This invention relates to an apparatus for processing soap comprising a housing including a first extrusion device for levigating and homogenizing a mass of soap and an evacuated chamber interconnecting the housing to a casing containing a second extrusion device for compression and compacting soap partially processed by the first extrusion device. The first extrusion device comprises a shank having flights disposed thereon, the end flight abutting and in wiping contact with the surface of a screen for forming "spaghettis" of partially processed soap.

This invention relates to an apparatus for processing soap. More particularly, the invention relates to the conversion of a conventional medium pressure soap plodder of single use into a high pressure plodder which will process both universal medium duty soap and heavy duty detergents.

The plodding of soap is a well known manufacturing process and generally includes subjecting soap to a series of extrusion or plastication operations. Soap is fed to a continuous screw or worm revolving within a closed cylinder where it undergoes levigation and homogenization and is then forced through a screen which converts the mass of soap into filaments or fine ribbons. Filaments of soap drop by gravity into a vacuum chamber enclosing a second rotating screw or worm serving to compress and compact the mass of soap and force it through a nozzle or orifice as a continuous bar.

In attempts to utilize a conventional double barrel soap plodder for processing detergent laundry bar formula blends and for reworking detergent laundry bar stock the apparatus performance has been found unsatisfactory due to drive overloading, stalling and fracturing of worms or screws. A conventional eccentric shank worm has an extended smear fin at the discharge end of the barrel adjacent the screen, the fin length being equal to one-half the diameter of the worm. Disadvantageously, when processing hard working material, such as detergent laundry bar product, the eccentric shank and long radius flight fills generate a lateral thrust on the barrel accounting for approximately 30 to 40% of allowable worm torque and the extended smear fin generates a full lateral thrust accounting for another 15 to 20% of allowable worm torque. Thus, the torque loading of a worm is about 50% lateral thrust and about 50% forward thrust. The excessive lateral thrust generated in the barrel and worm or screw assembly causes a maximum braking effect between the film of product on the barrel wall and the product contained within the flights resulting in a low efficiency performance or no performance whatsoever. For example, when utilizing an 8" screw having seven flight pitches for processing detergent laundry bar product, the maximum braking effect is never exceeded in three pitches in length. A braking area of this size will stall out a 20 horsepower motor because of low screw r.p.m. or surge feed.

It is therefore the primary object of this invention to provide an apparatus for efficiently processing a hard working soap product having a worm or screw assembly which will not be subject to excessive lateral thrust causing drive overloading, stalling and fracturing of worms or screws.

It is another object of the invention to provide a double barrel soap plodder having a worm or screw assembly which produces a straight forward thrust on the product mass resulting in maximum compression and shearing action on the product mass.

It is a further object of the invention to provide a double barrel soap plodder capable of processing both medium duty soap as well as heavy duty detergent.

In accordance with the objects of this invention, there is provided a double barrel vacuum soap plodder for processing hard working soap product, having the conventional worm or screw of the upper barrel replaced by a worm or screw, for example, with the extended fin on the discharge end removed by machining, for producing the maximum forward thrust on the product mass. The modified worm or fin can now be positioned within 3/16" to 3/8" of the screen assembly adjacent the end of the worm or screw for close wiping contact with the screen. The new worm or screw is termed as a "through-bore" worm or screw, respectively, because of the added length of the shank necessary to bring the end face of the worm or screw within 3/16" of the screen.

Advantageously, the adapting of a through-bore worm or screw assembly to a standard double barrel soap plodder does not require the changing of the barrel casting design. The beveled area normally occupied by the extended fin is, in converted equipment, filled in by a solid steel self-locking beveled ring. To provide additional shank length for the through-bore screw or worm the drive end of the modified screw or worm may be blocked out by placing a steel plug in the hub bore. Thus, the conversion of the plodder is a low cost operation.

These, together with the various ancillary objects and features of this invention, which will become apparent as the following description proceeds, are attained by this soap plodder, preferred embodiments of which have been illustrated in the accompanying drawings, by way of example only, wherein:

FIG. 1 is a vertical sectional view of a soap plodder constructed in accordance with the concepts of the present invention;

FIG. 2 is a partial fragmentary sectional view in an enlarged scale of an embodiment of the upper barrel of a double barrel soap plodder constructed in accordance with this invention, parts being broken away to show other parts in detail; to the top of the clamp and the top end of the barrel;

FIG. 3 is an exploded perspective view of a top barrel compression assembly;

FIG. 4 is a perspective view of a ribbed compression plate to be used in a top barrel compression assembly; and

FIG. 5 is a fragmentary sectional view of the ribbed compression plate taken along the plane of line 5--5 in FIG. 4.

