March 18, 1947. H. G. HOULTON 2,417,495

MANUFACTURE OF GREASE

Filed Dec. 10, 1943 2 Sheets-Sheet 1

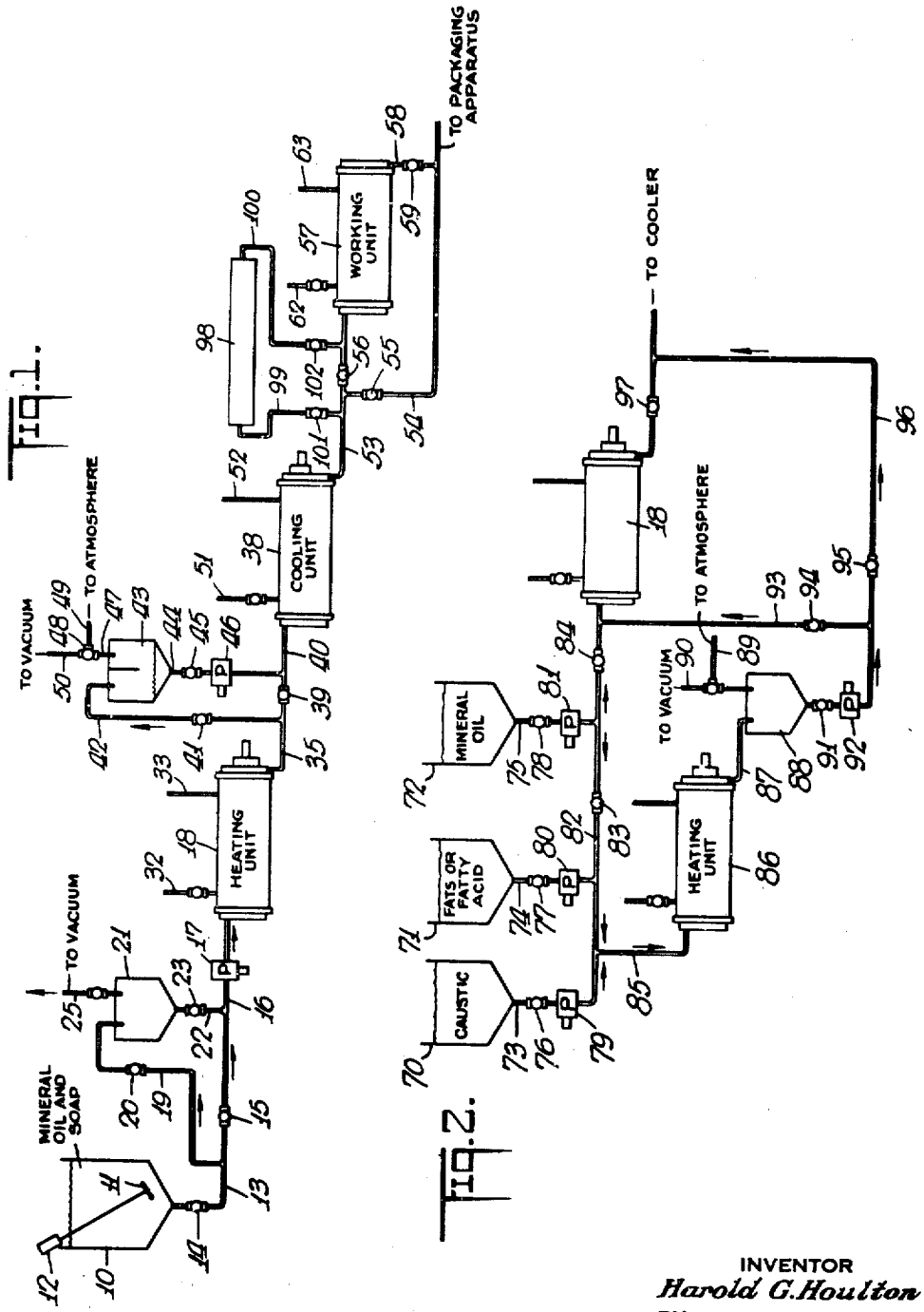


Fig. 1.

Fig. 2.

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Fig. 3.

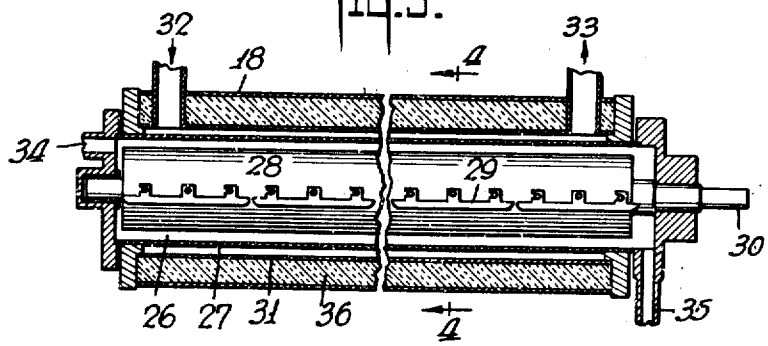


Fig. 4.

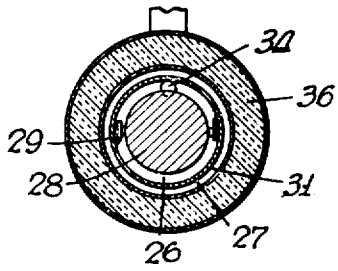


Fig. 5.

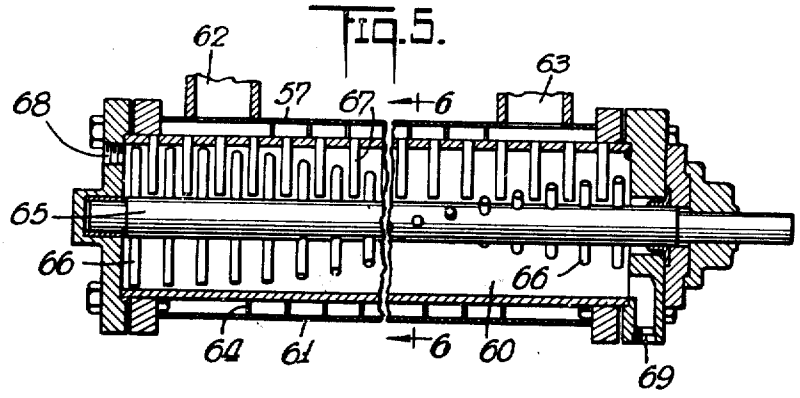
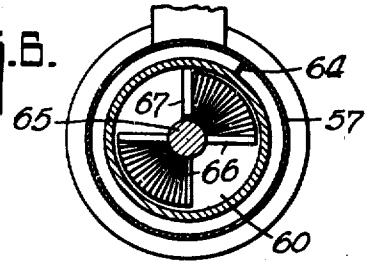


Fig. 6.



