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 permitting 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 combining the dough to permit accurate metering or dividing.

It is an object and advantage of a non-pressurized system that it eliminates or reduces scaling 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 provide 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 prefertment 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 a 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 hereinlater, 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 as in the horizontal chamber or trough. The dough mix was successfully developed as well as being successfully propelled in the direction of decreasing taper.

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 20 directions illustrated by the arrows in FIG. 1. Rollers 88, 90 smoothly propel or pump the developed dough downward 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 35 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 journalled 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) as above described. A flange 126 of the plate 114 has secured thereto a forked bracket 128, which rotationally 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 journaled in the front plate 132 and the rear plate 151 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 156.

It is to be noted that the r.p.m. of the shafts 46, 112, 150, and 20 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 included ingredients and the output of the dough pump rollers 88, 90 so that the height of the dough in the impeller chamber shall 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 walls in a manner appearing 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 inside 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 the range of ¾ 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 ¾ 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 just, 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 pressure 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 close 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 3/16 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 premixer 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 under 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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