Sept. 25, 1962 J. GARVEY 3,055,074

PLODDER LINERS

Filed March 22, 1957 3 Sheets-Sheet 1

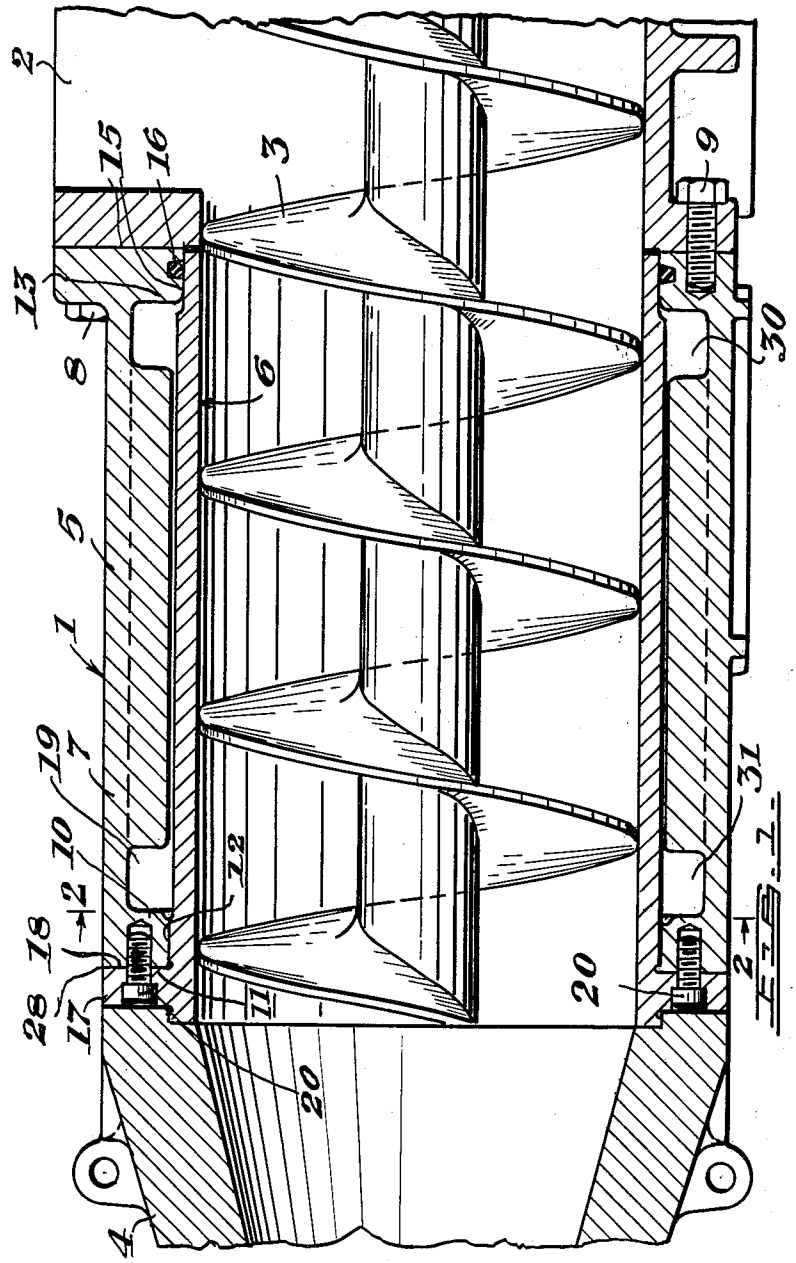


FIG. 1.

