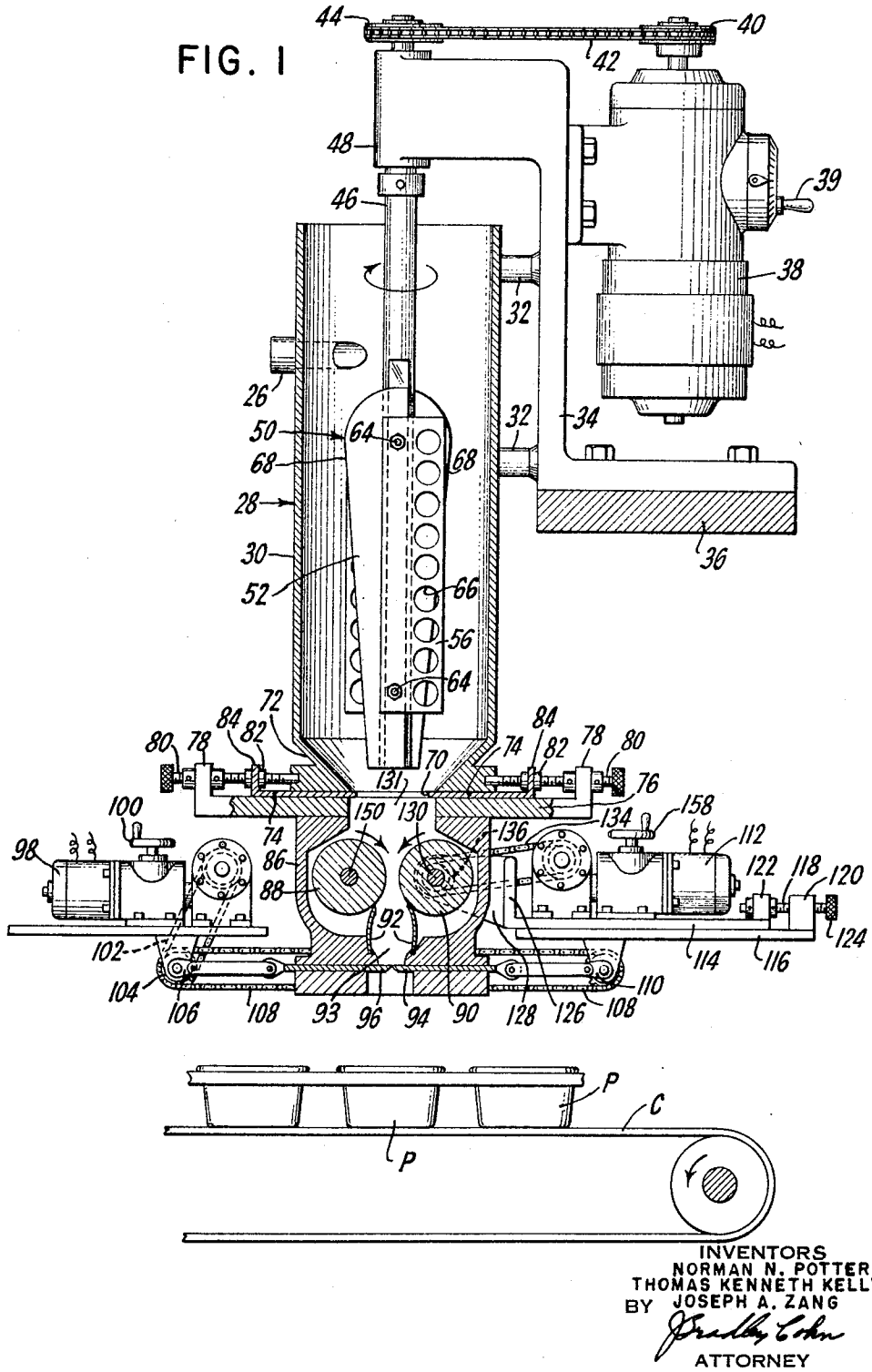
Oct. 25, 1966 N. N. POTTER ETAL 3,280,764

APPARATUS FOR RAPID MIXING

Filed April 3, 1963 2 Sheets-Sheet 1

FIG. 1



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Filed April 3, 1963 2 Sheets-Sheet 2

