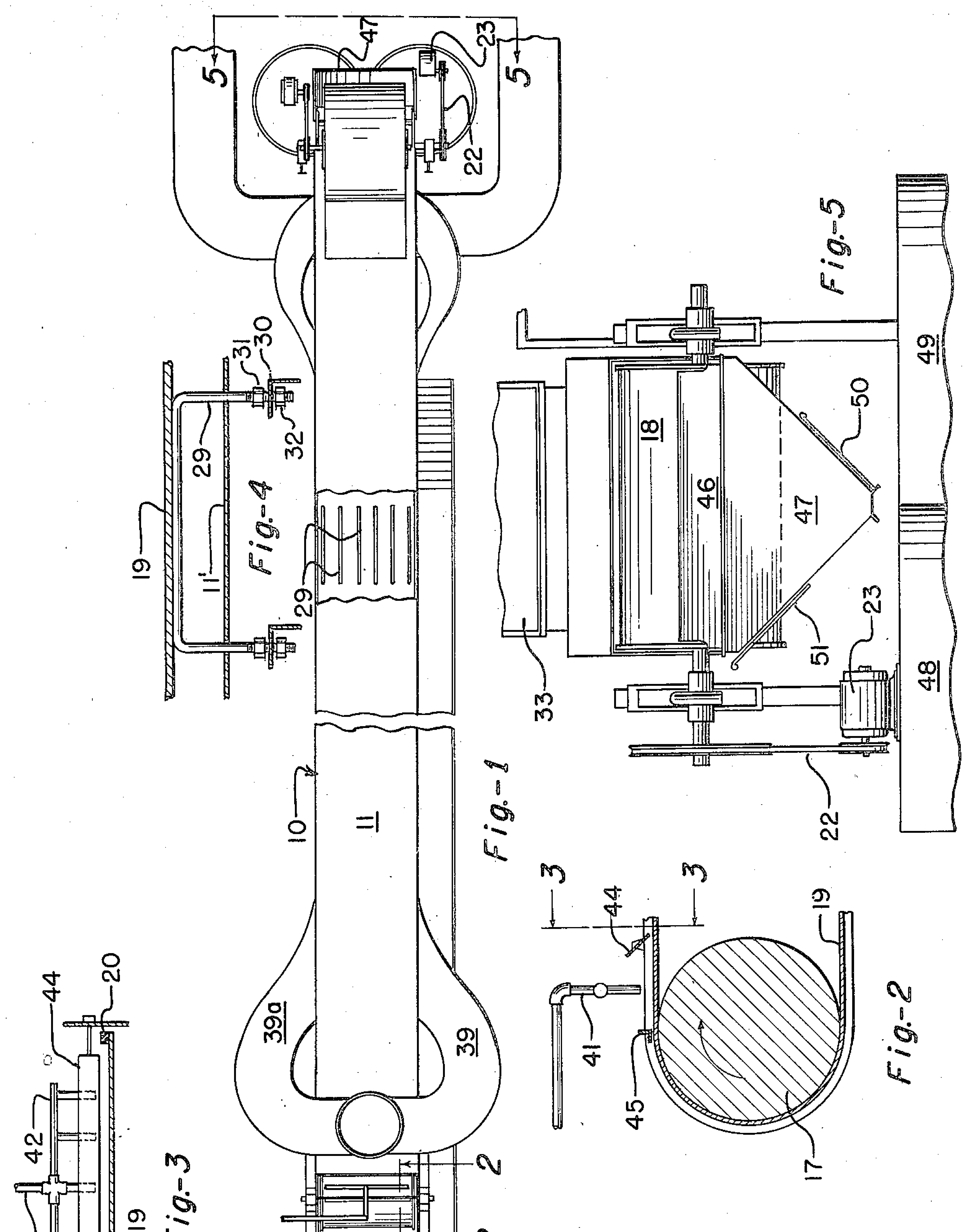
Oct. 31, 1950 A. A. BONDI 2,527,789

PROCESS OF AND APPARATUS FOR COOLING A LUBRICANT

Filed May 2, 1946 3 Sheets-Sheet 1



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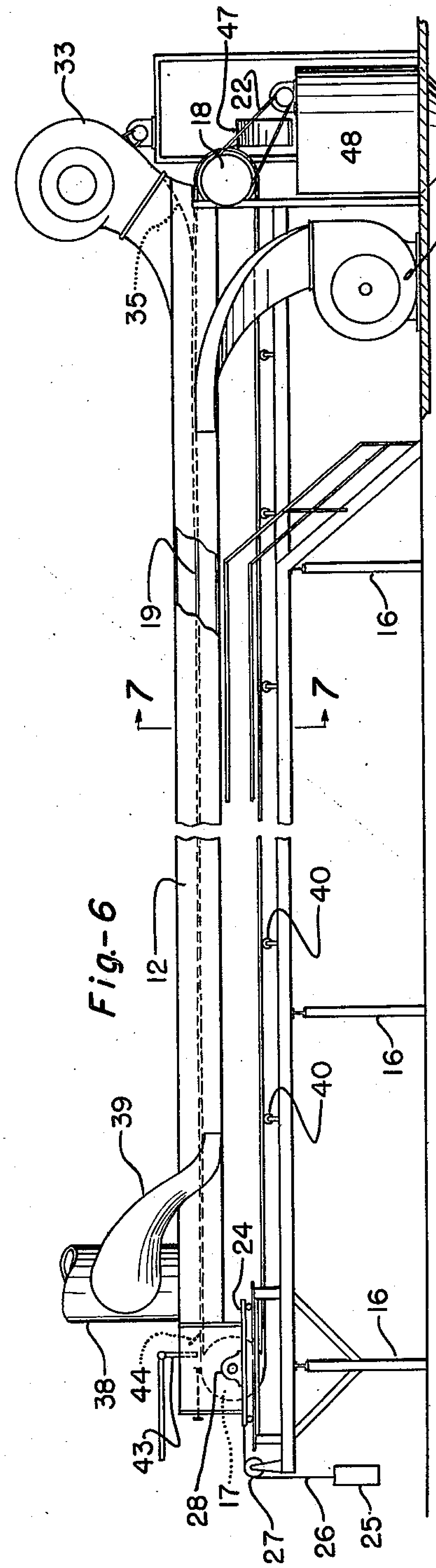