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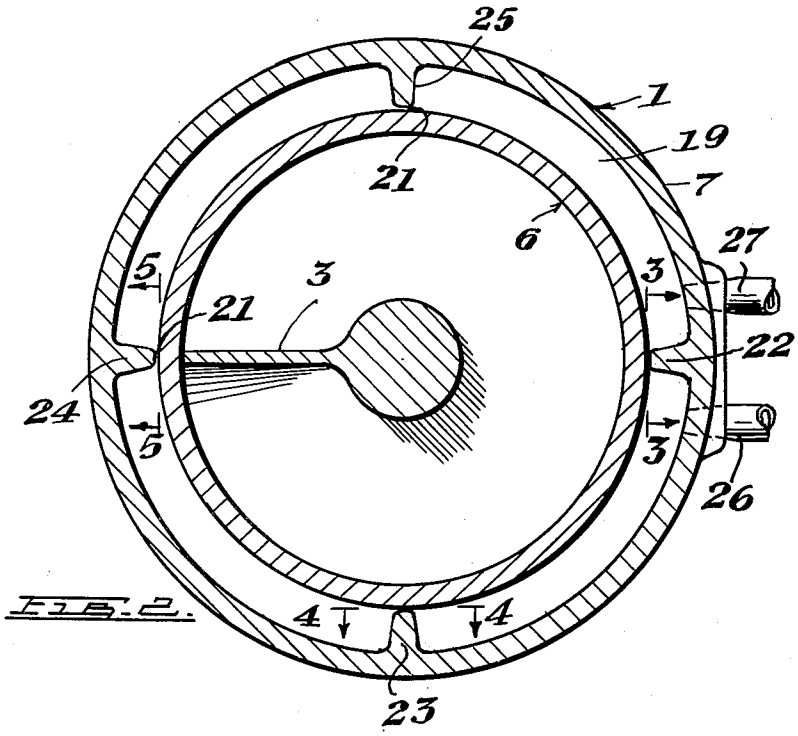


FIG. 2.

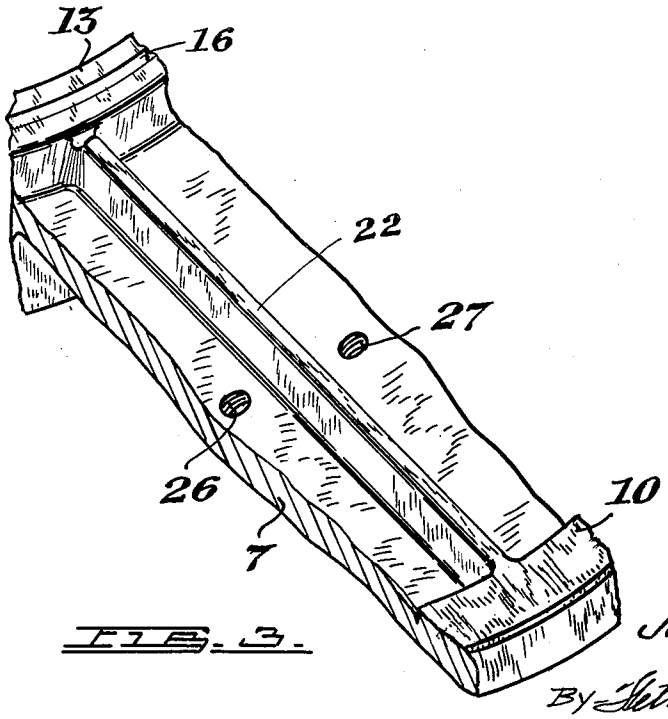


FIG. 3.

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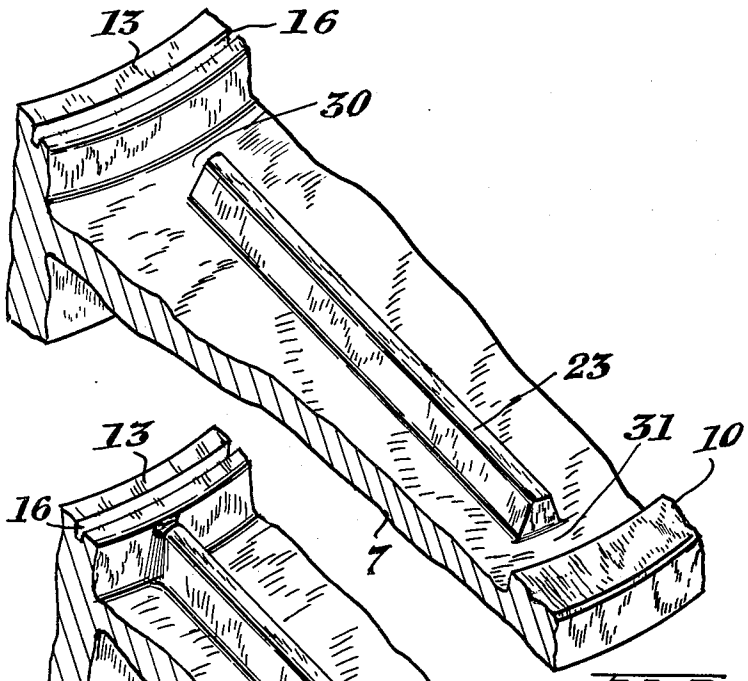


FIG. 4.