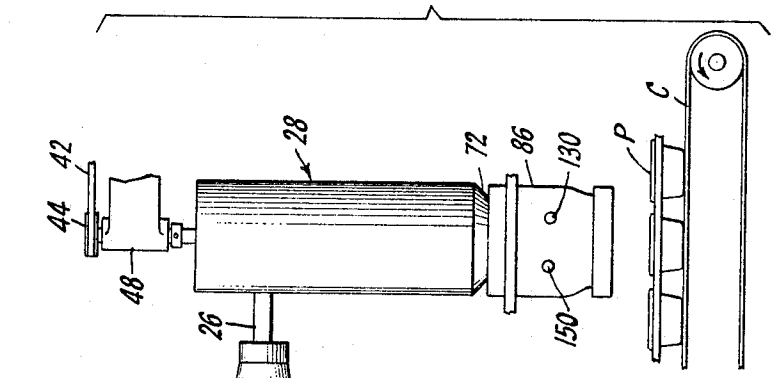


FIG. 5

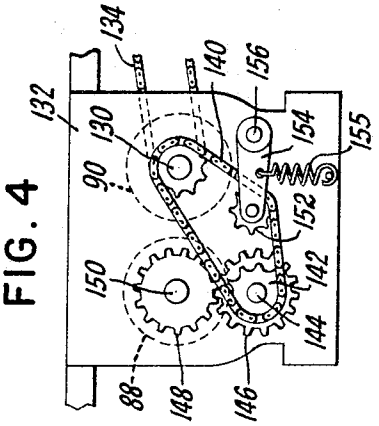


FIG. 4

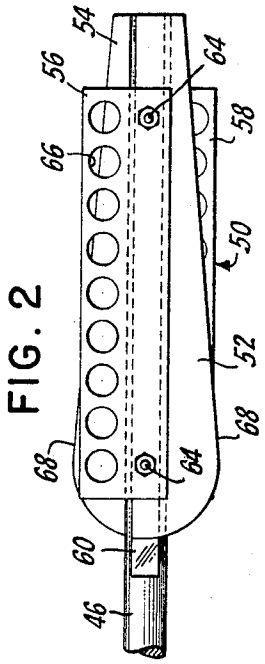


FIG. 2

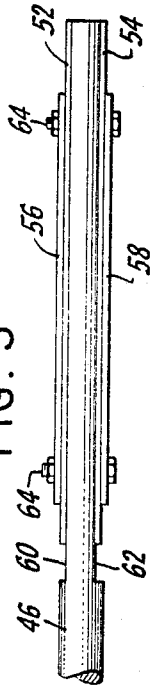


FIG. 3

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APPARATUS FOR RAPID MIXING

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4 Claims. (Cl. 107—38)

This invention relates to mixing machines for highly viscous substances, such as pastes and doughy masses where it is desired to obtain intensive work input into the mass. More particularly, it relates to bread dough development.

It is an object of this invention to provide a new and useful apparatus for mixing, conditioning or kneading alimentary pastes, doughs, batters and systems of similar rheology. The apparatus according to the instant invention is primarily designed for the purpose of producing extremely rapid work input into a mass, such as dough, and, in the case of dough, for the purpose of producing rapid development. The rapidity of development particularly adapts the instant invention to continuous processing. The embodiment herein illustrated accordingly shows the apparatus in continuous process equipment, although it is evident that batch operation is perfectly possible, if desired.

It is an object of the invention to devise apparatus for working a mass at a high energy input rate with high efficiency thereby permiting the use of smaller sized equipment with consequently less material in process at any given instant of time.

It is also an object of the invention to perform these operations in an open mixer at atmospheric pressure.

The advantages and objects of such apparatus provide for simplified construction, for example, such an apparatus may be manufactured of less material or lighter material, i.e., the strength requirements of the ingredient handling equipment, the impeller and the drives are far lower than in a closed or pressurized system.

It is an advantage and object of the present invention to provide a mechanism for mixing at atmospheric pressure and thereafter providing a means for collecting and confining the dough to permit accurate metering or dividing.

It is an object and advantage of a non-pressurized system that it eliminates or reduces sealing problems, provides ready cleaning and maintenance and improves safety.

Another object and advantage of the invention is to provide an impeller driven at a new high order of magnitude of speed with consequent reduction in torque on the impeller shaft.

Another object of the invention is to provide a mixer having balanced side thrust on the impeller shaft.

A further object of the invention is to reduce pressure surges in the system and at the dividing station as a result of providing means for atmospheric mixing. This results in improved accuracy of scaling.

Another object of the invention is to prvide a continuous system unaffected by pressure surges from the mixing elements and accordingly such elements may be operated without cyclical reference to the cut-off mechanism.