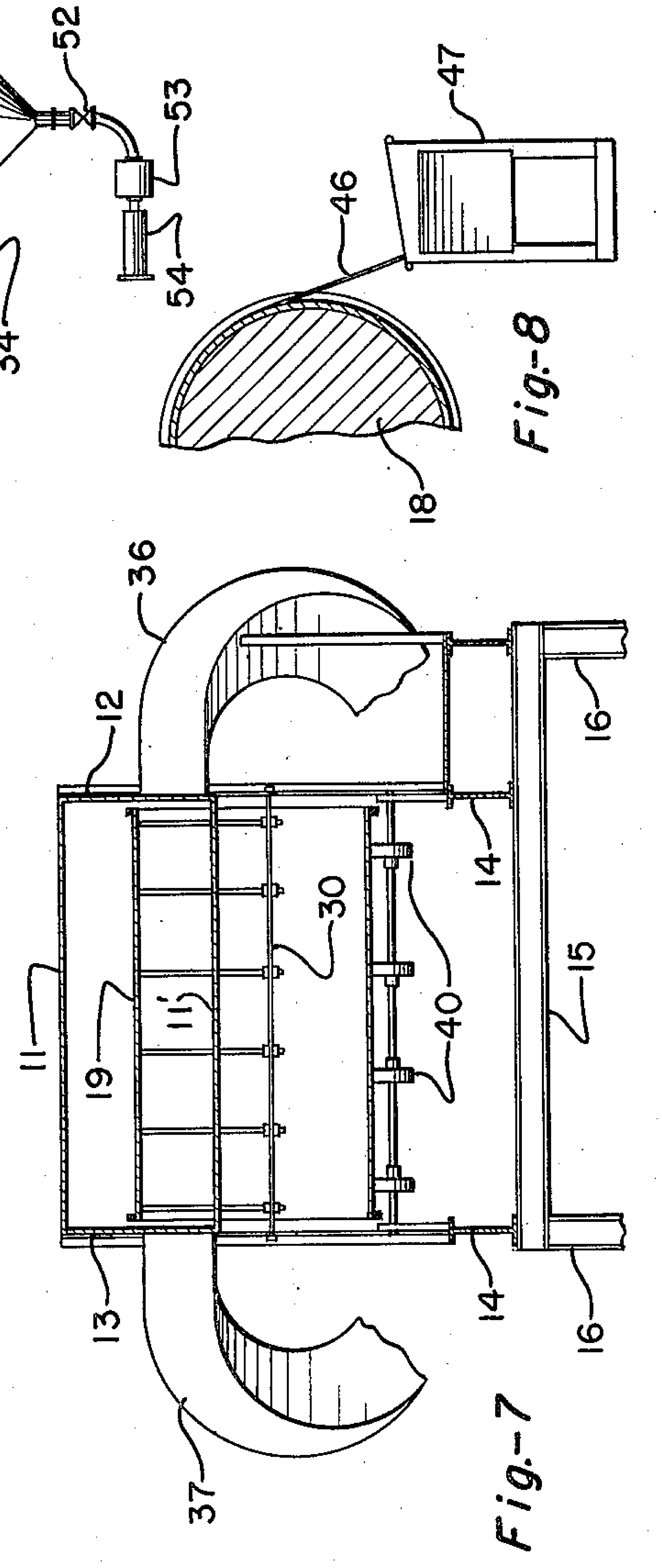

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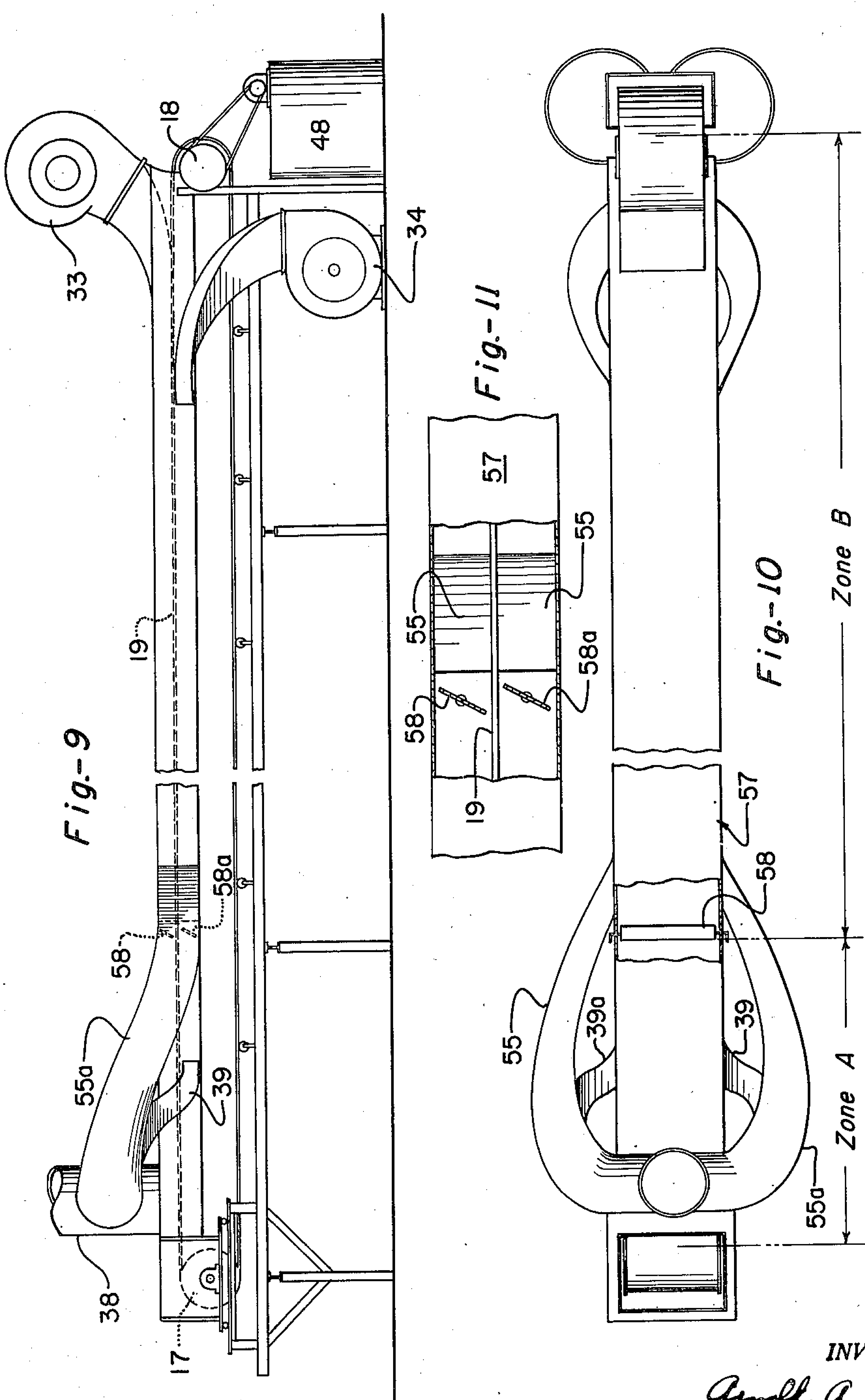