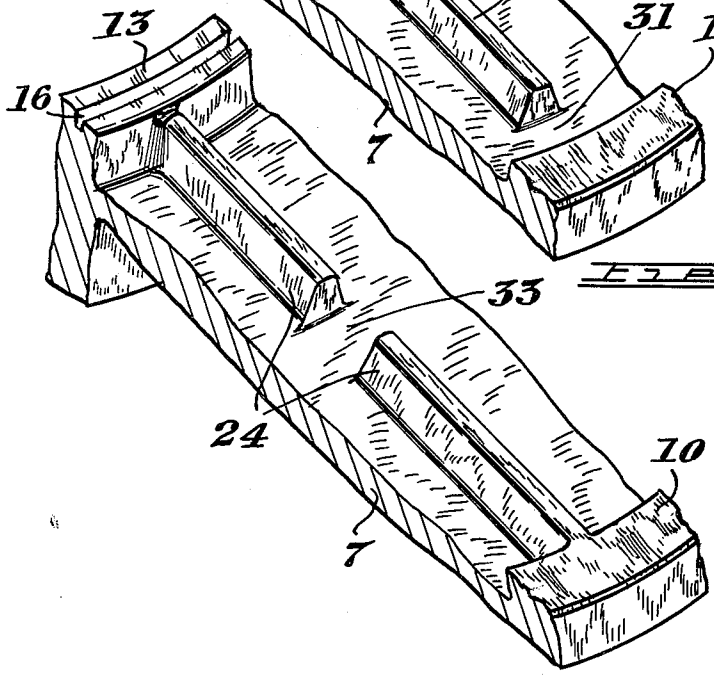


FIG. 5.

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United States Patent Office

3,055,074
Patented Sept. 25, 1962

3,055,074

PLODDER LINERS

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Filed Mar. 22, 1957, Ser. No. 647,896
1 Claim. (Cl. 25—8)

This invention relates to cylinders designed for use with the helical screws used in extruding machines, commonly designated "plodders," required in the soap and detergent manufacturing industry.

Prior to the present invention the vast majority of plodder machines used in soap and detergent manufacturing have been provided with a unitary cast iron cylinder having within its walls passages designed to allow the flow of cooling liquids. While such cylinders have been found satisfactory for use in connection with the production of conventional soaps, they have nevertheless displayed a number of characteristics which it would be advantageous to avoid. In many cases the wear on the inside of the cylinder has been excessive and, due to the weight of the helical screw which at least partially rests on the bottom, the cylinders have a tendency to become oval in shape. In some cases this situation can be rectified by reboring the cylinder and building up the screw flights so as to regain a suitable fit. In other cases, where the wear is severe, reboring is not possible and the cylinder must be scrapped.

When plodder machines having such cylinders have been used for the manufacture of bars of detergent, a number of the undesirable features of such cylinders which, although apparent when used with soap did not seriously reduce the machine's usefulness, have been accentuated to an extent that the manufacture of bars of detergent has been rendered very difficult. Two main reasons are generally considered responsible for these additional difficulties. In the first place, the temperature level at which detergents must be processed in the machine is usually appreciably higher than that used for soap, and the range of temperatures between which it is possible to secure satisfactory processing of detergent is relatively narrower than the usual temperature tolerances for soap. Secondly, since detergents are more chemically active than soaps there is a much greater tendency for them to attack and corrode the metal parts of machinery with which they become in contact. Such corrosive action has of course been known to be present during soap processing but its magnitude has not generally interferred with the securing of a satisfactory product. In the case of detergents, however, the corrosive action has in some cases been sufficiently violent that serious contamination of the output of the machine has occurred, thereby causing a great waste of material and time. Even where contamination of the product has not occurred to this extent, great difficulties have been experienced immediately after any temporary stopping or shut-down of the machine. When such occurs the inside of the plodder is subjected to bad corrosion and rusting action, particularly in hot climates or when the machine is left with detergent inside over an appreciable period of time such as overnight or a week-end. When such a machine is again put in operation it is not uncommon for at least two hours or more running time to elapse during which the output of the machine is badly contaminated with rust collected off the walls of the cylinders. Such waste of time and material has been a serious impediment to the satisfactory forming of detergent into bars.