Apparatus constructed in accordance with the invention inherently provides greater control over the final crumb structure of the bread.

It is a further object of the invention to provide roller means at the delivery or dividing station so the crumb grain of bread may be varied within a useful range by varying the roller clearance and/or the number of rolls.

It is an object of the invention, and a very beneficial

result, that it permits the continuous manufacture of specialty breads containing such friable items as raisins, nuts, citron and the like.

Accordingly, it is an object of the invention to provide a novel mixing or kneading apparatus capable of operation at atmospheric pressure, while providing efficient, rapid work rate input.

The novel features which we believe to be characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation may be understood by reference to the following description taken in connection with apparatus embodying the invention and shown in the accompanying drawings, in which:

FIG. 1 is a sectional elevation of a novel atmospheric developer with metering and depositing unit attached;

FIG. 2 is an enlarged detail showing of the impeller;

FIG. 3 is a detailed view of the impeller rotated at 90° from the FIG. 2 showing;

FIG. 4 is a detailed showing of the drive means of the metering chamber; and

FIG. 5 is a schematic illustration of a continuous bread-making system utilizing the novel structures of the invention.

Referring to FIG. 5 of the drawings, reference numeral **10** indicates a plurality of preferment brew tanks from which brew is delivered by the pump **12** to an incorporator **14** which may be of the type illustrated in the patent to Kruder 2,926,619. Incorporator **14** is driven by drive means housed in the housing **16**. Flour from the hopper **18** is fed by dry feeder **20** to the incorporator **14** wherein it is combined with the brew as well as oxidants from the tank **22** and shortening from the tank **24**. In the incorporator **14** the total ingredients of the bread dough are combined into a homogeneous premix which is delivered through the conduit **26** into the novel developer **28**.

Referring now to FIG. 1, the developer **28** has a cylindrical container **30** supported by brackets **32** attached to the stand **34** which is secured to the main frame **36** of the machine.

The geared variable speed motor **38** whose output speed is varied by rotation of the handle **39** is also attached to the supporting stand **34**. Motor **38** drives the impeller shaft **46** by means of a sprocket **40**, chain **42** and driven sprocket **44** secured on the shaft. Shaft **46** is journaled in a bearing **48** formed in the supporting stand **34**.

To the shaft **46** is secured an impeller **50**. The diametral sweep of the impeller **50** is relatively small with respect to the diameter of the cylindrical housing **30**. The motor **38** drives the shaft **46** at an r.p.m. of unusually high magnitude being on the order of 1,000 to 10,000, preferably 3,500 in one embodiment of the invention. The impeller **50** (FIGS. 2 and 3) consists of a pair of flat tapered plates **52**, **54** and a pair of rectangular plates **56**, **58** mounted on flats **60**, **62** of the shaft **46** by securing means, such as the nuts and bolts **64**. The rectangular plates **56** and **58** have a plurality of small openings **66** formed in them. It has been found that an impeller formed only of the rectangular plates **56**, **58** will, when operated in accordance with the invention, as more fully explained hereinafter, develop dough. It has also been found that the openings **66**, while not essential for the development of dough, nonetheless, augment and improve the operation of development. The tapered plates **52**, **54** perform, because of their tapered sides **68**, an additional very important function. The taper decreases in diameter toward the bottom of the vessel **30**. The taper, because of the high r.p.m. of the impeller, causes a definite propelling action downwardly urging the dough through the adjustable orifice **70**. This is of great value for use in a continuous

process. It is also useful in a batch process for evacuating the bowl. In one experimental model, tapered plates such as plates **52** and **54** were mounted on a horizontal shaft operating in a horizontal chamber or trough. The dough mix was successfully developed as well as being successfully propelled in the direction of decreasing taper. It is accordingly contemplated and understood that the invention is not in any way limited to a vertical mixer.

Referring again to FIG. 1, the housing or vessel **30** is cylindrical in shape but at its bottom it is reduced conically by the sloping walls **72**. The orifice **70** formed at the bottom of the wall **72** is made adjustable by a pair of sliding plates **74**, which are supported from beneath by a plate **76** having flanges **78** in which are journaled the threaded screws **80** engaging threaded nuts **82** mounted in a flange **84** of plates **74**. By rotating threaded screws **80**, the cross-sectional area of the orifice **70** may be varied. Beneath plate **76**, and in communication with the orifice **70**, is mounted a metering pump housing **86** containing a pair of counter-rotating rollers **88**, **90** rotating in the directions illustrated by the arrows in FIG. 1. Rollers **88**, **90** smoothly propel or pump the developed dough downwardly without degradation past the doctoring blades **92** to the dividing knives **94**, **96**.