With continuing reference to the accompanying drawings, particularly with reference to the embodiment shown in FIG. 1, wherein like reference numerals designate similar parts throughout the various views, reference numeral 10 is used to generally designate the top barrel through-bore worm or screw assembly of the present invention. In the embodiment shown in FIG. 1, a mass of soap is fed into an opening 12 from a hopper or chute 14 and enters worm 16, which will be described more fully hereinafter, rotating within cylinder 18 about drive shaft 32 which is driven by means, not shown. The worm 16 carries the soap forward, subjecting it to a compression and shearing action which results in levigation and homogenization of the mass of soap. The soap is forced first through screen 22 and then through apertures 20. Behind apertures 20 is a cut-off knife 24 which
rotates with worm 16 around shaft 32. The screen 22 is in a fixed position with respect to worm 16. These several successive mechanical operations serve to form loose pellets of partially processed soap "spaghetti."

The through-bore worm 16 includes an eccentric shank 26 and rounded worm flights 28 having a graduated flight pitch. The through-bore worm 16 may be manufactured by machining off the end film of a standard top barrel worm to the diameter of the worm so that the end flight 30 of through-bore worm 16 is in wiping contact with the entire surface of screen 22. The construction of the end flight 30 of the worm and the close tolerance (in the range of about $\frac{3}{4}''$ to about $\frac{1}{4}''$) between the end face of the worm 16 and screen 22 produce a maximum compression and shearing action on the product mass as it passes from the barrel and worm through the screen assembly of the plodder.

After partially processed soap passes through apertures 20 and is cut by the knife 24, it falls by gravity into vacuum chamber 34 connected to a vacuum device, not shown. The cut filaments of soap fall onto a second eccentric shank worm 36, situated within lower barrel 38 integral with the evacuated chamber. Worm 36 is driven by a worm gear, not shown, in preference of means of upper worm 16, about shaft 37. As the soap passes through the vacuum maintained in chamber 34, previously occluded air and moisture are removed, thereby enabling the formation of a low-moisture, striation-free final product. Worm 36 compacts and forces the soap through an opening 40 to a nozzle, not shown. Cylinders 18 and 38 are each provided a jacket 42 so that a heat exchange medium may be circulated around the cylinders to maintain the temperature of the soap being processed therein.

Although the aforementioned description is limited to the use of worms in both the upper and lower barrels of a double barrel soap plodder, it will be appreciated that screws may be used instead of worms in either or both of cylinders 18 and 38. In fact, it has been found that use of a through-bore screw 44 in the upper barrel, as illustrated by FIG. 2, having an annular volume per screw flight equivalent to that of a worm, performs in a manner superior to that of the through-bore worm because of the concentric design of the screw shank and the sharp profile of the flights 46 produce the maximum straight forward thrust on the mass of soap attainable by a similar extension assembly. This in turn results in a maximum compression and shearing action on the product mass passing through the modified screen 48 of the top barrel compression assembly, shown in exploded form in FIG. 3. Thus, performance of a through-bore screw in the top barrel of a plodder for processing hard working detergent product is more efficient than that of a through-bore worm. However, it is obvious that as the softness of the product to be processed increases, the performance differential between the worm and screw is diminished.

The use of a through-bore screw assembly in the top barrel has the additional effect of reducing the drive amperes loading up to 40% as compared to that required by a through-bore worm assembly in a plodder processing the same product. Replacement of a worm assembly by a screw in the bottom barrel, as well as in the top barrel, further reduces the drive amperes loading by 25%.

In the embodiment shown in FIG. 2, the upper barrel of a conventional double barrel soap plodder was converted to accommodate a through-bore screw 44 of wrap around weldment construction, the flights 46 being formed of substantially square flat bar stock. The end flight 50 of the screw is formed so that when the axle of rotation of the screw 44 is coaxial to the wall 52 of the housing the end face of the screw 44 is positioned within about 0.622" to about 0.0322" of the modified screen 48, see FIG. 3. The beveled area normally occupied by a worm fin is filled by a solid steel self-locking beveled ring 54.

The operation of the modified plodder is conventional. Soap processed by screw 44, at a temperature maintained by the flow of a suitable heat exchange medium about wall 52 jacketed by wall 42, passes through a compression assembly including a screen 48, a standard compression plate 56, and cut-off knife 34. A compression ring 58 surrounds beveled ring 54 and compression plate 56 to provide closeness of fit between the elements of the compression assembly disposed about shaft 60. Partially processed soap product is forced into vacuum chamber 34, formed by metal hood 62, evacuated by means, not shown, attached to glass covered port hole 64 having threads thereon.

Since a standard perforated screen as used in the plodder, having approximately a 40% open area, is subject to blockage when the screen is under compression against the drilled pattern of the compression plate, the soap being processed backs up behind the screen under the pressure of the load. Because this condition becomes critical in the processing of detergents, a modified compression plate 66, illustrated in FIG. 4, having a plurality of parallel spaced ribs 68 secured to ring 69 and perpendicularly disposed with respect to the plane of its circular circumference is preferred to the standard perforated compression plate. The approximately 75% open area of the former reduces the degree of soap back-up pressure considerably as compared to the latter.