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UNITED STATES PATENT OFFICE

2,527,789

PROCESS OF AND APPARATUS FOR COOLING A LUBRICANT

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Application May 2, 1946, Serial No. 666,790

5 Claims. (Cl. 252—42)

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The present invention relates to a process of and apparatus for the cooling of lubricants and especially lubricating greases.

More particularly, the present invention relates to a process of quickly cooling a lubricating grease containing a soap base which because of its inherent structure, or because of the presence of a crystallization inhibitor, prevents the formation of hard soap granules and subsequent disintegration of the grease upon the quick chilling. While the invention is, in general, applicable to all greases having the characteristics above stated, it is of particular value in the quick cooling of a lubricating grease containing an alkali metal soap of a higher fatty acid, said grease also containing a suitable lubricating oil, preferably a mineral oil, although there may be substituted for part of the mineral oil animal and/or vegetable oils.

From a process standpoint the invention comprises feeding a grease of the character set forth in a hot fluid condition to a heat conductive or heat conducting surface, forming on said surface a thin layer of the grease, and exposing the grease while in a quiescent state to the action of a heat absorbing medium until there is produced a gelled coherent mass of grease. In other words, while the grease is cooling, it is not subject to any shearing stress.

The invention also relates to a novel apparatus for cooling lubricating greases of the character herein set forth which enables the grease to be cooled in a relatively rapid manner in the absence of any shearing stress, that is while the grease is maintained in a quiescent state. Lubricating greases at the present time are ordinarily cooled by flowing the molten grease into a suitable pan or the like where a relatively thick layer of grease is formed, and the grease is then slowly cooled until substantially solidified or gelled.

It has also been proposed to cool grease by rapid flow through a narrow annulus through two concentric cylinders, one of which is provided with a jacket through which cooling water flows, and the other of said cylinders is equipped with scraper blades, one of said cylinders rotating at relatively high speed. This method of cooling is applicable to only certain lubricating greases containing aluminum soaps or lithium soaps, or both aluminum soaps and lithium soaps. The present invention is particularly applicable to the quick cooling of anhydrous soda base greases, and greases of this character can not be cooled in the apparatus of the character set forth, since

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during the cooling step the anhydrous soda base greases would be subjected to a shearing stress, and this seriously affects the property of the grease.

It may also be pointed out that another disadvantage of cooling greases while effecting rapid shearing of the grease during cooling is the excessive energy consumption of the cooling equipment, said energy consumption amounting to about 30 H. P. hours per thousand pounds of lubricating grease cooled. In contradistinction, employing the present invention, only 2 H. P. hours per thousand pounds of grease cooled are required.

In accordance with the present invention, it has been found that various types of greases can be successfully cooled if the grease is fed to a steel belt or the like so as to form a relatively thin continuous layer on the steel belt and subject it to a current of air or other cooling medium, so that the grease while being carried along with the belt is cooled in a uniform fashion free from shearing stress. By cooling in this manner, an unusual degree of transparency and smoothness of the finished grease can be produced, this same transparency and smoothness being extremely desirable characteristics of the grease. Further, the cooling of grease in this manner results in a grease of higher consistencies, and lesser amounts of soap can be used to produce a grease of equal consistency.

It is one of the objects of the present invention therefore to provide a method for the cooling of grease comprising feeding the grease in hot fluid condition to a heat conductive surface in an amount to form a thin layer on the surface, and then exposing the grease in the absence of shearing stress to the action of a heat absorbing medium.

A second object of the present invention is to flow a compounded grease in hot fluid condition onto a relatively thin metal band so as to form a thin layer varying from approximately 0.1'' to one inch in thickness on the band, and to thereafter move the metal band and grease through a cooling zone to form a highly transparent grease.

A third object of the present invention is to subject grease spread in a thin layer and in fluid condition on a metal band to movement through a cooling zone while subjecting the grease to a counterflow of cooling air so as to rapidly cool the same to the desired consistency.

