Approx. Time-6 seconds.



36-Revolution

Thirty-six complete revolutions of the planetary gearbox. Approx. Time-1 minute.

FIGURE 4

ROSS DOUBLE PLANETARY STIRRER PATH PATTERN

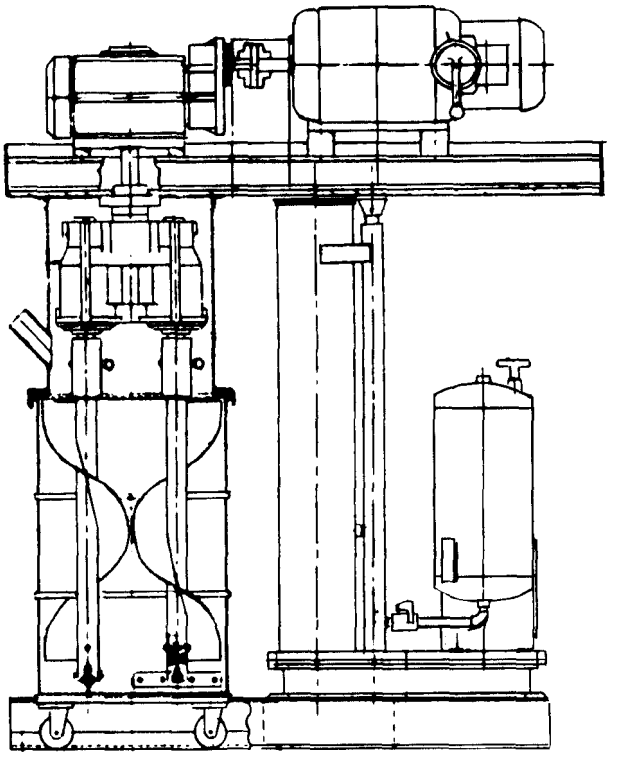


FIGURE 5

ROSS 55-GAL. DRUM DOUBLE PLANETARY MIXER WITH HELICAL STIRRERS

55-GALLON DRUM DOUBLE PLANETARY MIXER

A number of companies require the finished mixtures to be contained and shipped in standard 55-gallon drums. In an effort to reduce material handling steps for such companies, a design modification of the standard Double Planetary Mixer was developed. This design incorporates narrower but longer stirrer blades to suit standard 55-gallon drums. It also includes a special dolly with an anti-rotation positioning device. The 55-gallon drum sits on the dolly steadfastly during the mixing operation. This unit is available in both vacuum and non-vacuum design.

In lieu of the rectangularly shaped stirrer blades, special helical blades can be supplied with the 55-gallon drum Double Planetary Mixer (Fig. 5).

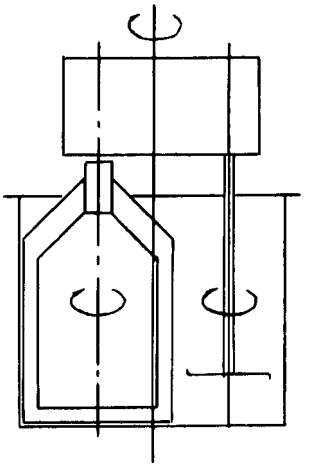


FIGURE 6

ROSS POWERMIX PLANETARY DISPERSER

The above blade design variation is well suited in applications where greater axial mixing action is desired. Aside from the standard planetary movement, the helical stirrers move the formulation components upwards and downwards simultaneously. These opposing yet positive axial mixing actions optimize interchange of both low and high density components. The helical stirrers are interchangeable with the rectangularly shaped planetary blades, thereby extending the capability of the equipment to multiple mixing operations.

POWERMIX

A relatively new development in the field of change-can mixing systems is the PowerMix. This mixer is a combination of two proven mixing technologies: a Double Planetary Mixer and a conventional High Speed Disperser.

The high speed disperser and the planetary stirrer work together during the mix cycle (Fig. 6). The high speed blade revolves on its own axis at speeds up to 5000 fpm. The planetary blade revolves on its own axis at slower speeds and acts as a feed device to the high speed blade. Simultaneously, both agitators revolve inside the mix can on a common central axis.

In a conventional change-can disperser, the disperser blade is situated in one fixed location in the mix can, thereby limiting its dispersion capability to the flow characteristics of the formulation components. In the Planetary Disperser, however, the disperser blade does not remain a

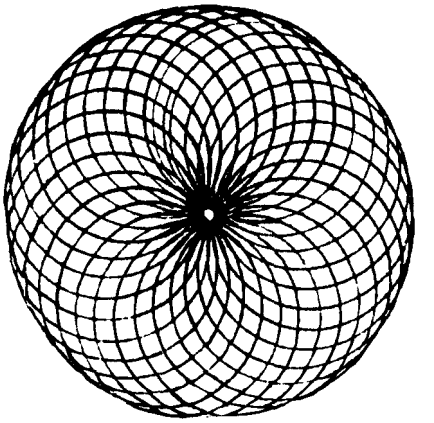


FIGURE 7

MIXING PATTERN OF A ROSS POWERMIX DISPERSER BLADE
AT ONE ORBITAL REVOLUTION

passive piece of equipment but instead, it actively reaches out and does its dispersion job while continuously going around in the mix can (Fig. 7).