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MANUFACTURE OF GREASE

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Application December 10, 1943, Serial No. 513,690

19 Claims. (Cl. 252—32)

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This invention is an improved continuous process for making grease, by the intermixing and blending of mineral lubricating oil and a stiffening agent. This agent is preferably a soap which may be preformed, or may be made up as a part of the process of making the grease, but it will be understood that various other stiffening agents may be used instead of soap.

Heretofore, practically all greases have been made by batch processes, although continuous processes have been proposed. In a batch process, such as employed for example in the production of aluminum stearate grease, the following steps are carried out:

1. A slurry of oil and soap is heated in a batch kettle to the required high temperature for solution of the soap in the oil.

2. The mixture is then cooled down to a predetermined lower temperature with simultaneous agitation or working.

3. The grease is dumped from the kettle into pans.

4. The pans are trucked or otherwise transported to some other location for further cooling, which usually requires a considerable period of time.

5. The grease is then shoveled or otherwise dumped into conveying or working apparatus.

The above steps involve an excessive amount of handling, which results in contamination and aeration. Therefore, it usually is necessary in batch processes to deaerate as a final step, before packaging. Deaeration at this stage is difficult, because the grease now is in a more solid form.

Among the objects of the invention are to secure greater simplicity and economy, better control of temperature, and better control of moisture content; to improve the color of light colored greases; to obtain complete deaeration; to render the process safer and properly operable by less experienced personnel; to reduce fire hazard; to avoid loss of oil by evaporation; to obtain larger yield per unit of apparatus; and to reduce the amount of material in process at any one time for a given hourly production.

As an important feature of the invention, a mixture of the stiffening agent or the ingredients employed in forming the same, and the mineral lubricating oil, in predetermined relative proportions, is passed continuously through a closed system in which it is simultaneously heated to a temperature above the point at which the stiffening agent is soluble in the oil, and violently agitated under pressure in a relatively thin confined

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layer, so that the mixture is converted into a homogeneous liquid.

This liquid mixture is continuously passed through another closed portion of the system which may be similar to that above referred to, and in which the temperature is rapidly dropped to below the melting point of the grease while being vigorously agitated in a relatively thin confined layer. By this agitation while the product is being chilled from a point above to a point below the solidifying temperature of the grease, the uniform distribution of the stiffening agent in the oil will be maintained while passing from solution to gel, and a uniform, homogeneous product is obtained.

In some cases the stiffening agent may be anhydrous, but in many cases it contains a small amount of water, and in some cases a small amount of air may enter the system in a premixing or other step. Air is an objectionable ingredient of the final product, and with some greases, all moisture should be eliminated, while with other greases the amount of moisture should be reduced to a point within a predetermined range.

As a further feature of the present process, the mixture may be passed through one or more chambers so disposed and under such pressure that air may be removed before the heating step and the moisture may be removed after the heating step. If moisture be present in the liquid mixture, a controlled portion of the moisture, or all of it, will flash to steam and escape, and none, or only the desired amount, will remain, and all of the air will be blown out.

In carrying out the present process, pre-manufactured soap may be mixed with the oil, or the saponification may be effected in the presence of the oil and in the combined heating and agitating chamber by mixing all of the metal hydroxide and the tallow, vegetable oil, animal oil, or other fat, with the mineral lubricating oil, or by mixing a portion of the mineral oil with the fat and another portion with the caustic.

Various other procedures may be employed, such for instance as preliminary mixing of the metal hydroxide with a part of the mineral oil, and mixing the fat with another portion of the mineral oil, and bringing these two mixtures together at the intake of the combined heating and agitating unit.

The metal hydroxide employed to form the soap may be that of calcium, aluminum, barium, sodium or other metal, or mixtures of such metal hydroxides, and the stiffening agent may be other

than a soap, such for instance as wax, oxidized asphalt, etc., depending upon the character and desired properties of the grease to be prepared. In the interest of brevity the stiffening agent will be referred to as soap, in the later description of embodiments of the invention.

It is to be understood that the present invention may be employed for making a wide variety of greases, and is not dependent upon the employment of any one of the many specific materials or any specific relative proportions of ingredients which are suitable for the purpose.

In my process, the heating and cooling in a closed conduit system eliminates danger of contamination and aeration, and makes possible close control of the temperature. The agitation and temperature changing in a thin film insures uniform heating and cooling throughout the mass, and therefore a much more uniform final product without hard and soft layers or parts of different consistency such as are common with the batch process, and whereby the further working above mentioned is unnecessary in applicant's process, and whereby greatly improved grease texture is obtained. This is particularly true of sodium base grease, barium base grease, and most calcium base greases. In some lithium and aluminum base greases, further working may be desirable to produce grease of more stable consistency as pointed out hereinafter.

I have discovered that by the process herein described the grease can be simultaneously worked and cooled down in a matter of seconds from a high heating temperature to the critical temperature below which it is not desirable to go in the rapid cooling and agitating stage, all as more fully set forth in my co-pending application Serial No. 616,589. In many cases the grease, after being cooled to the critical temperature, can be filled directly into the final containers. Even if in some cases it is found desirable to follow the initial rapid cooling and agitating step by a further slower cooling without working, or by a time lag without working, and then a final working before packaging, a great deal of time is saved in the initial rapid cooling and agitating step.

I have discovered also that by the process herein described the simultaneous rapid cooling and working can be carried down to a substantially lower critical temperature than with the batch process, without producing an unstable grease, that is, one in which partial separation of the ingredients occurs.

Also, more rapid cooling during the initial simultaneous working and cooling stage, and the possibility, in some cases, of going directly from the cooling unit to the packaging unit, results in a very considerable saving in time in the overall process.

These and other advantages of the present process will be set forth more fully hereinafter, and following a description of certain preferred embodiments of the invention.