A fourth object of the present invention is to quickly cool lubricating greases spread in thin layers while in a quiescent state when they are not subjected to shearing stress, said lubricating greases being insensitive to quick cooling, as herein set forth, in that they do not disintegrate subsequent to chilling and form hard soap granules. By thin layers of grease is meant layers of lubricating grease which are less than about one inch in thickness. Some greases by virtue of their structure are inherently insensitive to quick cooling as herein set forth, and others must have present crystallization inhibitors which may be organic or inorganic, said inhibitors preventing the formation of hard soap granules during and after cooling, said hard soap granules causing the lubricating grease to disintegrate. The invention is particularly applicable to the quick cooling, as herein set forth, of anhydrous soap greases containing 3 to 25% of a sodium soap of a higher fatty acid; and also to lubricating greases containing a lithium soap of the higher fatty acids, the lithium soap content varying from 3% to 20%, said percentages being taken on the total weight of the grease.

A fifth object of the present invention is to subject the grease while in a thin layer and in a quiescent state where it is not subjected to shearing stresses to a heat absorbing cooling medium, and thereafter terminate the cooling of the grease at a temperature permitting the soap content of the lubricating grease to crystallize, and then maintaining the grease in a quiescent state above the critical crystallization temperature, whereby the crystals of the soap present in the grease continue to grow. As a given grease, and especially the hydrous or anhydrous sodium soap and lithium soap greases start cooling from their heated fluid state, when the critical temperature is reached, the soap content of the grease begins to crystallize. If the lubricating grease is cooled below the critical temperature, the tendency of the soap content of the lubricating grease, as for example, the sodium soap of the higher fatty acids or the lithium soap of the higher fatty acids, to crystallize is substantially destroyed or inhibited, and simultaneously the growth of the soap crystals is inhibited. For anhydrous lubricating greases made with a mineral oil or any other hydrocarbon oil, or with an animal or vegetable oil, said grease containing about 3% to about 25% total soap content of which the sodium soap of the fatty acid may comprise 3% to 25%, the critical cooling temperature beyond which the grease should not be cooled in order to prevent crystallization of the soap content of the grease is 160° F. However, the total soap content of the grease may include in addition from 3% to 25% of a sodium soap of a fatty acid, 0.1% to 2% of other soaps, as for example, 0.1% to 2% of aluminum, barium, calcium, magnesium, or lithium soaps of saturated fatty acids of the character herein set forth and, particularly, those saturated fatty acids having between 14 and 22 carbon atoms in a molecule. The grease may also contain in addition from 3% to 25% of a sodium soap of a fatty acid, about 0.1% to about 2% of aluminum, barium, calcium, magnesium, or lithium soaps of 12-hydroxy stearic acid. The grease may also obtain in addition from 3% to 25% of sodium soap of a fatty acid, up to 2% of a mixture of soaps other than the sodium soap, as for example, a mixture of any or all of the soaps above set forth ranging from 0% to 100% of either component. For example, there may be up to 1% of aluminum soap of a fatty acid and up to 1% of a lithium soap of 12-hydroxy stearic acid or other hydroxy stearic acid, the balance of the soap content of the grease being 25% of a sodium soap of a fatty acid. In other words, it is clear from the above that the total soap content of the sodium soap grease may include small percentages ranging from .1% to 2% of other soaps.

A sixth object of the present invention is to provide a method of continuously cooling lubricating greases in thin layers of the character herein set forth and while in a quiescent state, the rate of cooling of the grease being varied as the grease cools from its hot fluid state, said procedure improving the quality of the resulting grease.

A seventh object of the present invention is to quickly cool greases of the character herein set forth while in thin layers in successive cooling zones, one cooling zone being adjacent the hot end of the cooling belt, and the other zone being adjacent the discharge end of the cooling belt, said zones being for convenience designated respectively hot and cold cooling zones, there passing through the zones a cooling medium, and there being a differential between the velocity of the cooling medium in the two successive cooling zones. The ratio of the velocity of the cooling medium in the cold zone to the velocity of the cooling medium in the hot zone varies over the range of 1:1 to 10:1.

An eighth object of the present invention is to provide an apparatus for the cooling of grease consisting substantially of a continuous metal band or belt capable of supporting the grease in substantially horizontal position, so as to enable the same to be spread out thereon in the form of a relatively thin uniform layer, and to provide a cooling zone or chamber through which the band or belt moves so as to rapidly and uniformly cool the same.

A ninth object of the present invention is to provide an apparatus for the cooling of grease comprising a horizontally disposed thin metallic belt, means to move the belt, and means providing a cooling zone about the belt, means to feed fluid grease to the surface of the belt adjacent one end, and means to remove the solidified grease from the other end of the belt.

A tenth object of the present invention is to provide an apparatus including a cooling zone for grease through which a thin metallic belt is moved, and a feeding zone which is suitably arranged so as to be free from the free flow of cooling medium so that rapid cooling of the grease is inhibited in the feeding zone and the fluid grease tends to spread out into a uniform layer.

An eleventh object of the present invention is to provide a novel apparatus for the cooling of grease, including a thin metallic belt and means to supply cooling air both above and below the belt and in substantial parallelism with the belt so as to uniformly cool a layer of grease disposed on the upper surface of the belt.

A twelfth object of the present invention is to provide novel supporting means for the belt which support the belt uniformly over its entire width and which may be adjusted so as to bring the belt into absolute horizontal position, said supporting means being so disposed that a minimum of air resistance to the flow of cooling air is produced thereby.

Other objects and advantages of the present invention will become apparent from the subsequent description and figures of the drawing, wherein:

Figure 1 is a plan view of a grease cooling apparatus in accordance with the present invention;

Fig. 2 is a detail of the end of the belt showing the cooling means and baffling means taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is a section taken on the line 3—3 of Fig. 2, illustrating the grease feeding means;

Fig. 4 is a detail of the supporting means for the upper portion of the belt;

Fig. 5 is a section taken substantially along the line 5—5 of Fig. 1;

Fig. 6 is a side elevation of the grease cooling apparatus of the present invention;

Fig. 7 is a section taken substantially along the line 7—7 of Fig. 6;

Fig. 8 is an enlarged detail of the means for removing the grease from the belt;

Fig. 9 is a side elevation of a modified form of the grease cooling apparatus; and

Fig. 10 is a plan view thereof.

