May 26, 1970 C. W. LITTLE, JR 3,514,079

FOOD EMULSIFYING MILL

Filed Jan. 4, 1968 2 Sheets-Sheet 1

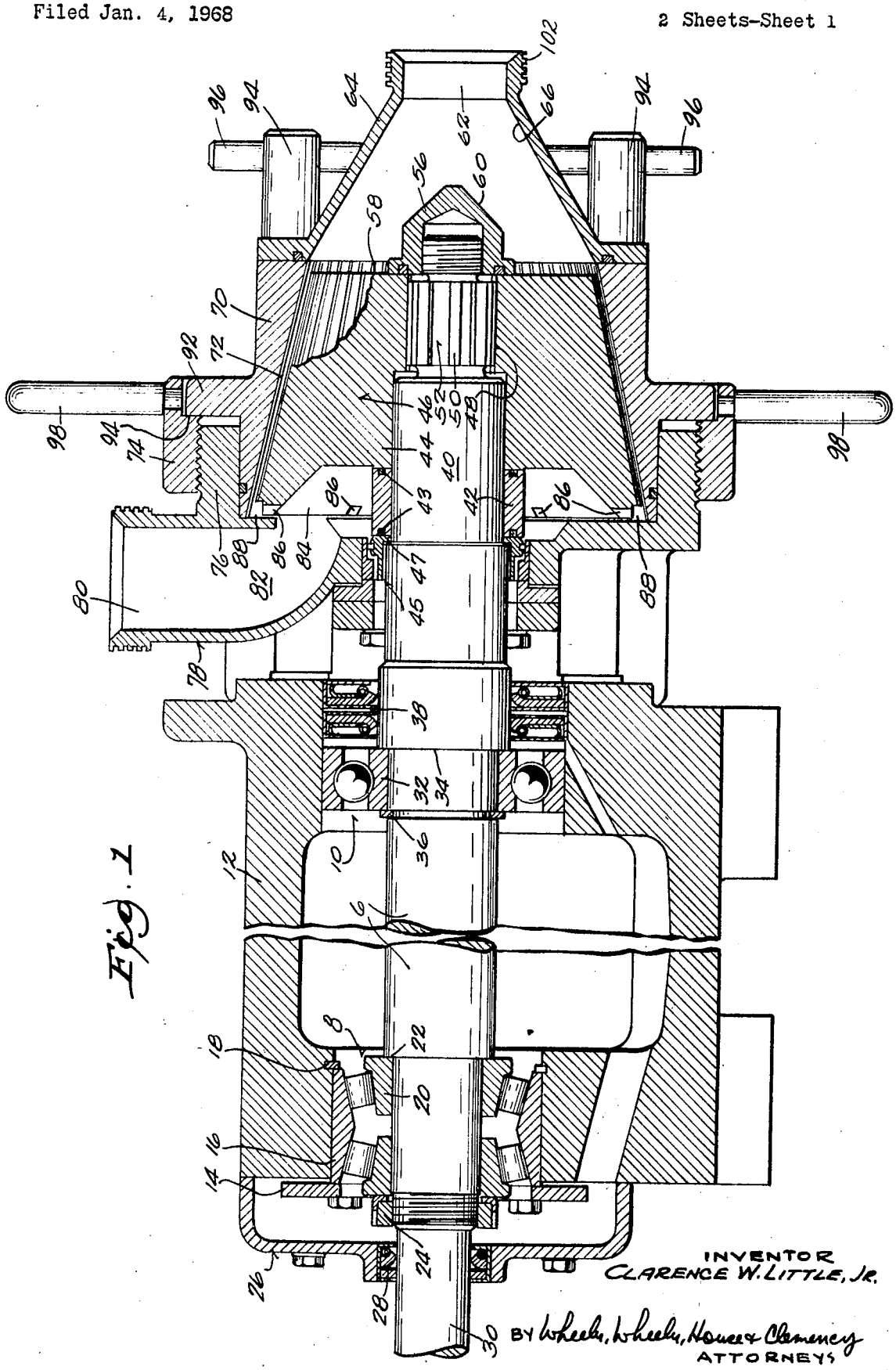