The dividing knives **94**, **96** reciprocate toward and away from each other in a cycle whose speed is independently adjustable by the geared motor **98**, whose output speed is controlled by the knob **100**. The output of the geared motor **98** is connected by the chain **102** to a sprocket **104** to whose shaft is connected a crank **106** operating the knife **96**. The sprocket is linked by the chain **108** to a similar sprocket and crank **110** operating the blade **94**. The crank **110** is 180° out of phase with crank **106**. Dough, continuously propelled by the pump rollers **88**, **90**, is cyclically severed into discrete portions by the knives **94**, **96** and deposited in baking pans P passing below on the conveyor C, which is moved at a controlled rate of speed by means not shown.

Referring to FIG. 1, the variable speed geared motor **112** is mounted on a plate **114** slidably supported on a bed **116**. A threaded screw **118** is threaded in a block **120** secured to the bed **116** and is journaled against axial movement in a block **122**. Rotation of the threaded screw **118** by means of a knurled knob **124** slides the plate **114** to the left and right (FIG. 1) a small distance. A flange **126** of the plate **114** has secured thereto a forked bracket **128**, which rotatably supports at each end thereof the shaft **130** of roller **90**. Shaft **130** protrudes through slotted openings in both the back plate **131** (not shown in full) and the front plate **132** of the housing **86**. Movement of the plate **114** by rotation of the knurled knob **124** accordingly moves the shaft **130** and roller **90** toward and away from the roller **88**. The shaft **130** is driven from the motor **112** by means of a chain **134** passing around a sprocket **136** secured on the shaft **130**. At its other end the shaft **130** carries a sprocket **138** which, by means of a chain **140**, is drivingly connected to a sprocket and gear cluster **142** rotatably mounted on a stud shaft **144** secured on the outer face of plate **132**. The gear **146** of the sprocket and gear cluster **142** meshes with a gear **148** secured on the outer end of shaft **150** of roller **88**. Shaft **150** protrudes through and is journalled in the front plate **132** and the rear plate **131** of chamber **86**. The slack of the chain **140** is taken up by an idler sprocket **152** journaled on the outer end of an arm **154** pivoted on a stud shaft **156** secured on the outside of plate **132**. Arm **154** is spring-loaded downwardly by tension spring **155**. The speed of the output of the motor **112** may be varied by adjusting the knob **158**.

It will be seen that the r.p.m. of the shaft **46** is independently controlled by the variable speed geared motor **38**. The r.p.m. of the rollers **88**, **90** is independently controlled by the variable speed geared motor **112**. The cyclical motion of the cut-off knives **94**, **96** is independently controlled by the geared motor **98**. The spacing of the rollers **88**, **90** may be adjusted by means of the knurled knob **124**, as above described. Thus there is independent control of the impeller r.p.m., roller r.p.m. and cut-off r.p.m., as well as the roller spacing. There also is independent control of the orifice opening **70** which provides a degree of control of the dough head above the rollers **88**, **90**.

Mode and method of operation

The novel developer, dough pump and divider illustrated in FIG. 1 receives dough pre-mix from conduit **26**. The height of the dough in the continuous processing is maintained by controlling the metering of the infeed ingredients and the output of the dough pump rollers **88**, **90** so that the height of the dough in the operation does not rise above the height of the impeller **50**. The impeller **50** being relatively small with respect to the diameter of the cylindrical vessel **30** does not wipe or sweep the walls of that vessel. However, for reasons not fully clear to us, but demonstrably dependent on the high order of the r.p.m. of the impeller, the dough is hurled against the wall in what appears to be a sufficient velocity to develop it on impact. The developed dough is pulled or kneaded back into the propeller so that in its course downwardly in the vessel **30** it becomes fully developed during the short hold-up time of approximately ½ to 1 minute.

The tapered edge **68**, as well as gravity, propels the developed dough downwardly where it passes out as a ribbon between the pump metering rollers **88**, **90**. It should also be noted that the metering rollers **88**, **90** pump and hence produce pressure in the area **93** (FIG. 1) which facilitates uniform extrusion. It is then cut into discrete pieces and deposited in the pans P, after which it is panproofed and baked out in a manner well known in the art.