Fig. 11 is an enlarged side elevation of a portion of the casing partly broken away to show the diverting baffles.

Referring to the figures of the drawing, and particularly Fig. 1 thereof, a grease cooling apparatus in accordance with the present invention is indicated in general at 10. The apparatus includes a sheet metal casing which is generally rectangular in cross section, as best shown in Fig. 7, including a top 11 and a pair of sides 12 and 13. The casing is supported as by longitudinal I-beams 14, carried on transverse beams 15 which are in turn supported in any conventional fashion on the columns 16. The casing is preferably constructed of sheet metal or may be constructed of any suitable thin material of sufficient structural strength.

Trained over suitable pulleys 17 and 18 is a steel belt 19, provided with a pair of strips preferably of a synthetic rubber, indicated at 20 and 21 respectively. These strips which extend entirely around the belt adjacent the edges thereof, prevent the hot grease from flowing off the edges of the belt. They are preferably bolted to the belt by suitable bolts not shown, although they may be riveted or otherwise suitably fixed to the belt. The right hand pulley 18 is driven by means of a suitable belt 22 from a variable speed transmission and motor indicated in general at 23 (Fig. 1). The belt is kept under tension by a suitable tension means consisting of a tensioning frame 24 urged by means of a weight 25 connected to the tensioning frame as by cables 26 and turned over suitable pulleys 27. Preferably, the weight 25 is sufficient to urge the frame 24 and journals 28 for the pulley 17 with sufficient force so that the steel belt is kept constantly under tension, and tends to assume a horizontal position. The upper course of the belt is preferably supported on a plurality of U-shaped steel rods, best shown in Fig. 4, and indicated by the reference numeral 29. A plurality of steel rods 29 are distributed across the width of the belt in any suitable manner. The lower ends of the steel rods are passed through supporting frame members 30, and are provided with a threaded section carrying nuts 31 and 32. This permits either end of the rods to be raised or lowered, so that the belt may be supported thereon in an absolutely horizontal position. Further, the use of these rods does not present any substantial air resistance to the flow of cooling air which is passing along the lower surface of the steel belt 19. The cooling air is fed into the outlet end of the casing about the belt from a pair of blowers 33 and 34, the blower 33 being positioned to direct air along the upper surface of the belt, and the blower 34 to direct air along the lower surface of the belt, as shown in Fig. 6.

A baffle is provided within the casing, indicated at 35, so that the air flow from the upper blower 33 is in substantial parallelism with the upper surface of the belt 19. A plurality of discharges are provided from the lower blower, one discharge being on each side of the casing, and indicated at 36 and 37 respectively. It will be noted that these discharges also feed in substantially parallel to the lower surface of the belt, and at the outlet end of the casing. The air is exhausted from the casing as by a stack 38 directly communicating with the upper or top of the inlet end of the casing, and provided with a pair of ducts 39 and 39a communicating with the casing below the upper course of the belt, as best shown in Figs. 1 and 6. The lower course of the belt is supported in conventional fashion on idler pulleys 40. The lower course of the belt 19a may also be supported in any suitable manner, but preferably by steel rods as described above and as shown for support of the upper course of the belt 19 in Fig. 4. This lower course 19a of the belt may be encased and provided with means of supplying cooling medium through the casing. In this manner, the lower course 19a may be used for the cooling of the grease, whereby the capacity of a given installation may be approximately doubled.

Grease is fed into the apparatus and distributed uniformly over the surface of the belt as by an inlet conduit 41, feeding into a header 42, provided with a plurality of distributing outlets 43. Positioned between the outlets 43 and the exhaust stack 38 is an adjustable baffle 44 which prevents too rapid cooling of the grease immediately after being fed, and permits the grease in hot liquid condition to spread out on the surface of the belt in a uniform layer. A dam in the form of an angle and indicated at 45 is provided to prevent the grease from flowing off the end of the belt. Preferably the dam or angle iron 45 is provided with oil resistant synthetic rubber ends or surfaces where it is in contact with the grease and there is thus provided prior to the exhaust stack of the device a relatively warm zone which is free from the cooling medium, i. e. as otherwise the cold air striking the grease is likely to cause chilling and non-uniformity in layer structure upon being fed.

The outlets 43 in general should be more than six inches and less than eighteen inches apart, preferably from eight to fourteen inches apart, since if they are too close too much grease will be fed, and if they are too far apart non-uniform distribution of grease will be produced. In order to insure uniform flow of the hot fluid grease from all of the outlets, the combined cross sectional area of the outlets 43 should be smaller by about 25 to 50% than the cross sectional area of the header 42.

The belt as shown in Fig. 6, is rotated in a clockwise direction, and the cooled grease is removed from the belt as by a scraper 46, best shown in Fig. 8. A funnel 47 is positioned to catch the grease being removed from the belt and distribute the same into either one of a pair of tanks 48 and 49 respectively, as shown in Fig. 5. The funnel 47 is provided with a pair of ports at each of its sides, closed by sliding covers 50 and 51. When the cover 51 is in the position shown in Fig. 5, grease will be fed into the tank 48. When the cover 51 is slid downwardly to close the opening, and the cover 50 is slid upwardly to open the port, grease will be fed into the tank 49. The tanks 48 and 49 are provided with conical bottoms, and feed through a valve 52 and a positive displacement pump 53 into a suitable grease strainer 54.

In the form of the apparatus shown in Figs. 9 and 10, an intermediate pair of exhaust ducts 55 and 55a are provided at a point 56 located approximately one-third of the distance between the hot end of the casing and the cold end of the casing, the point 56 being closer to the hot end of the casing. The point 56 definitely marks the dividing line between the so-called "hot zone" A and the so-called "cold zone" B. Also within the main casing 57 which corresponds to the casing 10 shown in Figs. 1 to 6, inclusive, there are provided adjustable baffles 58 and 58a which serve to regulate the relative amount of air flowing through the discharge ducts 55 and 55a respectively and the balance of the main casing. The intermediate exhaust ducts may be connected to the exhaust ducts 39 or communicate directly with the stack 38.