In the accompanying drawing there is shown somewhat diagrammatically, apparatus which may be employed in carrying out my improved process. In these drawings:

Fig. 1 is a diagrammatic layout of an apparatus adapted for carrying out the process.

Fig. 2 is a diagrammatic showing of certain alternative arrangements and connections of units.

Fig. 3 is a longitudinal section through the units which may be employed in the main heating and cooling stages.

Fig. 4 is a transverse section taken on the line 4—4 of Fig. 3.

Fig. 5 is a longitudinal section through a unit which may be used in the final working stage, and

Fig. 6 is a section on the line 6—6 of Fig. 5.

Apparatus units and connections which may be employed in carrying out the invention are shown diagrammatically in Fig. 1, and the operation may be as follows:

Predetermined relative proportions of a premanufactured soap and mineral oil are placed in a tank 10 and subjected to a relatively thorough mixing in any suitable manner, as for instance by means of an agitator 11 driven by a motor 12. As a result of this premixing there is formed a slurry with the soap in suspension in the oil. The slurry is ordinarily formed at room temperature, and may be withdrawn from the tank 10 through a discharge line 13 having a control valve 14. In order that slurry may be continuously delivered to the line 13 there would ordinarily be provided a plurality of the tanks 10 with separate valve connections so that while a slurry is being made in one tank the prepared slurry may be withdrawn from another.

In case a relatively light grease is to be made, such as the lighter form of lithium stearate grease, the mixture of soap and light-bodied oil will not pick up any appreciable quantity of air during agitation in the tank, but if a relatively heavy-bodied grease, such as aluminum stearate grease or heavier lithium stearate grease is being made, it may be found that undesirably large quantities of air may become entrained in the oil-soap slurry in the tank. If deaeration is not necessary, the slurry is delivered from the line 13 through a valve 15 and line 16, and is forced by a pump 17 into and through the heating unit 18.

In case a heavy-bodied grease is being made, and air has been incorporated in the slurry during the mixing in the tank 10, the valve 15 is closed, and the slurry from the line 13 is delivered through a line 19 having a valve 20, and discharged into a deaerator chamber 21 which is connected by a line 22 and valve 23 to the line 16. The deaerating chamber may be of any suitable form, and is closed so that a vacuum may be maintained therein by any suitable form of vacuum pump connected through a valve controlled line 25.

A suitable heating unit 18 which may be employed is shown in some detail in Figs. 3 and 4. This unit includes a chamber 26 formed as a thin, annular, confined space between the peripheral wall 27 of a cylindrical vessel and a comparatively large core 28 mounted therein. The core is provided with scrapers 29 which engage the wall 27, and the agitator may be rotated at relatively high speed, in any suitable manner, as for instance by an electric motor drive on a shaft extension 30 of the agitator. Surrounding and spaced from the wall 27 is a jacket 31 providing an annular space for the heating fluid which may be delivered through a valve controlled inlet 32 at one end and discharged through an outlet 33 at the other end. The pump 17 delivers to an inlet 34 at one end of the heating unit, and the heated and mixed material is discharged through an outlet 35 at the opposite end. The jacket for the temperature changing medium is preferably encircled by a layer of insulation 36.

The oil soap slurry is forced continuously and

under pressure through the heating unit 18 by the action of the pump, and in the heating unit the slurry is heated to such a temperature as may be required to effect solution of the soap in the oil. The agitator effects a uniform dispersion of the soap in the oil, and as the temperature changing medium causes the soap to go into solution, there is effected a uniform solution and dispersion of the soap while maintaining the slurry under a pressure sufficiently high to prevent vaporization of the oil or any of the moisture that may be present. The supply of heating medium is controlled by the valve inlet 32, so that the temperature to which the slurry and the resulting solution is heated may be varied in accordance with the character of the soap employed. Steam may be used as the heat exchange medium in those cases where it is not necessary or desirable to heat the slurry to a temperature above 300° F. If it is required to heat the slurry to a higher temperature, such as for example 400° F. and above, it is desirable to employ a heating medium having a very much higher boiling point than water at atmospheric or higher pressure. A suitable heating medium which may be employed where higher temperatures are employed is that known by the trade name "Dowtherm."

The details of the heating unit shown in Figs. 3 and 4 form no portion of the present invention, and various other heating units may be employed in which thorough agitation and effective heating may be simultaneously produced. It is important that the heating unit be part of a closed system which may be maintained under pressure, so that the oil cannot vaporize, and it is highly desirable that the chamber of the heating unit be of such construction as will maintain the material in a comparatively thin, confined layer, so that there will be only a relatively small amount of material undergoing heating and agitation, and the material may thus remain in the chamber for only a matter of seconds.

It is also desirable that the agitator have a scraper which will remove any films from the heat transfer wall 27 and thus facilitate rapid heat transfer and prevent scorching and other damaging reaction to any of the ingredients.

The hot solution of the soap in the oil is passed from the outlet 35 to a cooling unit 38 which may be substantially identical in mechanical construction with the heating unit 18.

Usually premanufactured soaps such as lithium stearate, aluminum stearate and calcium stearate may be obtained commercially in substantially anhydrous form, so that elimination of moisture from the oil-soap mixture is unnecessary. When such soaps are used they may pass directly from the outlet 35 through an open valve 39 in a line 40 leading to the cooling unit.

In some cases the soap bases as secured from the supplier or as manufactured by the grease manufacturer, may contain undesirable amounts of moisture, or the soap bases may be such as are inherently hydrous. Where such soap bases are employed it is desirable to effect moisture control or elimination immediately following the heating stage, and prior to the cooling.

This moisture elimination may be accomplished in the system illustrated in Fig. 1 by closing the valve 39 and opening a valve 41 in a line 42 leading to a flash tank 43.

The flash tank is a closed one and has a delivery line 44 controlled by a valve 45 and leading to a pump 46 discharging the mixture into

the inlet 49 of the cooling unit. The flash tank is provided with means whereby it may be maintained at atmospheric pressure or at any desired pressure below that maintained in the heating unit, or below that of the atmosphere, and preferably has a baffle between the inlet and the outlet.