A further improvement of the performance of a double barrel soap plodder results when the overall length of the nozzle, not shown, attached to the oil or discharge end of the lower barrel is limited to a length equal to the diameter of the barrel bore. Plodders utilizing conventional nozzles operate under excessive stress caused by the long swaging line of the nozzle. The swage line of a nozzle is the hypothetical overall length of the high shear line inside the nozzle from a point on the large entry bore surface to the center of the small discharge bore, disregarding the contour of the nozzle. Generally, it may be said that the longer the nozzle length, the greater the shearing thrust required. The degree of shortening of the nozzle length will depend upon the quality of extrusion desired. Indicative of the improved performance is the fact that there is a 15% to 20% reduction in drive amperes loading when the shortened nozzle is used on a plodder extruding three-week old detergent laundry bar scrap cuttings.

The following specific examples illustrate the invention:

**EXAMPLE I**

The performance of a top barrel through-bore worm assembly and a through-bore screw assembly were compared to that of a standard worm assembly:

(a) standard worm assembly (product hardness index, 50 medium soft)

(b) through-bore worm assembly (reduction in drive amperes loading—20% product hardness index, 35 though)

(c) through-bore screw assembly (reduction in drive amperes loading—41% product hardness index, 10/12 though hardness)

**EXAMPLE II**

The performance of a standard worm, through-bore worm and through-bore screw assemblies in the top barrel assembly were compared on Puerto Rico Detergent Laundry Bar scrap cuttings three weeks old. The plodder barrel was normalized by residual heat.

Run 1: The top barrel included a standard worm assembly, shredder wheel, ¾" screen,¹ and compression plate, all rotating at 16 r.p.m. and processing 1,920 lbs. soap per hour. The amperes load varied between 23 to 28 amperes.

¹ A ¾" screen was used because the standard worm could not pass through the ½" screen assembly.
Run 2: The top barrel included a through-bore worm assembly, \( \frac{3}{8}'' \) screen and compression plate and rotated at approximately 40 r.p.m. processing 3,090 lbs. soap per hour. The ampere load was in the range of 25 to 28 amps.

Run 3: Run 2 was repeated with the exception that a through-bore screw was used instead of a worm. The apparatus processed 3,945 lbs. soap per hour at an ampere load of about 28 to 32 amps.

EXAMPLE III

A top barrel worm was prepared for the experimental run by machining off the tip of the diameter of the worm. The bevel of the top barrel normally used for the sweep of the worm fin was fitted with a beveled filler ring with a straight bore of such a length to be able to fill in the gap left by the removed shredder wheel. The clearance between the end face of the worm and the screen ranged between \( \frac{3}{8}'' \) to \( \frac{5}{8}'' \).

The drive end of the modified worm was blocked out so that the discharge end of the worm was within \( \frac{3}{8}'' \) to \( \frac{5}{8}'' \) of the screen by placing a steel plug in the hub bore and disregarding the gap between the hub face of the worm and the end wall of the plodder barrel. The resulting performance was most impressive.

The performance of the through-bore worm justified replacement with a through-bore screw (wrap around flight weldment construction) of a proper overall length. The pitch of the flights was a duplication of the worm flights. The flights were formed of flat bar stock as square as possible with the radius of the fillet welds in the range of \( \frac{3}{8}'' \).

A latitude of modification, substitution and change is intended in the foregoing disclosure, and in some instances some features of the present invention may be employed without a corresponding use of other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention herein.

I claim:

1. A soap plodder comprising a housing, rotating means in said housing for levigating and homogenizing a mass of soap, perforate means of larger diameter than the diameter of said housing attached to said housing for removing impurities from said soap and for feeding loose pellets of soap spaghetti out of said housing, said rotating means comprising shanks having flights disposed thereon, and end flight means on said rotating means abutting and in wiping contact with the entire surface of said perforate means for forcing soap through said perforate means along a surface larger than the cross-sectional area of said housing.

2. A soap plodder according to claim 1, including compression plate means located adjacent said perforate means for preventing blockage of said perforate means by accumulated soap during processing of said soap under pressure from said rotating means.

3. A soap plodder according to claim 2, including knife means located adjacent said compression plate means for shearing soap in the form of loose pellets from the soap spaghetti passing through said compression plate means.

4. A soap plodder comprising a housing, first rotating means in said housing for levigating and homogenizing a mass of soap, a casing, conduit means connecting said casing to said housing for feeding partially processed soap from said housing to said casing, second rotating means in said casing for compressing and compacting the soap partially processed by said first rotating means, perforate means of larger diameter than the diameter of said housing attached to said casing for removing impurities from said soap and for feeding loose pellets of soap spaghetti into said conduit means, means for evacuating said casing for removal of air from soap as it passes into said casing from said conduit means, said first and second rotating means comprising shanks having flights disposed thereon, and end flight means on said first rotating means abutting and in wiping contact with the entire surface of said perforate means for forcing soap through said perforate means along a surface larger than the cross-sectional area of said housing.

5. A soap plodder according to claim 4, wherein said casing is disposed below said housing.

6. A soap plodder according to claim 5, including compression plate means located adjacent said perforate means for preventing blockage of said perforate means by accumulated soap during processing of said soap under pressure from said rotating means.

7. A soap plodder according to claim 6, including knife means located adjacent said compression plate means for shearing soap in the form of loose pellets from the partially processed soap spaghetti before said soap passes into said conduit means.

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