Utilizing the form of apparatus shown in Figs. 9 and 10, a portion of the cooling area or other cooling gaseous medium may be exhausted, that is let out at an intermediate point of the casing 57, the amount of air which is let out being regulated by means of the baffles 58 and 58a to thereby perform the first stage of cooling at a higher temperature level, that is at a lower rate of cooling as is desirable with some greases in order to improve their quality. In other words, the time of cooling is divided up into two periods, a first period and a second period. The rate of cooling when the grease is hot, that is during the first period, is lower than the rate of cooling during the second period when the grease has already cooled somewhat and started to gel. By exhausting the cooling medium intermediate the hot and cold ends of the cooling grease layer, there is maintained a control over the velocity of flow of the cooling medium in the casing while the cooling medium is in contact with the moving layer of the grease. The distance through which the grease spread in a thin layer travels from the hot end of the grease layer to the cold end of the grease layer is divided, as stated, into what may be termed a "hot zone" A and a relatively cool zone B, and the grease is then cooled in these zones or stages, namely a first stage and a second stage. In the first stage at and adjacent the hot end of the grease layer the velocity of the cooling medium is preferably lower than the velocity of the cooling medium in the second cooling stage at and adjacent the cool discharge end of the grease layer. The ratio of the velocity of the cooling medium in zone B, that is, the second stage, to the velocity of flow of the cooling medium in the hot zone A, that is the first stage, may vary over the range of 1:1 to 10:1. In other words, the rate of cooling in zone A is lower than the rate of cooling in the second cooling stage in zone B. More specifically, the rate of cooling of the lubricating grease from its hot fluid state which may be as high as 450° F. down to about 200 to 275° F. is slower than the rate of cooling in the second cooling stage in zone B where the grease cools to about room temperature which in different localities may vary from about 40° F. to 120° F. If desired, the cooling may be carried out in two stages so that in zone B the grease is cooled down to about 200° F., that is above the critical temperature of the grease where the grease is in a rubbery stage, and then the grease may be stored and converted to a gelled buttery texture.

The cooling medium may be conditioned by adjusting its temperature and/or velocity, and by other physical or chemical characteristics to cool the grease at a slower rate of cooling in zone A than in zone B. For example, for soda soap grease the rate of cooling in zone A may be such as to cool the grease down to 200° F. to 275° F. during a time period of travel initially therethrough than the period of travel in zone B. For example, with 100 foot belt, zone A may have a length of 33⅓′ and zone B a length of 66⅔′. With a uniform rate of cooling in each zone, the grease may be cooled down to 200 to 275° F. in zone A and from 200 to 275° F. to room temperature in zone B. The ratio of the time of cooling in zone B to zone A when it is desired to cool at different rates may vary from 2:1 to 5:1.

Preferably the grease is fed to the belt at such a speed so that a layer of grease of the proper thickness is produced. If the layer on the belt is more than approximately one inch thick, the rate of cooling will be prohibitively low, and in the case of certain greases the grease will tend to flow in an uncontrollable manner along the belt, due to the slow rate of gelation. If the layer is less than 0.1″, the rate of heat transfer through the grease is more rapid than the rate of heat removal from the grease by the air stream within the practicable range of air pressures, and air velocities. Preferably, the grease is cooled by air at room temperature, but the air used for cooling purposes may be passed through a suitable refrigeration plant and supplied to the cooling duct at a temperature as low as 0° F. On the other hand, where warm outside temperatures prevail, the cool air may be supplied at temperatures as high as 120° F. In other words, in general the cooling air at atmospheric or higher pressures may be supplied at temperatures of 0° to 120° F. Preferably however, the grease should be cooled to approximately 90° F., and therefore the cool air should be supplied at a temperature lower than 90° F. and preferably between 40° F. and 90° F. Since the grease moves in a thin layer on the belt, the various particles of grease are not displaced relative to one another, and there is no shearing stress set up.

In general, the belt is preferably approximately 100 feet long, and moves at a speed of 13 feet per minute, so that the total time of cooling for the average grease is approximately 7 minutes. This is sufficient to cool the grease and set the same at least to a jelled mass. The blowers 33 and 34 may be a standard type of blower capable of blowing approximately 30,000 cu. ft. a minute, and the tanks 48 and 49 are capable of holding one charge of the belt. In the case of a belt approximately 6 ft. wide and 100 ft. long, this would amount to approximately 15,000 pounds. By providing two tanks of this type, the grease may be allowed to remain in a quiescent condition after cooling.

The present apparatus and process may be applied to the cooling of aluminum stearate base grease from a temperature of approximately 400° F. to 100° F., but preferably from 330° F. to 120° F. The cooling of aluminum stearate grease between these temperature ranges will transform the same from a fluid state to a rubbery mass. The apparatus may also be utilized for the cooling of soda base greases, and preferably those soda base greases which contain small amounts of higher polyalkylene glycols, these polyalkylene glycols being preferably those above the tri-alkylene glycols and including the polyethylene glycols, the polypropylene glycols, the polybutylene glycols and/or the monoesters of the aforementioned polyglycols having a molecular weight varying from about 500 to 6500. Good results have been obtained by using polyglycols having a molecular weight of about 700.