Fig. 1

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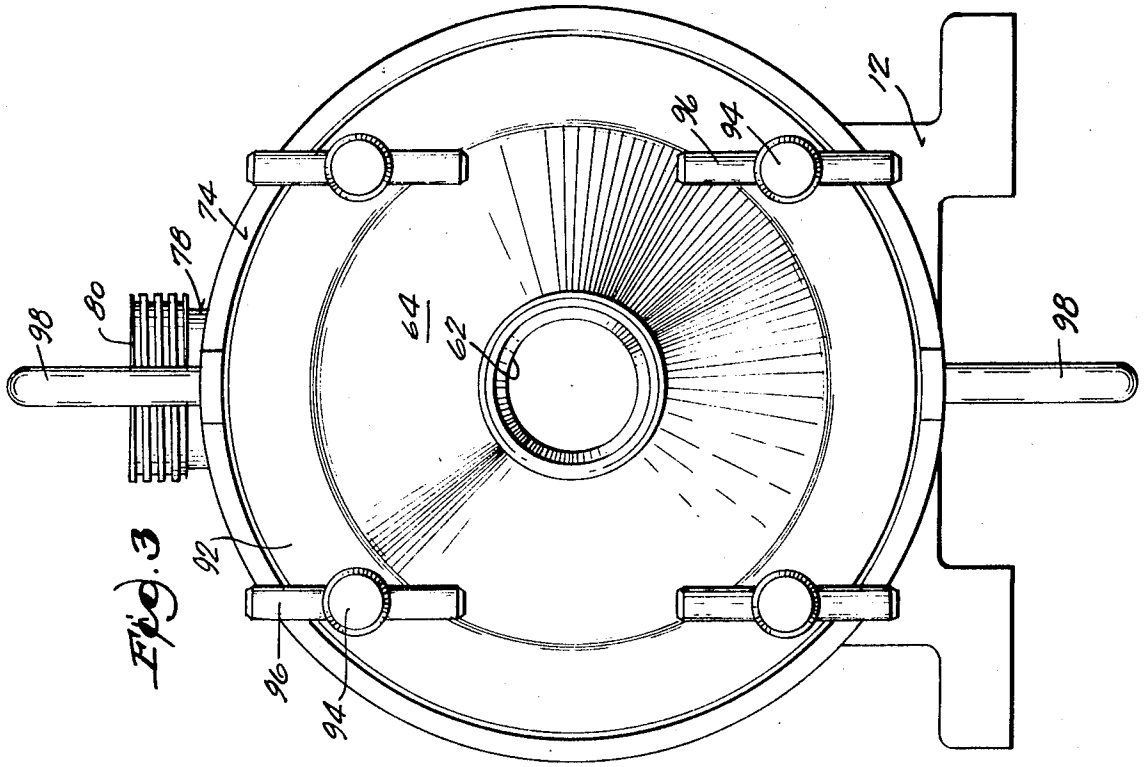