As shown, the flash tank has an outlet pipe 47 provided with a three-way valve 48 with one branch 49 leading to the atmosphere and another branch 50 leading to any suitable means for producing a vacuum. By turning the valve 48 to connect the flash tank to the atmosphere, the pressure in the flash tank will drop to that of the atmosphere, and by reason of the higher temperature of the soap-oil mixture, the moisture will flash to steam and escape. If it is desired to insure a complete removal of all moisture, then it may be desirable to turn the valve 48 so as to maintain a vacuum in the flash tank. If it is desired to retain a small amount of moisture in the soap, or if the temperature of the material in the flash tank is such that there may be vaporization of the oil, the valve may be turned to a point where it will throttle the outlet 47 and maintain a pressure in the flash tank above that of the atmosphere but below that of the vapor pressure of the material in the heating unit.

The valve 41 may serve as a throttle valve so that the pressure ahead of the valve may be 300 to 400 pounds and beyond the valve, 25 to 50 pounds, so that all moisture will flash off in the tank 43, even without dropping pressure to the atmosphere, and thus in some cases the pump 46 may be omitted.

In the cooling unit the temperature is reduced to a point below that at which the soap is soluble in the oil, but by reason of the vigorous agitation and the extremely rapid cooling effected in the cooling unit, the passage of the soap from the dissolved condition to a gel condition does not result in any separation of the soap from the oil, and the mixture is maintained homogeneous. Other advantages of this rapid cooling and vigorous agitation will be set forth hereinafter.

The heat exchange medium may be supplied to the jacket of the cooling unit through a valve controlled inlet 51, and discharged through an outlet 52. The medium may be brine, cold water or hot water, depending upon the amount of heat to be withdrawn, the time during which the heat withdrawal is accomplished, and the rapidity of flow of the cooling medium through the jacket.

As above noted, the cooling unit may be the same in details of construction as the heating unit, and as shown in Figs. 3 and 4, but various other forms of cooling units may be employed. It is important that the grease be vigorously agitated while being cooled; that it be cooled in a comparatively thin, confined layer so that there is rapid heat transfer; and that films forming on the heat transfer wall be rapidly scraped therefrom and thoroughly intermixed with the body of the material passing through the unit.

If the operation of the cooling unit 38 be properly controlled, the grease will issue therefrom through the line 53 at the proper critical temperature, and the final grease will be a very stable product with no visible syneresis. Therefore, in most cases the grease may be delivered from the line 54 controlled by a valve 55, and directly to the packaging apparatus.

In some cases it may be found desirable to

subject the grease to an additional relatively slow working, in order to provide a softer grease of more stable consistency. Such additional working may be accomplished by closing the valve 55 and opening a valve 56 leading to a working unit 57 in which the grease is relatively slowly worked while passing in relatively large volume through a chamber maintained under controlled pressure. The worked grease leaving the working unit may pass through a line 58 leading to the packaging apparatus, and controlled by a valve 59.

Ordinarily the grease passing through the working unit 57 will be merely held at a substantially constant temperature approximating that at which it is delivered from the cooling unit 38. However, in some cases it may be desirable to effect some slight additional reduction in temperature of the grease as it passes through the working unit.

Various different forms of working units may be employed, and that illustrated in Figs. 5 and 6 is merely one example. In the form illustrated there is provided a cylindrical chamber 60 surrounded by a jacket 61 through which cooling medium may be delivered through an inlet 62, and from which it may be discharged through an outlet 63. Within the cooling jacket there may be a helical baffle 64 to prevent direct by-passing of the cooling medium from the inlet to the outlet. Within the chamber is a shaft 65 having pins, blades or other working elements 66, preferably extending substantially radially and arranged helically. The peripheral wall of the chamber carries a series of pins, blades or other baffle elements 67, so positioned that they extend inward radially substantially to the shaft 65, and arranged alternately with the elements 66 on the shaft. The material may be continuously delivered to the chamber through an inlet 68 at one end, and continuously discharged through an outlet 69 at the other end.

In the process as above described there is provided a tank 10 for mixing a premanufactured soap and oil. In many cases the grease manufacturer desires to manufacture his own soap, or to make the soap simultaneously with and as a part of the process of making the grease. In Fig. 2 there is illustrated a modified form of apparatus in which the soap may be manufactured as a part of the complete process. Separate tanks 70, 71 and 72 are provided for the caustic, the fats or fatty acids, and the mineral oil. These tanks have outlets 73, 74 and 75, respectively, and such outlets are controlled by valves 76, 77 and 78, and leading to pumps 79, 80 and 81. These pumps discharge to a line 82 having a valve 83 between the connections to the pumps 80 and 81. This line discharges to the inlet of the heating unit 18, and between said unit and the connection to the pump 81 there is provided a valve 84. When it is desired to make the soap separately the valve 83 is closed, and caustic is fed from the tank 70 through the valve 76 and metering pump 79 to a line 85, while fats or fatty acids are fed from the tank 71 through the valve 77 and metering pump 80 to said line 85. The mixture is passed through a heating unit 86 similar to the heating unit 18 above described, and which may be heated either with steam or Dowtherm, depending upon the temperature employed. The reaction involved in making the soap from the caustic and fatty acid results in the production of moisture, and it is desirable that at least the greater part of such moisture be removed before the soap is mixed with the mineral oil. For this purpose, the soap may be discharged from the heating unit 86 through a line 87 to a flash tank 88, which may be similar to the flash tank 43 and have connections 89 and 90 to the atmosphere and to a vacuum, respectively.

The deaerated and partially dried molten soap is discharged from the flash tank 88 through a valve 91 and by means of a pump 92 to a line 93 leading to the inlet of the heating unit 18. This line has a valve 94 so that when the soap is being made as above described, the valves 84 and 94 may be opened and the soap delivered to the heating unit 18 by the pump 92 through line 93 and valve 94 while the oil is delivered to the heating unit by pump 81 through valve 84. From the heating unit 18 the grease may be delivered to a cooling unit the same as in the form shown in Fig. 1.

In some cases it is desirable to carry out the saponification simultaneously with the manufacture of the grease, and in the same unit. This may be done by using the heating unit 86 as the main heating unit, and cutting out the heating unit 18. By opening the valve 83 and closing the valves 84 and 94, the caustic, fats or fatty acids, and the mineral oil may be delivered through the line 85 to the heating unit 86, and through the flash tank 88. By opening a valve 95 in the line 96 the pump 92 may deliver the hot liquid grease to a cooling unit similar to 38 shown in Fig. 1.