The method and apparatus herein set forth is especially applicable to soda base greases which either by virtue of their structure or because of the admixture of crystallization inhibitors have been made insensitive to quick chilling in thin layers in that they do not disintegrate subsequent to cooling in thin layers. By quick cooling is meant cooling in thin layers from approximately 400° F. or 450° F., but preferably from around 330° to 380° F. to room temperature in a period of less than one hour, and preferably in less than thirty minutes when the grease is cooled in units of 100′ long and 6′ wide. Preferably the grease can be quickly cooled in a time period of 3 to 15 minutes when spread in thin layers and cooling down from 450° F. to room temperature. More specifically, an anhydrous sodium soap grease containing between 3 and 25% of a sodium soap of a higher fatty acid, as for example sodium stearate, may be cooled in accordance with the present invention provided it does not disintegrate during or after cooling in thin layers of less than one inch thickness from a temperature of about 365° F. to about 200° F., and in many cases to room temperature which may vary from 40° F. to 90° F. to 120° F. in less than one hour. Some hydrous sodium soap lubricating greases inherently have a structure which makes the greases insensitive to quick chilling, as herein set forth. Others must have incorporated therein crystallization inhibitors such as the alkylene polyglycols, their esters and aromatic ethers, as well as other poly ethers including aromatic, aliphatic, and cycloaliphatic ethers containing at least one hydroxyl group per molecule. These compounds are designated crystallization inhibitors, that is they prevent the soap in the lubricating grease from forming hard granules which separate from the oil of the grease and cause the grease to disintegrate.

A soda soap grease which is particularly adapted for cooling in accordance with the present process is set forth in co-pending application, Serial No. 655,887, filed March 20, 1946.

A typical soda base grease which may be cooled utilizing the present apparatus may comprise the following ingredients:

Stearic acid, 200 gms. (3.35%)
Hydrogenated Castor Oil, 35 gms. (0.58%)
Polyethylene Glycol 1500 molecule wt., 10 gms. (0.166%)
Coastal pale oil, 100 vis., 500 gms. (8.35%)
Sodium Hydroxide, 32.5 gms. (.535%)
or
Metallic Sodium, 18.5 gms.
Coastal pale oil, 100 vis., 630 gms. (10.5%)
Coastal red oil, 2000 vis., 4600 gms. (76.519%)

In producing a grease from the above ingredients, the stearic acid, hydrogenated castor oil, polyethylene glycol, coastal pale oil, and the saponifying agent are all mixed together and the temperature raised to 260° F. until the reaction mass assumes a syrupy appearance. There is then added additional coastal oil and additional

red oil, and the temperature is maintained at about 360° F. while stirring until a substantial completely homogeneous mass is obtained. Hot grease is then fed on to the belt **19** of the present apparatus at such a rate so that a depth of grease layer of one-half inch is produced. Cooling air is supplied to the tunnel or casing by the blowers **33** and **34** at a velocity of 3000 feet per minute, and a temperature of approximately 90° F. The belt is moved at a speed of 13 feet per minute so that the grease remains on the belt for approximately 7 minutes, and is then discharged into one of the tanks **48** or **49**. The temperature of the grease upon discharge to the tank is 150° F. The grease is then strained through the strainer **54**.

There is produced a non-bleeding transparent soda base chassis grease of excellent mechanical stability, having the ASTM work penetration of 298 decimillimeters after 60 strokes, and 318 decimillimeters after 300 strokes. The resulting grease had a melting point of 348° F., and acidity equivalent to 0.08% oleic acid. Other types of grease may be cooled in the present apparatus and in accordance with the present method. For example, as previously pointed out, aluminum stearate grease may be cooled in the present apparatus.

The herein set forth process of cooling and apparatus may be used for the cooling of lithium base greases. A typical lithium soap grease may be compounded as follows:

	Per cent
Lithium stearate	9.5
Solvent refined coastal oil, 75 vis. at 100° F.	61.5
Solvent refined Bright stock oil	30

The above ingredients are mixed and cooked at a temperature of about 390° F. in the conventional manner. The grease is then pumped on to the belt **19** at such a rate as to provide a spread layer of grease of about 3/8″ in thickness. A 100 foot unit of the grease is cooled in 8 minutes from a temperature of about 390° F. to a temperature of about 160° F. and there is produced a grease of smooth buttery texture having a worked penetration after 60 strokes of 319 decimillimeters, and after 300 strokes of 335 decimillimeters, the grease had a melting point of 335° F.

In calculating the belt speed, the following formula is used:

$$U_b=\frac{V}{t}\frac{1}{h\cdot w}$$

where

U_b=belt speed
V/t=volume to be produced per unit time
h=thickness of grease layer
w=width of belt

For a belt of given dimensions therefore, the only true variable is h if a certain rate of heat removal is to be attained, since the following equation applies:

$$\frac{q}{t}=Q_0A\frac{wl}{h^2}f(u)$$

Where q/t equals rate of heat removal per unit time, l equals belt length, $f(u)$ equal an exponential function of the temperature difference between grease and air along the belt. A equals the rate of heat transfer of the grease, and Q_0 equals the total amount of heat to be removed per unit of area. It is obvious therefore from the two equations above that the belt speed can be readily determined once the belt dimensions and rate of production under given temperature conditions have been fixed, since, as previously pointed out, the thickness of the grease layer should be kept within certain definite limits. Preferably the air velocity is one which will give a heat transfer coefficient above 4 B. t. u. per hour per square foot per degree F. in order to remove the heat faster from the grease surface over a major area of the belt than it is conducted to the surface from within the interior of the grease mass. The corresponding air velocity can then be determined from the graph given in William H. McAdams "Heat Transmission," 1942, p. 206. Obviously, there are upper limits of air velocities which can be used best on economic considerations, since the power required increases rapidly with the volume of air handled.

In general, in carrying out the present invention, the saponifiable organic constituents of the grease making batch may be any of the saponifiable organic constituents used generally in the production of a grease. Fatty acids usually used in grease making are in general the saturated fatty acids containing up to 32 carbon atoms, and usually from 14 to 22 carbon atoms; and the unsaturated acids containing up to 32 carbon atoms and usually ranging from 18 to 22 carbon atoms. Instead of using the fatty acids, the glycerides thereof may be used as well as the monohydric alcohol esters of said fatty acids or the wax esters of said acids. The oil constituent of the grease making batch is usually a mineral oil such as well known in the art, but may be a vegetable oil or an animal oil or fat usually used in the production of anhydrous soda base greases or in the production of lithium soap greases. The saponifying medium may be sodium hydroxide or metallic sodium. More specifically, the fatty acid constituent of the grease making batch which may be a saturated fatty acid or an unsaturated fatty acid includes stearic acid, 12-hydroxy stearic acid, 9,10-dihydroxy stearic acid, 4-hydroxy palmitic acid, iso-stearic acid, iso-palmitic acid, 12-hydroxy, 9-oleic acid (ricinoleic acid), oleic acid, linoleic acid, hydrogenated fish oil fatty acids, palm oil fatty acids, cotton seed oil fatty acids. Further, abietic acid and/or the corresponding glycerides thereof, and/or naphthenic acids may be incorporated in the grease making batch.