In the past at least one attempt has been made to

inhibit this corrosive action and the contamination of the product which results from it. This has involved the use of a stainless steel or other suitable non-corrosive metal liner fitted inside the cast iron cylinder so as to provide a more chemically inert surface for contact with the soap or detergent. Such liners have invariably comprised a tube pressed into the cylinder and having close contact therewith at all points on the outside of the liner, the passages for a cooling liquid being cast inside the cylinder itself so that the cooling water does not come into direct contact with the surface of the liner. Moreover, it has been usual permanently to fasten such liners into place at each end of the cylinder. Such attempts to inhibit corrosion of the machine have not been entirely successful. The liners, usually rolled from stainless steel in sheet form and welded into a tube, have been very difficult to make and to fit into a given cylinder. In many cases they have become distorted during the pressing operation in which they are placed inside the cylinder and thus do not provide accurate and consistent clearance with the flights of the screw which rotates inside the cylinder and causes the soap or detergent to move along its length toward the nozzle. Of equal seriousness is the inadequate cooling system which such units involve. The heat conduction of stainless steel is not as efficient as that of cast iron from which the cylinders proper are usually made so that, by placing a stainless steel liner inside the cylinder, a good deal of the heat generated during the compressing operation on the soap or detergent, which would otherwise be conducted away, is retained inside the machine and therefore makes difficult quality control of the product and even reduces the speed at which it would otherwise be possible to run the machine. This condition follows from the introduction of a stainless steel liner into a conventional cast iron cylinder because, by so doing, an additional layer of poor heat conducting material has been introduced between the soap or detergent and the coolant. To reduce this effect such stainless steel liners have invariably been made from very thin stock, of the order of 1/16 to 1/8 inch, so as to reduce the thickness of the poor heat conducting layer. While this immediate purpose can to some extent be accomplished by making the liner very thin, such design complicates the manufacture of the liners and accentuates the difficulties associated with inserting them inside the cylinder in such a manner that they remain true and present a smooth, perfectly cylindrical surface concentric with the helical screw.

Still further disadvantages of prior designs of plodders become apparent when it is necessary to renew the surfaces of the cylinder and the helical screw due to corrosion and wear. As explained above, in the case of unlined cast iron cylinders wear very often manifested itself by the cylinder aperture becoming oval in shape, the elongation usually occurring in the vertical direction due to the weight of the screw resting at least partly on the bottom of the cylinder. When this occurs it is sometimes possible to rebore the cylinder and then build up the flights of the helical screw to give the appropriate fit. But in order to achieve adequate heat conduction it is necessary to design the cooling channels to be quite near the inside surface of the cylinder, thus reducing the degree of reboring which can take place. In such circumstances the life of a cylinder will be relatively short since under conditions of severe wear or corrosion only a limited amount of reboring can take place before the thickness of the casting between the inside surface of the cylinder and the cooling channels become so thin as

to be dangerous. In the cases where cast iron cylinders have been provided with stainless steel liners, the remedies for wear have been at least as difficult, if not more so. When a relatively thin stainless steel liner is placed inside a cylinder by means of a press fit, and permanently fastened at each end, its removal from the cylinder is a task of formidable dimensions, if, indeed, it can be undertaken on an economic basis at all.

Finally, and perhaps the most serious disadvantage of all prior cylinder construction, there is the fact that resurfacing the inside of both lined and unlined cylinders invariably involves the complete stripping down of the machine and returning it to the manufacturer. This results in a serious loss of production from important units of capital equipment, in addition to labour and other expenses consequent to the repair itself. Indeed it is a known fact that one of the most serious causes of production loss in soap manufacturing establishments has been the so-called "down time" hitherto associated with automatic line machinery, which includes plodder machines.