Fig. 3

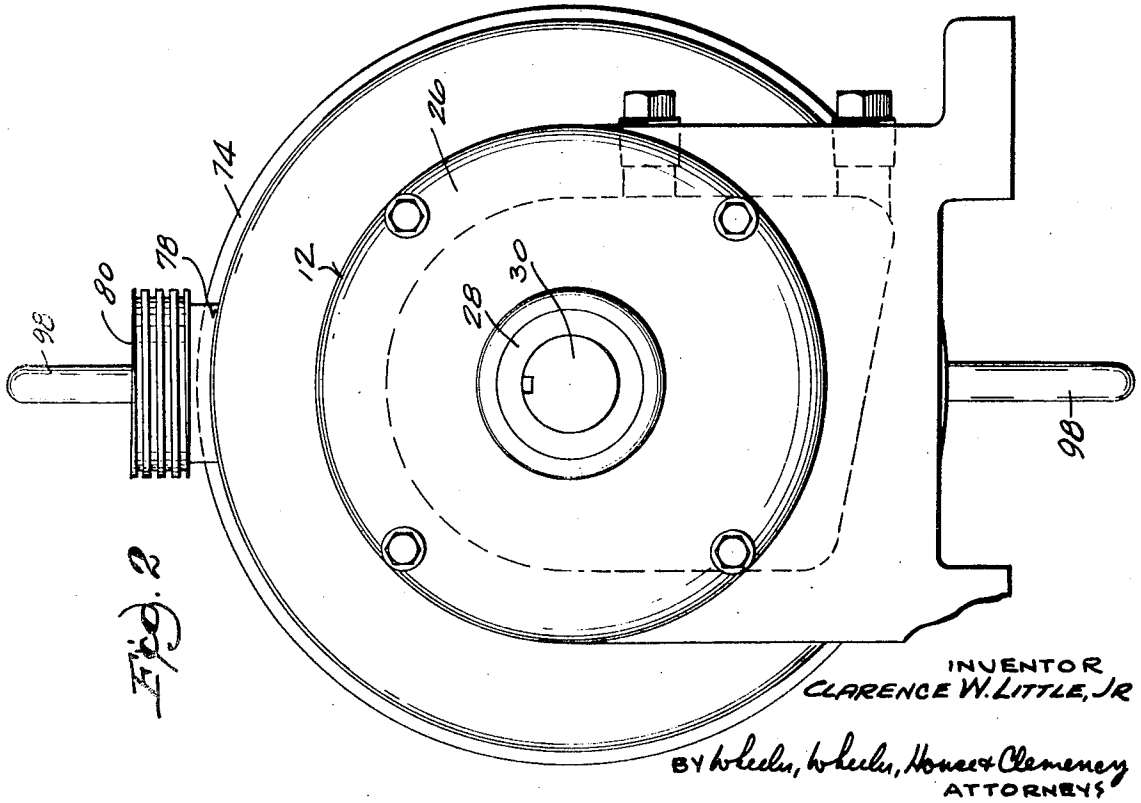



Fig. 2

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3,514,079

# FOOD EMULSIFYING MILL

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U.S. Cl. 259—9 5 Claims

## ABSTRACT OF THE DISCLOSURE

A conical mill rotor is fixed to its drive shaft with its large inlet end proximate the drive shaft bearing. Clearance adjustment is made by axial movement of the stator. A tapered delivery throat mounted on the stator leads smoothly and axially from the small end of the mill.

## BACKGRGOUND OF THE INVENTION

In counterflow mills, as well as aiding-flow and neutral mills, it has been traditional to enter the material at a front center port and discharge it at a rear port leading from the periphery of the rotor proximate the rotor shaft and bearing.

In counterflow conical mills, therefore, the small end of the rotor cone has normally been proximate the shaft bearing, and the large end of the cone has been at the end of the mill remote from the bearing. The rotor has usually been adjusted along the shaft for variation of clearance between the rotor and the stator, although stator adjustment has also been known. In any case, the prior art has caused the pre-emulsified product to enter the mill through a relatively clear passage at the larger end of the cone, remote from the shaft bearings, and the emulsified product has been required to emerge through an indirect passage leading outwardly from the center of the mill.

In contrast, the pre-emulsified product admitted to the mill of the present invention enters through the body and prior to emulsification traverses the region of maximum turbulence about the shaft to reach the large end of the mill. The emulsified product then emerges with minimum turbulence substantially rectilinearly from the small end of the cone through a smooth surfaced stationary throat remote from the shaft bearings. It will be shown that this is important for several reasons. The principal objectives originally sought in the instant mill are increased bearing and shaft strength and ease of cleaning. However, a number of unexpected advantages were achieved, in addition to these objectives.

For one thing, many emulsified products, mayonnaise being a prime example, are somewhat sensitive and tend to break down if the emulsion is overworked, once formed. In prior art mills, it has long been accepted that the emulsion breaks down in at least some portion of a treated quantity of mayonnaise when the mill is stopped and started during processing. When a high quality product is required, it has been common to draw off that portion of the emulsion which has partially broken down due to stopping and starting.

There is an unexpected advantage in the instant construction in that there is little or not tendency for the emulsion to break down. The instant mill can be connected directly to a surge hopper on the filling machine and can be stopped and started as required. This is apparently due to the fact that the delivery in the instant mill is smooth and substantially rectilinear and through a relatively stationary axial throat, the emulsion formed in the mill being exposed to minimum turbulence in the course of its emergence.



In addition, there is another interesting and unsuspected advantage in that materially lower power is required in the operation of the instant mill.