The grease making batch may also comprise any combination of the aforementioned materials in grease making proportions, all as known in the prior art. The glycerides of the saturated and unsaturated fatty acids may also be used.

The term "anhydrous sodium soap grease" is used in the sense common in the art; namely, that the amount of moisture present is less than .25% based on the weight of the grease and preferably is less than .1% based on the weight of the grease. In general, the polymerized higher polyalkylene glycols having between 2 and 6 carbon atoms in the alkylene groups are effective in carrying out the present invention, but those containing the ethylene and propylene groups are preferred. However, the butylene, amylene, and hexylene glycols may be used. The average molecular weight of the polyethylene glycols used in carrying out the present invention may vary from 200 to 7000 or 400 to 7000, the preferred molecular weight varying from 1000 to 4000. It appears that the most effective average molecular weight is about 1500. However, any of the compounds set forth in applicant's application Ser. No. 655,887 may be used in carrying out the present invention.

Referring again to the sodium soap greases including the anhydrous sodium soap greases produced in accordance with the present invention, said greases may carry from 1% to 50% of a sodium soap of a fatty acid of the character herein set forth, but more usually carry from about 1% to 15%, and preferably from 3½% to 7½% or 10%.

The amount of the polyalkylene glycol including the polyalkylene glycols having between 2 and 6 carbon atoms in the alkylene groups of a molecular weight hereinbefore referred to may be present in the grease in amounts ranging from about .01% to .1% based on the weight of the grease, but preferably the minimum amount present in the grease should be about .05% in order for the grease to be efficiently and quickly cooled within the spirit of the present invention. The preferred limit then becomes about .05% to 1.0% or greater amounts.

What is claimed is:

1. The method of producing an improved grease containing up to 25% of an alkali metal soap selected from the class consisting of sodium and lithium soaps of a higher fatty acid, comprising feeding the grease in a hot fluid condition to a heat-conductive moving surface, forming a thin layer of grease thereon, and cooling the grease while in a quiescent state by subjecting the grease to the action of a counter-current gaseous heat absorbing medium for less than an hour until there is produced a smooth homogeneous grease.

2. The method of producing an improved grease containing from about 3% to 25% of a sodium soap of a higher fatty acid, comprising feeding the grease in a hot fluid condition to a heat-conductive moving surface, forming a thin layer of less than about one inch thick of grease thereon, and cooling the grease while in a quiescent state by subjecting the grease to the action of a stream of counter-current air for from about 3 to 15 minutes until there is produced a smooth homogenous grease.

3. The method of producing an improved grease containing from about 3% to 25% of a lithium soap of a higher fatty acid comprising feeding the grease in a hot fluid condition to a heat-conductive moving surface, forming a thin layer of less than about one inch thick of grease thereon, and cooling the grease while in a quiescent state by subjecting the grease to the action of a stream of counter-current air for from about 3 to 15 minutes until there is produced a smooth homogeneous grease.

4. The method of producing an improved grease containing from about 3% to 25% of a sodium soap of a higher fatty acid and from 0.1% to 1% of a grease structure modifier selected from the polyalkylene glycols having a molecular weight between 200 and 7000, comprising feeding the grease in a hot fluid condition to a heat-conductive moving surface, forming a thin layer of less than about one inch thick of grease thereon, and cooling the grease while in a quiescent state by subjecting the grease to the action of a stream of counter-current air for from about 3 to 15 minutes until there is produced a smooth homogeneous grease.

5. The method of producing an improved grease containing from about 3% to 25% of a sodium soap of a mixture of stearic acid and hydrogenated castor oil in which the stearic acid is present in predominant amount and from 0.1% to 1% of a grease structure modifier selected from the polyethylene glycols having a molecular

weight between 200 and 7000 comprising feeding the grease in a hot fluid condition to a heat-conductive moving surface, forming a thin layer of less than about one inch thick of grease thereon, and cooling the grease while in a quiescent state by subjecting the grease to the action of a stream of counter-current air for from about 3 to 15 minutes until there is produced a smooth homogeneous grease.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
Re. 16,699	Cano	Aug. 9, 1927
496,469	Wolff	May 2, 1893
916,319	Iveson et al.	Mar. 23, 1909
1,037,545	Savy	Sept. 3, 1912
1,086,762	Fuller, Jr.	Feb. 10, 1914

Number	Name	Date
1,141,683	Bausman	June 1, 1915
1,250,496	Passburg	Dec. 18, 1917
1,375,380	Gates	Apr. 19, 1921
1,385,636	Mathy	July 26, 1921
1,469,316	Hartshorn	Oct. 2, 1923
1,529,813	Restein	Mar. 17, 1925
1,609,849	Wagner	Dec. 7, 1926
1,753,828	Greer et al.	Apr. 8, 1930
1,937,463	Nill	Nov. 28, 1933
1,939,672	Dotzer et al.	Dec. 19, 1933
2,088,610	Rasmussen	Aug. 3, 1937
2,136,969	Downey	Nov. 15, 1938
2,150,250	Scott	Mar. 14, 1939
2,289,727	Randolph	July 14, 1942
2,307,562	Bausman	Jan. 5, 1943
2,363,037	Arnold	Nov. 21, 1944
2,406,655	Bax et al.	Aug. 27, 1946

FOREIGN PATENTS

Number	Country	Date
9,308	Great Britain	1903