I have found that a number of the disadvantages inherent in prior designs of soap plodders, particularly those identified with lack of adequate heat conduction, corrosion with consequent contamination of the product, and loss of time and production involved in completing repairs to the machine, can be overcome by using a cylinder arrangement in accordance with my invention. I provide a cylinder assembly for a helical screw plodder machine used in the manufacture of bars of soap or detergent comprising a hollow, cylindrical body member having on its inside surface a plurality of cooling fluid baffling fins and a detachable corrosion resistant liner adapted to fit inside the body member in concentric engagement with it, the body member and the liner being designed to form liquid tight joints at each end, the outside surface of the liner, the inside surface of the body member, including the cooling fins, forming between them at least one flow path for a cooling liquid so that the liquid comes into direct contact with the outside surface of the liner. The liner extends far enough back into the machine so that all the inside cylindrical surface of the plodder presents a corrosion resistant face to the soap or detergent. In a preferred embodiment of my invention I find it advantageous to connect the liner to the body member at the front or nozzle end of the machine by means of an outwardly extending radial flange integral with the nozzle end of the liner and through which extend appropriate fastening devices adapted to hold the liner rigidly in place and to effect, in combination with a gasket, a substantially liquid tight joint. Additionally, in order to obtain the fullest advantage of my cylinder arrangement, it is advantageous to select the materials from which the cylinder liner and the helical screw flights are made so as to ensure, as between these two components, that the greater part of the wear is sustained by the cylinder liner. With such an arrangement an expendable cylinder liner, which is relatively inexpensive, can be easily replaced without stripping down the machine. A succession of such liners can then be used in conjunction with a single helical screw, thereby avoiding the necessity for frequent replacing or building up screw flights and the resultant expense which arises from such extensive "down time" repairs and replacement of entire conventional cylinders and/or screws.

It is thus an object of my invention to provide a cylinder arrangement for a soap plodder which presents a corrosion resistant work surface to the soap inside the machine and at the same time admits of adequate conduction, away from the soap, of the heat generated during the compressing action of the screw.

It is also an object of my invention to provide a cylinder arrangement for a plodder machine which will facilitate the use of such machines in the manufacture of bars of detergent.

A further object of my invention is to provide a cylinder arrangement for a plodder machine which includes an easily removable cylinder liner which can be replaced in a minimum amount of time, without completely dismantling the machine.

It is also an object of my invention to provide a removable liner so designed that, as between the liner and the helical screw which revolves inside it, the liner sustains the greater part of the wear, thus making it possible to maintain the required clearance between the flights of the screw and the cylinder walls merely by replacing the liner.

These and other objects and advantages of my invention will become apparent as the following description proceeds.

In the drawings:

FIGURE 1 is a side elevation, in section, of the barrel or cylinder part of a helical screw plodder machine such as is used in the manufacture of bars of soap or detergent;

FIGURE 2 is a cross-sectional view of the whole of the cylinder of the machine, taken across the line **2—2** on FIGURE 1;

FIGURE 3 is a perspective view of a section of the hollow cylindrical body member taken along lines **3—3** of FIGURE 2;

FIGURE 4 is a section of the hollow cylindrical body member taken along the two section lines **4—4** on FIGURE 2;

FIGURE 5 is a section of the hollow cylindrical body member taken along the lines **5—5** on FIGURE 2.

FIGURE 1 depicts the cylinder region of a helical screw plodder machine having a cylinder generally represented at **1** extending on the top of the machine from the edge of the casting defining hopper aperture **2**, and on the bottom of the machine from the housing (not shown) of the main bearing for the helical screw **3**, up to the conical nozzle **4** which is rigidly, but releasably, attached to the front end of the cylinder assembly. The cylinder assembly **1** comprises two parts, a hollow cylindrical body member **5** which is concentric with and surrounds a liner **6** as shown. The body member **5**, which is preferably cast steel, comprises a cylindrical shell **7**, and is maintained in pressure tight connection with the rear part of the machine by means of a series of equally spaced cap screws such as **8** and **9**. The front end of body member **5** comprises an inwardly extending flange **10** provided with a carefully machined flat end surface **11** and an accurate interior cylindrical surface **12** as shown. Similarly the rear end of body member **5** is provided with an inwardly extending flange **13** having an accurate flat end surface and interior cylindrical surface **15**.