Aside from acting as a feed device to the disperser blade, the planetary stirrer also prevents the accumulation of undispersed formulation components that normally cling on the interior walls of the mix can. The planetary blade has a close clearance with the walls of the can.

Because of the combined mixing actions of the Planetary Disperser, this unique equipment offers new processing efficiencies to manufacturers, particularly to those producing highly viscous products that require high speed/high shear dispersion.

Numerous optional features and auxiliary equipment can be incorporated in modern change-can mixers. These include vacuum or high internal pressure design, jacketed mix can for heating or cooling, special materials of construction, scrapers, automated control packages and vacuum/condensate collection systems. The most significant development and well appreciated among these is the Follower Plate Discharge System.

Before the development of the Follower Plate Discharge System, an all-too-familiar scenario after the mixing process was someone literally taking a spatula and scraping the mixed product from the can. This scene can now be eliminated by simply placing the mix can in the Follower Plate Discharge System and allowing its platen to push out the viscous mixture either through a discharge valve at the bottom of the can or through an opening on the platen itself. The savings in time, labor and process steps using the System are usually dramatic.

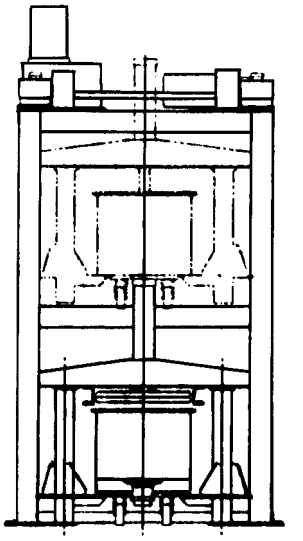


FIGURE 8

ROSS FOLLOWER PLATE DISCHARGE SYSTEM WITH AN ELEVATOR

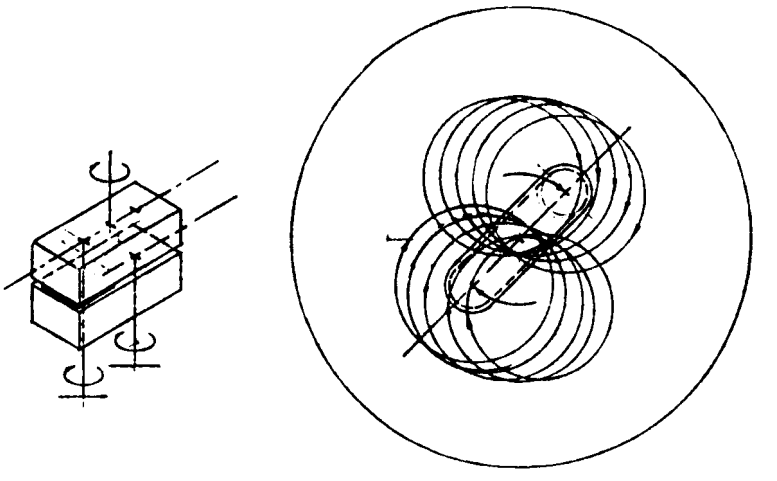


FIGURE 9

ROSS UNIVERSAL MIXER ADJUSTED AT 0 DEGREE POSITION

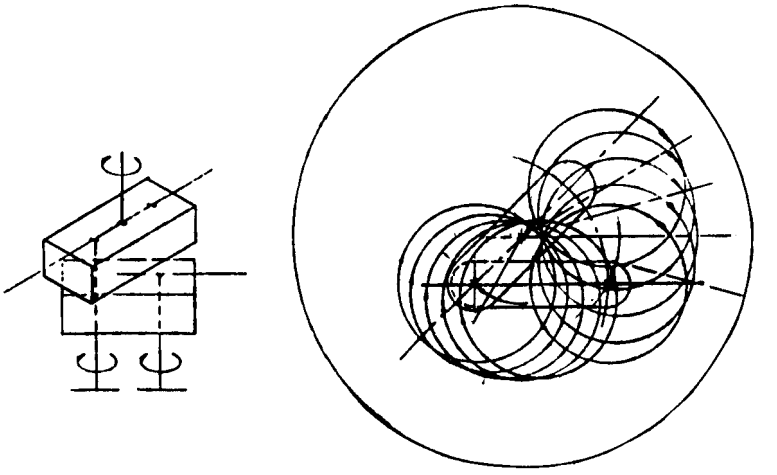


FIGURE 10

UNIVERSAL MIXER ADJUSTED AT 45 DEGREE POSITION

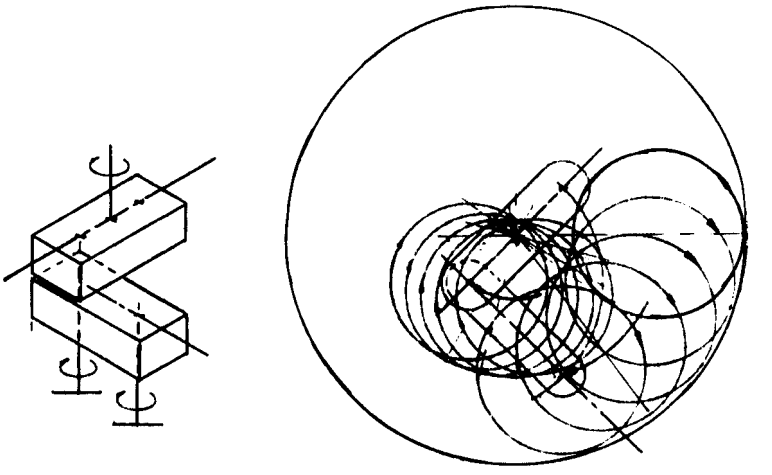
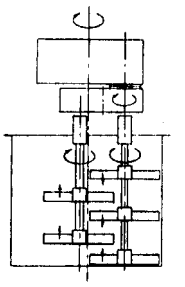
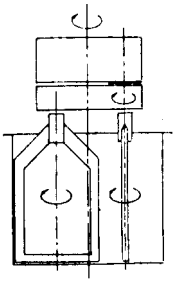


FIGURE 11

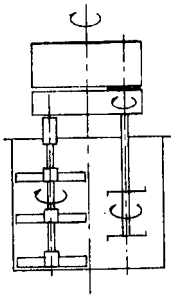
ROSS UNIVERSAL MIXER ADJUSTED AT 90 DEGREE POSITION



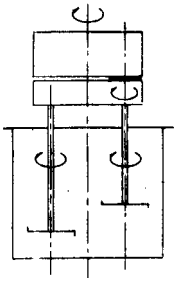
OVERLAPPING TURBINES



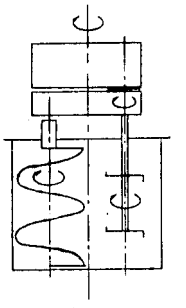
PLANETARY PADDLES



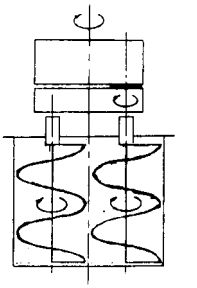
TURBINE/DISPERSER



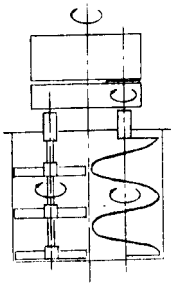
DISPERSER BLADES



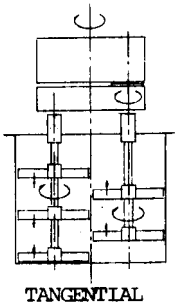
AUGER/DISPERSER