It has been found that the ratio of the effective radius of the impeller **50** to the radius of the bowl **28** should be approximately 4–10. In a specific embodiment of the invention, a bowl was used having an eight inch diameter. The best development appeared to occur when the clearance of the edges of the paddle **50** to the inner wall of the bowl **28** was about two inches. The downward range for satisfactory development appeared to be about ¼ inch clearance. The clearance between the adjacent peripheral surfaces of the rollers **88**, **90** was found preferably to be adjustable within a range of 1/16 to ½ inch. In a conventional white bread the lower end of this range was more preferably employed. However, in a specialty bread, such as raisin bread, it was found that the raisins, or other friable material, were not damaged when the rollers were moved apart to approximately ¼ inch.

The point of independent adjustability of r.p.m., pump metering, roller clearance, and the period of the cut-off cycle is significant. As is well known, flours of different strength require a different work input, and this can be selectively determined for each grade of flour or formula employed and differences compensated by variation within a small range in the r.p.m. of the impeller for any given throughput.

In order to control throughput to accommodate the capacities of a particular bakery as, for example, oven capacity, the r.p.m. of the metering roller pump **88**, **90** is adjustable as must, of course, be the input feed which, however, does not form part of this invention and which is known in the art. Once a throughput and work input rate are established, scaling may be accomplished by suitable adjustment of the cycling period of the cut-off knives by means of the knob **100** of motor **98**.

The atmospheric developer **28** has no pressure surges as in known conventional continuous pressurized developers. This is due to many factors, including:

(1) Absence of pressurization;

(2) Axial flow of the material with respect to the impeller shaft;

(3) The large clearance between the impeller and the side walls,

This absence of pressure surges permits the complete independent adjusting of the cut-offs 94, 96, and also provides improved uniformity and accuracy of scaling. Since bread dough is a compressible fluid, pressure surges have an adverse effect on scaling accuracy and require special means to overcome the inherent problem.

One important distinction between the disposition and mode of operation of the rotatable element of the present continuous mechanical dough developer and the rotatable elements of other dough developers, well known in the art, both with respect to their spatial relationship to the housings in which they are enclosed and the order of rotative velocities should be emphasized. In other previously known developers, the rotatable element was so disposed that, during a considerable portion, if not all, of its travel, it swept clost to the inner surface of its container. The preferred spacing between the outer periphery of the rotating element and the inner surface of the housing was about 1/16 of an inch. It was considered that the dough was subjected to an approximation of the kneading action of the home-made-bread-maker, which was idealized as being the most desirable action for developing dough. The speed of rotation heretofore was relatively slow.

In developing dough according to the present method, it has been found that the minimum effective spacing between the outer edge of the rotatable element and the wall of the container is at least four times as great as was used in the prior method and preferably thirty-two or more times as great. One-quarter inch is the very minimum and 2 inches or more has been found to be most effective. The speed of rotation of the rotatable element herein is many times faster than heretofore.

Apparently the action so obtained is the repetitive hurling of dough portions, with accompanying stretch and impact, upon the bowl wall and then drawing and regathering the portions back into the range of the rotatable element.

The minimum and maximum dimensions of the various components and their disposition and spacing, other than as specified in the foregoing, are not critical. Obviously dough developers in accordance with the invention may be considerably smaller or larger, as dictated by the desired output, and practical manufacturing considerations.

What is claimed is:

1. In a dough developer attachable to a dough pre-mixer to receive dough pre-mix therefrom, a cylindrical chamber substantially vertically positioned, a shaft rotatably mounted in said chamber substantially co-axial therewith, drive means drivingly connected to rotate said shaft,

said drive means being of the variable speed type, at least one elongated blade secured to said shaft in said cylindrical chamber, said blade having a radius substantially less than the radius of said cylindrical chamber, a bottom wall in said chamber, an orifice formed in said bottom wall, a pair of spaced parallel rollers positioned beneath said orifice, means mounting said rollers for rotation, variable speed drive means drivingly inter-connected to said rollers to drive said rollers oppositely one to the other so that material received by said rollers from said orifice may be fed downward as a ribbon and cut-off means beneath said rollers operatively constructed to sever said ribbon, at preselected time intervals, whereby said first-named drive means may rotate said shaft and blade at various peripheral velocities without varying the rotary velocity of said rollers and the time intervals of said cut-off means.

2. A device substantially as set forth in claim 1 further characterized in that said blade is tapered to describe upon rotation an inverted cone.

3. A device substantially as set forth in claim 2 wherein at least one of said rollers of said pair may be moved in parallelism toward and away from said other roller.

4. A device substantially as set forth in claim 1 further characterized by a blade on said shaft having multiple openings formed therein.

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