The liner **6** is mounted inside the body member **5** so as to engage with and effect liquid tight joints between these two members at each end of the cylinder assembly. At the rear end of the cylinder assembly the outside diameter of the liner may be reduced slightly as shown and firmly engages with the interior cylindrical surface **15** of the flange **13**. If desired a groove **16** may be machined at about the middle of surface **15** so as to permit use of an O ring type gasket of neoprene. The front end of the liner is provided with an outwardly extending mounting flange **17** adapted to engage, by means of its rearwardly facing surface **18**, the flat end **11** of body member **5**. To facilitate making a liquid tight joint it is advantageous to insert a gasket **28** between these two surfaces. The contacting surfaces at each end are accurately machined so as to permit close and uniform engagement of the respective parts around the entire circumference of the cylinder assembly.

As is best shown in FIGURE 1, there is thus a liquid tight engagement between the liner **6** and flanges **10** and **13** at each end of body member **5**. As is also clear from FIGURE 1, these liquid tight connections form, together with the liner **6** and shell **7**, an annular chamber **19** for a cooling liquid and into which baffling fins integral with the body member **5** may project, as described below. The

liner and body member are designed so as to leave a close sliding fit between them, and the liner is held in position inside body member **5**, by means of a series of uniformly spaced cap screws **20** which extend through flange **17** into the end of body member **5**.

As best shown in FIGURE 2 four cooling fluid baffling fins, **22**, **23**, **24** and **25**, integral with shell **7** extend into chamber **19**. Preferably, and only to facilitate manufacture and assembly, a small clearance **21** is left between the inner edge of each fin and the outer surface of the liner. The baffle fin **22**, which may conveniently be oriented on one side of the cylinder assembly, extends all the way from flange **13** to flange **10** as shown in FIGURE 3. On the lower side of baffle fin **22** a water inlet **26** extends through the shell **7** into the chamber **19** between the shell and the liner. An outlet connection **27** of similar construction is disposed above baffle fin **22**.

At the bottom of the cylinder assembly fin **23** extends into chamber **19**, and as shown in FIGURE 4 it does not extend completely from flange **13** to flange **10**, but small channels **30** and **31** are left between the ends of the fin and the flanges.

On the side of the cylinder assembly opposite the inlet and outlet connections, baffle fin **24** extends into the chamber **19** as shown in FIGURE 5. In this case the ends of the baffle fin **24** connect with flanges **13** and **10**, but there is a centrally located notch **33** dividing the baffle fin into two parts. Similarly a fourth baffle fin, shown at **25** in FIGURE 2, extends into chamber **19** at the top of the machine. This baffle fin has the same configuration as baffle fin **23** located at the bottom of the cylinder, and, as shown in FIGURE 4, has two channels **30** and **31** at each end.

As is clear from the figures, when the cylindrical body member and the liner are in assembled position so that a liquid tight joint is effected at each end, the baffle fins **22**, **23**, **24** and **25** together with the inlet and outlet apertures **26** and **27** define a labyrinth-like path for a cooling liquid, the term "labyrinth-like" being used to connote that, when cooling liquid is introduced into the chamber **19** it cannot flow in a direct path around the assembly from inlet aperture **26** to outlet aperture **27**, but is forced to follow paths which involve some degree of flow along the length of the assembly, as well as around it. In particular, when the water is introduced by means of inlet aperture **26** into chamber **19**, it must flow down towards the bottom of the assembly since the fin **22** effectively blocks off chamber **19** completely because it extends continuously from flange **10** to flange **13**. At the bottom the flow lines must pass through the channels **30** and **31** at each end of the baffle fin **23**. The flow may then continue up the other side of the cylinder but when it reaches baffle fin **24** the flow lines must concentrate at the centre of the baffle fin so as to pass through notch **33**. Similarly, the flow lines at the top of the cylinder are forced to each end so as to pass through channels **30** and **31**. Finally, once the cooling liquid has passed baffle fin **25** it may freely flow down chamber **19** to the outlet aperture **27** and thence outside the cylinder assembly.