In some cases it may be found difficult to get complete saponification of the caustic and fat or fatty acids, if all of the oil is added to the other ingredients delivered to the heating unit 86. In that event the valve 95 is closed, the valve 94 is opened, and a valve 97 leading from the heating unit 18 is also opened, while valves 83 and 84 are regulated so that a predetermined portion of the mineral oil passes to the line 85 and through the unit 86, while the remainder of the mineral oil passes directly through the valve 84 to the inlet of the heating unit 18. Thus a partially formed grease is prepared in the unit 86, and this partially formed grease is then delivered through the flash tank 88 and line 93 to the inlet of the heating unit 18, where the partially formed grease is mixed with the oil entering through the valve 84. The mixture is further heated and agitated in the unit 18 to effect thorough mixing and solution of the partially formed grease in the oil which has entered directly from the tank 72. In some cases the flash tank 88 may be by-passed, if the quantities and characteristics of the initial soap-forming ingredients are closely controlled so that no excess moisture is formed in the saponification step, and the moisture is finally removed at the flash tank 43.

With some greases, and more particularly lithium base greases from light viscosity oils; and some aluminum base greases, I have discovered that improved gel structure is obtained by providing a time lag or gelling time with relatively little or no agitation after an agitating and partial cooling step and before a final agitating or working and cooling step. This may be effected by providing an elongated chamber 98 having its opposite ends connected by pipes 99 and 100 to the pipe 53 on opposite sides of the valve 56 and having valves 101 and 102 so that by closing valve 56 and opening valves 101 and 102, the grease may be diverted through the chamber 98 and flow slowly through the latter. For instance, with lithium base grease, the cooler 38 may rapidly cool the grease down to about 210° F. while the agitator is rotating 300 to 700 R. P. M.

The chamber 98 may be of such capacity that the grease flows slowly therethrough and is in the chamber from 10 to 30 minutes. The chamber may be insulated so that the temperature drop in the chamber is small and the grease may discharge through the pipe 100 to the working unit at about 185° F.

Different greases require different gelling times as this will vary with the mineral oil and the soap base, and as above indicated, with some greases the chamber 98 and the time lag and gelling time are not necessary.

The agitator in the working unit 57 may be rotated at only 100 to 300 R. P. M., and the cooling there may be to about 90 to 150° F.

Instead of using the agitator shown in Figs. 5 and 6, I may use one which has both a scraper blade as shown in Figs. 3 and 4 and other non-scraping blade providing a small clearance (for instance 1/64") to cause a breaking down of the gel structure and the production of a softer and smoother product of stable consistency. Other forms of working may be employed. For instance, it may be pumped through screens or passed through mills or other apparatus.

For some greases, or under some conditions, the hot liquid grease may be made in batch kettles and passed through the unit 38 or the units 38, 98 and 57 to cool and improve the texture.

In the foregoing I have referred to a thin, confined layer. The word "thin" is to be interpreted as relative to the diameter of the chamber and the circumference of the heat transfer surface. Ordinarily the thickness of the layer to be agitated should not be over about 10% of the diameter of the heat transfer wall. For instance, a 10" diameter chamber might have an 8½" shaft or core leaving an annular space for a ¾" layer. Thus there is provided a large surface to volume ratio.

The pressure drop in the flash chamber 43 may be controlled by a float acting on a steam and air outlet valve so that the valve may open, close, or remain in such position that the pressure in the flash chamber will be only such as will force the grease through the other units of the apparatus. With the valve closed, pressure will build up, the outflow will be speeded up, the level in the flash chamber will drop, and the valve will reopen.

Although the cooling and agitating is disclosed as in a thin film and by an agitator, the cooling and agitating might in some cases be effected by throwing the material in fine streams or droplets by centrifugal force over or against a cooling surface.

The slurry of soap and oil may in some cases be formed of a dry, finely divided caustic in suspension in the fat or fatty acid.

By means of the improved process above set forth, many advantages are obtained. There is greater economy, due to less heat radiation loss than is the case with open batch kettles. It is not necessary to heat to as high a temperature to insure the desired reaction or solution temperature in all parts, since the heating is done in a totally enclosed chamber, and uniform heating is produced throughout.

A greater yield is generally obtained. By "yield" as understood in the grease industry, is meant a larger final quantity of grease for a given amount of soap, or conversely, less soap for a given quantity of grease.

High yield is advantageous, because the soap is more expensive than the oil. Greater yield is produced in the present process due to the more thorough mixing and dispersion of the soap throughout the oil. For instance, instead of using 15% of lithium soap with the oil, a highly satisfactory grease may be made using only 12% of the soap. This saving of one-fifth of the amount of soap, and this reduction of 20% in the cost of this ingredient, are important advantages of the present process.

In a batch process an excess of soap is commonly put in to insure the minimum amount throughout the mixture, whereas in the present process only the minimum amount of soap is needed, because it is uniformly dispersed throughout the oil.

A much more rapid, uniform and effective heating is obtained by reason of the agitation in the thin, confined layer, and the scraping of films from the peripheral wall.

There is a better control of temperature, because only a small amount of material is undergoing mixing and heating in the processing zone at any one time, and due to the uniform heating throughout the confined layer, it is possible to approach more nearly the exact temperature to effect solution of the soap in the oil, and throughout the mixture.

With a batch process it is common to heat to a higher temperature than actually required, to effect soap solution, because of the non-uniform heating. An important advantage of preventing overheating, as in my present process, is that it lessens or prevents oxidation, as indicated by improved or lighter color of the final grease.

A further advantage of close temperature control and rapid heating in a thin confined layer is that the temperature which is produced at the outlet of the heating unit may be maintained uniform, and this makes possible a more accurate control of the flash tank temperature and pressure conditions, and an elimination of moisture to a uniform degree.

Control of moisture content is also effected, by reason of the fact that the mixture is maintained under pressure during the heating period, and thus no moisture is given off during this step. As the moisture is flashed off under accurately controlled conditions in the flash tank, the desired moisture content is accurately obtained. Such moisture elimination is not necessary in the case of greases embodying anhydrous soaps, but even these normally anhydrous soaps as furnished in commercial form often do contain some moisture, and by means of the present process this may be readily eliminated.

A further advantage is obtained by the deaeration of the slurry prior to the heating step. By delivering the slurry at room temperature to the flash tank 21 the air is removed. Air present in the soap while it is being heated results in oxidation, which tends to produce an undesirable darkness. It is practically impossible to effect deaeration before heating in a batch process, since the mixture tends to pick up air during agitation and heating in the batch kettle. In applicant's process the heating is effected in the absence of air, and any air present is removed prior to the heating.