The passage through which material enters the mill is relatively tortuous as compared with the discharge passage. To the extent that any viscous material traverses a tortuous passage, power is necessarily consumed. Since the pre-emulsified material is much less viscous than the emulsified product, and since the less viscous pre-emulsified product traverses the less direct inlet passage, there is much less power consumed than is required in a conventional mill in which the less direct passage is at the outlet and hence is traversed by the more viscous finished emulsion. Thus, there is lower torque demand on the motor than is the case in the conventional mill. The decrease in power required is notable.

There is further decrease in power requirements because the mill is able to create an excellent emulsion with much wider spacing between rotor and stator than is needed on a traditional mill. This phenomenon is not clearly understood but it may also be attributable to the fact that the emulsion is not over-milled. In any event, whatever the reason, there is a very significant difference. For example, a salad dressing formula that required a setting of thirty one-thousandths of an inch clearance between rotor and stator of a traditional mill was found to form an excellent emulsion in the instant mill at spacings between eightly and one hundred thousandths of an inch. This three or four fold increase in clearance also results in reduction in back pressure.

By reason of these factors, the instant mill operates (in a given size) with only 10 H.P. as compared with 20 H.P. required by a conventional mill of like capacity.

## SUMMARY OF THE INVENTION

The invention consists primarily in the mounting of the conical rotary mill with the base of its cone-shaped rotor adjacent an inlet through the body and proximate the shaft bearings, the fixed discharge throat being smoothly tapered and extending beyond the end of the shaft and rotor to provile for delivery of the emulsified product axially from the smaller end of the rotor and with minimum turbulence. Preferably the discharge throat is fixed against rotation and has no movement except for the fact that it is attached to the stator and participates in axial stator movement which adjusts clearance between the stator and rotor in the mill.

In addition to the fact that the mill with inlet through the body and axial exit through the throat at the small end of the mill produces a superior product with less power than conventional mills, there are mechanical advantages in that the mill is more easily cleaned; its shaft is more rigid, and its bearings are sturdier and more easily withstand the relatively high thrust load of the mill; and a superior mechanical seal can be provided.

## DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in axial section of a mill embodying the instant invention.

FIG. 2 is a view of the mill in rear elevation.

FIG. 3 is a view of the mill in front elevation.

## DETAILED DESCRIPTION

The drive shaft **6** is supported on rear bearings **8** and front bearings **10** which are mounted in a bearing housing **12**. A bearing retainer plate **14** screwed to housing **12** clamps the outer race **16** of the rear bearing **8** against a stop ring **18**. The inner race **20** engages shoulder **22** of shaft **6** and the shaft is anchored to the inner race by lock nut **24**. The bearing case cover **26** is bolted to the housing **12** and has appropriate packing at **28** about the driving end **30** of shaft **6**.

Similarly, the inner race **32** of the forward bearing **10** is confined between a shoulder **34** on the shaft and a lock ring **36** in a groove of the shaft. Suitable packing at **38** is employed between the shaft and the bearing housing **12** where the forward end of the shaft leaves this housing.

The forward end of shaft **6** is shouldered, having a portion **40** of reduced diameter on which there is a spacing sleeve **42** having packing **43** at both ends and axially abutted by the hub portion **44** of rotor **46**. Where the shaft passes through the body **78**, there is a seal assembly **45** including a gasket **47** abutted by O-ring packing **43** of spacing sleeve **42**.

The hub **44** has internal splines at **48** which are complementary to the splines **50** on the reduced extremity **52** of the shaft. A nut **56** on the shaft is engaged with the small end **58** of the rotor **46** to hold the rotor tightly against the spacing sleeve **42**. The nut **56** is preferably tapered at **60** toward the discharge port **62** provided in the smaller end of the conically taperd stationary throat **64**. The internal wall surface **66** of this throat is preferably smooth and the axial delivery through the throat is accomplished with minimum turbulence.

The discharge throat **64** is mounted on the stator **70** of the mill. Conventionally the internal surface of the stator is provided with ribs such as that shown at **72**. The taper of the stator corresponds to the taper of the rotor **46**. Clearance is adjustable by movement of the stator **70** axially with respect to the rotor and against a stop provided by a ring **74** which is adjustably threaded to a sleeve **76** on the body **78**. The means of adjustment will only be described in general terms herein because it is to constitute the subject matter of a separate application for patent.