AUGER BLADES



TURBINE/AUGER



TANGENTIAL TURBINES

FIGURE 12

The Follower Plate Discharge System is generally installed on a platform to permit discharge of the mixture into containers or directly to packaging machinery. However, an elevator mechanism can be incorporated in the System to enable automatic lifting of the mix can 42" above the floor (Fig. 8). This optional feature eliminates the need for a platform.

CONCLUSION

Because of the changing needs of the market and due to the continuing emergence of better and more advanced raw materials, the processor in the adhesives and sealants and other process industries is continually faced with a multitude of tasks in order to conform with such changes and developments. Today, he or she is constantly calling on process equipment manufacturers for different types of equipment to suit several process requirements.

Understanding the special needs of the processors today, specialty equipment manufacturers such as ourselves are placing more and more emphasis on machine design innovations. As a result of this concentration on innovations and also in line with our more than a century of commitment to the process industries, we have developed a revolutionary change-can mixing concept.

This new-generation mixing equipment which we refer to as the Ross Universal Mixer is suitable for use on multiple mix cans of different sizes. In effect, a processor can use one Universal Mixer with small mix cans for research and development purposes, with medium-sized mix cans for pilot plant work, and with larger mix cans for mixing on a production scale. Figs. 9, 10 and 11 show the unique primary-secondary gearboxes which can be adjusted easily to swing out the mixer blades to conform with the size of the mix can to be used. These gearboxes are infinitely adjustable from 0 to 180-degree positions.

A more important advantage of this hybrid mixing equipment is that it can be supplied with a wide choice of mixer blade designs. The following figures illustrate the numerous combinations that can be supplied, making this equipment a truly universal unit for multiple mixing applications.

We do hope that our development of the Universal Mixer is a positive contribution and assistance to your continuing development and production efforts in the pharmaceutical industry.