A further advantage is in the reduction of fire hazard, loss of oil by evaporation, and oxidation by the air of the atmosphere. With a batch kettle one sometimes maintains a blanket of carbon dioxide or steam over the hot material. In applicant's process no such blanket is needed, as the heating is effected only while the oil is in

a closed system and under pressure, so that evaporation is prevented, there are no fumes which are liable to become ignited, and there is no contact with the air.

A further advantage results from the fact that there is only a small amount of material in process at any one time. Thus any failure of utilities or equipment is not as serious as in a batch process where large amounts are handled at one time.

In the present process the heating is effected in the heating unit, and the cooling is effected in the cooling unit, in a matter of seconds, even though the temperature range may be up to 400° F. or higher in the heating unit and down to 110 to 120° F. in the cooling unit. The heating is effected in the absence of air, so that oxidation is prevented. As the cooling is effected very rapidly, there is no danger of overworking so long as the grease is above the critical temperature below which the desired gel structure might be broken down. Thus, there is a tighter gel structure and less bleeding or syneresis of the final product. The grease may be continuously delivered from the cooling unit at any temperature desired, and in accordance with the character of the grease, and delivered directly to the packaging apparatus, either with or without working in the unit 57, as may be desired by the operator, or as may be necessary for the particular character of grease being manufactured.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises bringing together the oil and stiffening agent in substantially the relative proportions desired in the final product, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer through a zone having a heat-transfer wall, and heating said thin layer of mixture in said zone through said wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, while simultaneuosly continuously and rapidly removing films from said heat-transfer wall and violently and continuously mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall; thereby to effect extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency.

2. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises bringing together the oil and stiffening agent in substantially the relative proportions desired in the final product, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer under pressure through an elongated zone having a heat-transfer wall, and heating said thin layer of mixture in said zone through said wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, while simultaneously continuously and rapidly scraping films from said heat-transfer wall and violently and continuously mechanically mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall; thereby to effect extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency.

3. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises bringing together the oil and stiffening agent in substantially the relative proportions desired in the final product, continuously flowing the the mixture of oil and stiffening agent as a relatively thin confined layer under pressure through an elongated annular zone having a heat-transfer wall, and heating said thin layer of mixture in said zone through said wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, while simultaneously continuously and rapidly scraping films from said heat-transfer wall and violently and continuously mechanically mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall; thereby to effect extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency.

4. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises bringing together the oil and stiffening agent in substantially the relative proportions desired in the final product, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer under pressure through an elongated zone having a heat-transfer wall, and heating said thin layer of mixture in said zone through said wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, while simultaneously continuously and rapidly removing films from said heat-transfer wall and violently and continuously mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall; thereby to effect extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency; and deaerating the mixture of oil and stiffening agent prior to said heating operation.

5. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises premixing the oil and stiffening agent in substantially the relative proportions desired in the final product so as to form a slurry of the stiffening agent and the oil, said premixing being done at a temperature substantially below that at which solution of the stiffening agent in the oil occurs, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer under pressure through an elongated zone having a heat-transfer wall, and heating said thin layer of mixture in said zone through said wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, while simultaneously continuously and rapidly removing films from said heat-transfer wall and violently and continuously mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall; thereby to effect extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of

the stiffening agent and oil, producing a hot grease of uniform consistency.

6. The process of claim 5 in which the said premixing is done substantially at room temperature.

7. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises bringing together the oil and stiffening agent in substantially the relative proportions desired in the final product, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer first through a heating zone having a heat-transfer wall and then through a cooling zone having a heat-transfer wall, heating said thin layer of mixture in said heating zone through the said wall thereof to a temperature at least sufficient to effect solution of the stiffening agent in the oil, and cooling said thin layer of mixture in said cooling zone through the said wall thereof, said heating and said cooling each being effected while simultaneously continuously and rapidly removing films from the respective heat-transfer walls and rapidly and continuously mixing the same with the remainder of said mixture in said respective thin layers whereby substantially continuously to bring relatively fresh material to said respective transfer walls; thereby to effect, in the heating zone, extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency, and to effect, in said cooling zone, correspondingly rapid cooling of said mixture in said layer to a uniform temperature and to maintain said thorough and intimate dispersion of the stiffening agent and oil.

8. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises bringing together the oil and stiffening agent in substantially the relative proportions desired in the final product, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer first through a heating zone having a heat-transfer wall and then through a cooling zone having a heat-transfer wall, heating said thin layer of mixture under pressure in said heating zone through the said wall thereof to a temperature at least sufficient to effect solution of the stiffening agent in the oil, and cooling said thin layer of mixture in said cooling zone through the said wall thereof, said heating and said cooling each being effected while simultaneously continuously and rapidly scraping films from the respective heat-transfer walls and rapidly and continuously mixing the same with the remainder of said mixture in said respective thin layers whereby substantially continuously to bring relatively fresh material to said respective transfer walls; thereby to effect, in the heating zone, extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency, and to effect, in said cooling zone, correspondingly rapid cooling of said mixture in said layer to a uniform temperature and to maintain said thorough and intimate dispersion of the stiffening agent and oil; said cooling being to a temperature substantially below the temperature at which the stiffening agent is soluble in the oil.

9. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises bringing together the oil and stiffening agent in substantially the relative proportions desired in the final product, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer first through a heating zone having a heat-transfer wall and then through a cooling zone having a heat-transfer wall, heating said thin layer of mixture under pressure in said heating zone through the said wall thereof to a temperature at least sufficient to effect solution of the stiffening agent in the oil, and cooling said thin layer of mixture in said cooling zone through the said wall thereof, said heating and said cooling each being effected while simultaneously continuously and rapidly removing films from the respective heat transfer walls and rapidly and continuously mixing the same with the remainder of said mixture in said respective thin layers whereby substantially continuously to bring relatively fresh material to said respective transfer walls; thereby to effect, in the heating zone, extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency, and to effect, in said cooling zone, correspondingly rapid cooling of said mixture in said layer to a uniform temperature and to maintain said thorough and intimate dispersion of the stiffening agent and oil; said cooling being to a temperature substantially below the temperature at which the stiffening agent is soluble in the oil; and continuously passing the cooled grease through a confined space of relatively large cross-section to provide a time lag for gelation, while substantially maintaining the temperature of the cooled grease in said space at the discharge temperature from the cooler.

10. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises bringing together the oil and stiffening agent in substantially the relative proportions desired in the final product, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer first through a heating zone having a heat-transfer wall and then through a cooling zone having a heat-transfer wall, heating said thin layer of mixture under pressure in said heating zone through the said wall thereof to a temperature at least sufficient to effect solution of the stiffening agent in the oil, and cooling said thin layer of mixture in said cooling zone through the said wall thereof, said heating and said cooling each being effected while simultaneously continuously and rapidly removing films from the respective heat transfer walls and rapidly and continuously mixing the same with the remainder of said mixture in said respective thin layers whereby substantially continuously to bring relatively fresh material to said respective transfer walls; thereby to effect, in the heating zone, extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency, and to effect in said cooling zone, correspondingly rapid cooling of said mixture in said layer to a uniform temperature and maintenance of said thorough and intimate dispersion of the stiffening agent and oil; said cooling being to a temperature substantially below the temperature at which the stiffening agent is soluble in the oil; continuously passing the cooled grease into a confined space of relatively large cross-section to provide a time lag for gelation, while substantially maintaining the temperature of the cooled grease in said space

at the discharge temperature from the cooler, discharging the gelled grease from said space, and further cooling the discharged grease while simultaneously working the same.

11. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises premixing the oil and the stiffening agent in substantially the relative proportions desired in the final product, so as to form a slurry of the stiffening agent and the oil, said premixing being done at a temperature substantially below that at which solution of the stiffening agent in the oil occurs, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer under pressure through a zone having a heat-transfer wall, heating said thin layer of mixture in said zone through said wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, while simultaneously continuously and rapidly removing films from said heat-transfer wall and violently and continuously mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material, to said transfer wall, thereby to effect extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent in oil, flashing off moisture from the heated mixture after leaving said heating zone, and then rapidly cooling the mixture.

12. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises premixing the oil and stiffening agent in substantially the relative proportions desired in the final product so as to form a slurry of the stiffening agent and the oil, said premixing being done at a temperature substantially below that at which solution of the stiffening agent in the oil occurs, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer under pressure through a zone having a heat-transfer wall, and heating said thin layer of mixture in said zone through said wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, while simultaneously continuously and rapidly removing films from said heat-transfer wall and violently and continuously mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall; thereby to effect extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency; deaerating said slurry prior to the aforesaid heating; continuously discharging the heated grease from said heating zone, and then rapidly cooling the discharged grease for gelation.

13. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises premixing the oil and stiffening agent in substantially the relative proportions desired in the final product so as to form a slurry of the stiffening agent and the oil, said premixing being done at a temperature substantially below that at which solution of the stiffening agent in the oil occurs, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer under pressure through an elongated zone having a heat-transfer wall, and heating said thin layer of mixture in said zone through said wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, while simultaneously continuously and rapidly removing films from said heat-transfer wall and violently and continuously mechanically mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall; thereby to effect extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency; deaerating the mixture prior to the aforesaid heating; continuously passing the heated grease from said heating zone and then rapidly cooling the grease for gelation by flowing the hot grease as a relatively thin confined layer through an elongated cooling zone having a heat-transfer wall and cooling said thin layer in said cooling zone through said wall thereof while simultaneously continuously and rapidly scraping films from said last mentioned wall and rapidly and continuously mechanically mixing the same with the remainder of said mixture in said thin layer, whereby substantially continuously to bring relatively fresh material to the heat transfer wall of said cooling zone, thereby to effect extremely rapid cooling of the grease in said layer to a uniform temperature and to maintain the said intimate and thorough dispersion of the stiffening agent and oil.

14. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises premixing the oil and stiffening agent in substantially the relative proportions desired in the final product so as to form a slurry of the stiffening agent and the oil, said premixing being done at a temperature substantially below that at which solution of the stiffening agent in the oil occurs, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer and stiffening agent as a relatively thin confined layer under pressure through an elongated zone having a heat-transfer wall, heating said thin layer of mixture in said zone through said wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, while simultaneously continuously and rapidly removing films from said heat-transfer wall and violently and continuously mechanically mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall; thereby to effect extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency; deaerating the mixture prior to the aforesaid heating; continuously passing the heated grease from said heating zone, then rapidly cooling the grease for gelation by flowing the hot grease as a relatively thin confined layer through an elongated cooling zone having a heat-transfer wall and cooling said thin layer in said cooling zone through said wall thereof while simultaneously continuously and rapidly scraping films from said last mentioned wall and rapidly and continuously mechanically mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to the heat transfer wall of said cooling zone thereby to effect extremely rapid cooling of the grease in said layer to a uniform tem-

perature and to maintain the said intimate and thorough dispersion of the stiffening agent and oil, continuously passing the cooled grease through a space of relatively large cross-section to provide a time lag for gelation while substantially maintaining the grease at the temperature at which it is discharged from the cooling zone, and continuously discharging the gelled grease from said gelation space.

15. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises premixing the oil and stiffening agent in substantially the relative proportions desired in the final product so as to form a slurry of the stiffening agent and the oil, said premixing being done at a temperature substantially below that at which solution of the stiffening agent in the oil occurs, continuously flowing the mixture of oil and stiffening agent as a relatively thin confined layer under pressure through an elongated zone having a heat transfer wall, heating said thin layer of mixture in said zone through said wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, while simultaneously continuously and rapidly removing films from said heat transfer wall and violently and continuously mechanically mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall; thereby to effect extremely rapid heating of said mixture in said layer to a uniform temperature and to effect a thorough and intimate dispersion of the stiffening agent and oil, producing a hot grease of uniform consistency; deaerating the mixture prior to the aforesaid heating; continuously passing the heated grease from said heating zone, then rapidly cooling the grease for gelation by flowing the hot grease as a relatively thin confined layer through an elongated cooling zone having a heat-transfer wall and cooling said thin layer in said cooling zone through said wall thereof, while simultaneously continuously and rapidly scraping films from said last mentioned wall and rapidly and continuously mechanically mixing the same with the remainder of said mixture in said thin layer, whereby substantially continuously to bring relatively fresh material to the heat transfer wall of said cooling zone, thereby to effect extremely rapid cooling of the grease in said layer to a uniform temperature and to maintain the said intimate and thorough dispersion of the stiffening agent and oil, continuously passing the cooled grease into a space of relatively large cross-section to provide a time lag for gelation while substantially maintaining the grease at the temperature at which it is discharged from the cooling zone, discharging the gelled grease from said gelation space, and further cooling the gelled grease while working the same.