From the foregoing description it is clear that flow lines having longitudinal as well as circular components are set up. Moreover it will be noted that the cooling liquid is in direct contact with the outside of the liner **6** since this surface, together with the inside surface of body member **5** and baffle fins **22**, **23**, **24** and **25** form the labyrinth-like path through which the liquid flows. This arrangement means that the heat generated in the liner **6** by the action of the screw **3** on the soap or detergent inside the machine is conducted away from the liner directly, and does not have to pass through a cylinder casting before being absorbed by the liquid. Moreover, by removing the nozzle **4** from the machine, the cap screws **20** can be removed, thus making it possible to withdraw the liner **6** from inside body member **5**. This is possible because of the sliding fit between the liner and the body member at each end, and the fact there is no continuous contact between these parts along the middle or central portion of the assembly. When the cap screws **20** are removed the liner can be withdrawn by means of well known pulling devices. It is then a simple matter to insert a new liner in the machine and secure it in place by means of screws **20**. Finally, it will be noted that this operation can be completed while the machine is in place on the floor of the factory in which it is used.

Because of the very considerable original cost of helical screw **3**, and the correspondingly high cost of compensating for wear by building up its flights, it is desirable to choose the alloys from which the screw and liner are made so that, as between the screw and liner, the majority of wear will be sustained by the liner. As is clear from the figure, the liner is of relatively simple construction and can be easily removed without "stripping-down" the whole machine. Such being the case it is a much less costly and much faster process to renew the liner than it would be to repair and build up the flights of the screw.

To secure the relative wear resisting properties of the screw and liner it is possible to have the former made from a light weight alloy having high corrosive and wear resistance characteristics. This can be used in combination with a liner fabricated from stainless steel so as to have both the requisite corrosion resisting properties and wear resisting properties inferior to that of the screw.

By way of example only, one particular combination of materials from which satisfactory results may be expected would consist of a liner fabricated from stainless steel having a Brinell hardness of approximately 145 to 150, whilst the screw casting would be formed from stainless steel having superior corrosion resisting characteristics and a Brinell hardness of 250 to 350 approximately. The specifications of the alloys are such as to minimize galling, and will result in an overwhelming majority of the wear being sustained by the liner. The thickness of the casting for the liner may be of the order of $\frac{13}{16}$" which, when finished will result in a liner with a thickness of about $\frac{11}{16}$". The periphery of the screw flights may have a minimum face measurement of $\frac{3}{8}$".

In cases where a stainless steel screw is used in combination with a stainless steel liner a clearance of the order of $\frac{4}{1000}$ of an inch between the flights of the screw and each side of the liner is ordinarily required. When newer type non-corrosive alloys are used for fabricating the screw a considerably larger clearance, of the order of approximately $\frac{9}{1000}$ to $\frac{11}{1000}$ of an inch, is required on each side of the screw. The selection of the relative size of these parts will obviously depend on such factors as the heat expansion characteristics of both the screw and the liner and can be carried out by the application of well known design principles.

What I claim as my invention is:

In a plodding machine for the physical working of soap or detergent: a liquid cooled cylinder assembly including a hollow cylindrical body member and an expendable removable liner therefor, a nozzle releasably attached to the front end of the body member, and a helical screw adapted to rotate within the cylinder assembly; said body member having inwardly extending flanges at each end thereof, and inwardly extending baffling fins located on the inside surface of said body member between said flanges; said removable liner adapted to fit concentrically inside the body member and effect liquid-tight joints with the inwardly extending flanges, thereby forming an annular chamber for the cooling liquid between the body member and the liner intermediate the ends thereof with the said baffling fins extending into the annular chamber; said liner having a substantially smooth cylindrical exterior surface in the region thereof forming one wall of the annular chamber with said exterior surface being substantially wholly exposed to the cooling liquid; said liner also having at its front end, an outwardly extending annular flange adapted to engage with

the front end of the body member; removable fastening means extending through the annular flange into the body member to retain the liner inside the body member such that, upon removal of the nozzle and the fastening members, the liner can be withdrawn from inside the body member without removal of the helical screw; inlet and outlet orifices for the cooling liquid extending through the body member into the annular chamber; said helical screw having wear resistance qualities superior to those of the liner whereby, as between the two, the majority of wear is sustained by the liner.

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