Body **78** has a port at **80** for the admission of the pre-emulsified material. From this port a passage **82** curves toward the shaft and axially toward the outlet in order to enter a cavity **84** in the larger end of the rotor **46**. From this cavity radial slots **86** open outwardly to an annular feed chamber **88** between the rotor and the internally ribbed stator. From the chamber **88**, the material passes through the narrow clearance between the stator and rotor and becomes emulsified in so doing. It emerges from this clearance into the discharge throat **64** and leaves axially with relatively little resistance through the outlet port **62**.

Since the passage which communicates with the large end of the mill is somewhat tortuous, it has been found very desirable for producing emulsion of high quality that the material traversing this passage be the pre-emulsified material. Moreover, since the pre-emulsified material is far les viscous than the material which has been acted upon by the mill, the fact that the less viscous material traverses this tortuous passage has the result of important savings in power which would otherwise be required for the operation of the mill. Relatively little power is required to cause flow of the emulsified material through the throat **64** to the outlet **62**, since the axial flow is substantially rectilinear and the surface of the throat is smooth.

The ring **74** threaded on the sleeve **76** provides a firm abutment for the stator flange **92** against the shoulder **94** of the ring. When the flange **92** is bolted to the sleeve **76**, the stator is positioned very securely and accurately to locate its interior milling surface at the desired spacing



from the outer periphery of rotor **46**. As best shown in FIG. 3, the flange **92** has a plurality of bolts **94**, each provided with an operating handle **96**. These bolts are selectively engageable in threaded openings provided at regular intervals so that in each of a number of small increments of adjustment of the threaded stop ring **74**, the stator **70** can be bolted to the body **78**. A large handle **98** is connected to the stop ring **74** to facilitate its manipulation. The angle of the cone and the pitch of the thread have, in practice, been so designed that for each twenty degrees of rotation of the stop ring, the stator clamped thereto will show a change in mill clearance of one-one-thousandths of an inch. As already stated, this spacing can be materially greater than is required by conventional mills.

By unbolting the stator **70**, it can very readily be removed to expose the nut **56** for release of the rotor from the shaft. With these parts removed, all of the surfaces traversed by the material to be milled are exposed for ready cleaning.

It will be observed that the threads **100** of the body about the port **80** are designed to receive a sanitary coupling and the same is true of the threads **102** about the discharge port **62**.

What is claimed is:

**1.** A mill for emulsifying edible material, said mill comprising a shaft, bearing means for the shaft from which a free end of the shaft projects, a rotor member and a stator member having complementary conical surfaces with an intervening space for material to be emulsified, at least one of said surfaces being provided with emulsifying means, the rotor member being mounted on the free end of the shaft and disposed within the stator member, a mill body having means for supporting the stator member, said body including means for providing an inlet passage for material to be emulsified, said inlet passage extending inwardly toward said shaft and toward the larger end of the stator member and about the larger end of the rotor member, means for guiding toward the space between the said members such material as traverses the inlet passage, a discharge throat mounted on the stator member and leading axially therefrom beyond the rotor member and beyond the end of the shaft, said discharge throat having an interior surface merging smoothly with the interior surface of the stator member and continuing for a substantial distance axially and conically toward a reduced delivery port, said throat being free of surfaces capable of causing turbulence.

**2.** A mill according to claim **1** in which said body has a projecting generally cylindrical sleeve engaged telescopically by a complementary annular surface with which the stator member is provided, the said sleeve being concentric with the shaft and the stator member being slidably adjustable thereon axially of the shaft, a stop nut threadedly engaged with the sleeve, radially projecting stop means on the stator member engaged with said stop nut for predetermining the clearance of the said surface of the stator member with respect to the surface of the rotor member, and means for urging the stator member toward said body and thereby maintaining the said engagement of the stator member with said stop nut.

**3.** A mill according to claim **2** in which said stop means and nut and the means which urges the stator member toward the body are all external whereby they are not exposed to material traversing said space and the clearance between said members is substantially uniform.

**4.** A mill according to claim **1** in which the means for guiding material toward the space between said members include an annular feed chamber between the body member and the larger end of the rotor member, and a cavity in the rotor member, said rotary member having a flange between said cavity and said feed chamber and being provided with slots opening through said flange to place said cavity in communication with said chamber, the space between said members opening from said chamber.

5. A mill according to claim 1 in which the free end of the shaft is threaded and provided with a conical nut projecting into said discharge throat and having a portion engaging and extending axially from the small end of the rotor member.


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