16. The continuous process for the manufacture of grease from oil and soap, which comprises continuously forming a soap stock by bringing together a fat and a saponifying agent in predetermined relative proportions and continuously and rapidly flowing the mixture thereof as a relatively thin confined layer under pressure through a heating zone of relatively small transverse cross-section and having a heat-transfer wall while simultaneously heating said thin layer through said wall and continuously and rapidly removing films from said heat-transfer wall and violently and continuously mechanically mixing the same with the remainder of said mixture in said thin layer, the heating temperature being sufficient to effect saponification, continuously flowing the resultant soap stock from said zone together with oil through a second zone of like character, in substantially the relative proportions desired, as a relatively thin confined layer under pressure while simultaneously continuously and rapidly removing films from the heat-transfer wall of the second zone and violently and continuously mechanically mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall, the temperature in the second zone being sufficient to effect solution of the soap in the oil, and continuously delivering the hot grease from said second zone.

17. The continuous process for the manufacture of grease from oil and soap, which comprises continuously forming a soap stock by bringing together a fat and a saponifying agent in predetermined relative proportions and continuously and rapidly flowing the mixture thereof as a relatively thin confined layer under pressure through a heating zone of relatively small transverse cross-section and having a heat-transfer wall while simultaneously heating said thin layer through said wall and continuously and rapidly removing films from said heat-transfer wall and violently and continuously mechanically mixing the same with the remainder of said mixture in said thin layer, the heating temperature being sufficient to effect saponification, continuously flowing the resultant soap stock from said zone together with oil through a second zone of like character, in substantially the relative proportions desired, as a relatively thin confined layer under pressure while simultaneously continuously and rapidly removing films from the heat-transfer wall of the second zone and violently and continuously mechanically mixing the same with the remainder of said mixture in said thin layer whereby substantially continuously to bring relatively fresh material to said transfer wall, the temperature in the second zone being sufficient to effect solution of the soap in the oil, and continuously delivering the hot grease from said second zone, while deaerating and flashing off water from the soap stock intermediate the first and second zones by effecting substantial reduction in pressure on the soap stock delivered from the first zone.

18. The continuous process for the manufacture of grease from oil and a stiffening agent, which comprises deaerating the oil and stiffening agent and bringing them together in substantially the relative proportions desired in the final product, and then continuously flowing the deaerated mixture of oil and stiffening agent under pressure through a heating zone while maintaining in said zone a temperature sufficient to effect solution of the stiffening agent in the oil.

19. A continuous closed system for the continuous manufacture of grease from oil and a stiffening agent comprising in combination means providing two elongated annular processing zones, interconnected by closed conduit means, and each of which zones has a heat-transfer wall and is of relatively small transverse cross-section, means for forming a mixture of oil and stiffening agent in predetermined relative proportions, means for causing said mixture to flow as a relatively thin confined layer serially through said two zones and for subject-

ing the mixture to elevated pressure in the first of said zones, means for heating the layer in said first zone through its respective heat-transfer wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, means for rapidly and substantially continuously removing films from said wall and for violently mechanically mixing the same with the remainder of the mixture in said thin layer in said first zone, whereby to substantially continuously bring relatively fresh material to said transfer wall, means for rapidly and substantially continuously removing films from the transfer wall of said second zone and for rapidly mechanically mixing the same with the remainder of the mixture in the thin layer in said second zone, whereby to substantially continuously bring relatively fresh material to said transfer wall of said second zone, means for cooling the thin layer of grease in said second zone through its respective heat transfer wall to near the gelation temperature of the grease, a third zone connected with the second zone through a closed conduit for continuously receiving cooled grease through such conduit from the second zone, said third zone having a substantially larger transverse cross-

section than that of said second zone and being constructed and arranged to permit at least partial gelation of the grease without substantial agitation, a fourth zone, means including a closed conduit for delivering grease from said third to said fourth zone, and means for simultaneously continuously working and further cooling the grease in said fourth zone.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,084,974	Kaufman	June 22, 1937
2,222,589	Bradley	Nov. 26, 1940
2,257,945	Fraser	Oct. 7, 1941
2,298,317	Smith	Oct. 13, 1942
2,318,668	Calkins I	May 11, 1943
2,319,405	Ittner	May 18, 1943
2,332,202	Calkins II	Oct. 19, 1943
2,339,873	Morway et al.	Jan. 25, 1944
2,343,736	Beerbower et al.	Mar. 7, 1944

Certificate of Correction

Patent No. 2,417,495. March 18, 1947.

HAROLD G. HOULTON

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 12, line 10, claim 3, strike out "the" before "mixture"; column 16, lines 42 and 43, claim 14, strike out "and stiffening agent as a relatively thin confined layer"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of July, A. D. 1947.

[SEAL]

LESLIE FRAZER,
First Assistant Commissioner of Patents.

ing the mixture to elevated pressure in the first of said zones, means for heating the layer in said first zone through its respective heat-transfer wall to a temperature at least sufficient to effect solution of the stiffening agent in the oil, means for rapidly and substantially continuously removing films from said wall and for violently mechanically mixing the same with the remainder of the mixture in said thin layer in said first zone, whereby to substantially continuously bring relatively fresh material to said transfer wall, means for rapidly and substantially continuously removing films from the transfer wall of said second zone and for rapidly mechanically mixing the same with the remainder of the mixture in the thin layer in said second zone, whereby to substantially continuously bring relatively fresh material to said transfer wall of said second zone, means for cooling the thin layer of grease in said second zone through its respective heat transfer wall to near the gelation temperature of the grease, a third zone connected with the second zone through a closed conduit for continuously receiving cooled grease through such conduit from the second zone, said third zone having a substantially larger transverse cross-

section than that of said second zone and being constructed and arranged to permit at least partial gelation of the grease without substantial agitation, a fourth zone, means including a closed conduit for delivering grease from said third to said fourth zone, and means for simultaneously continuously working and further cooling the grease in said fourth zone.

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