

May 7, 1968

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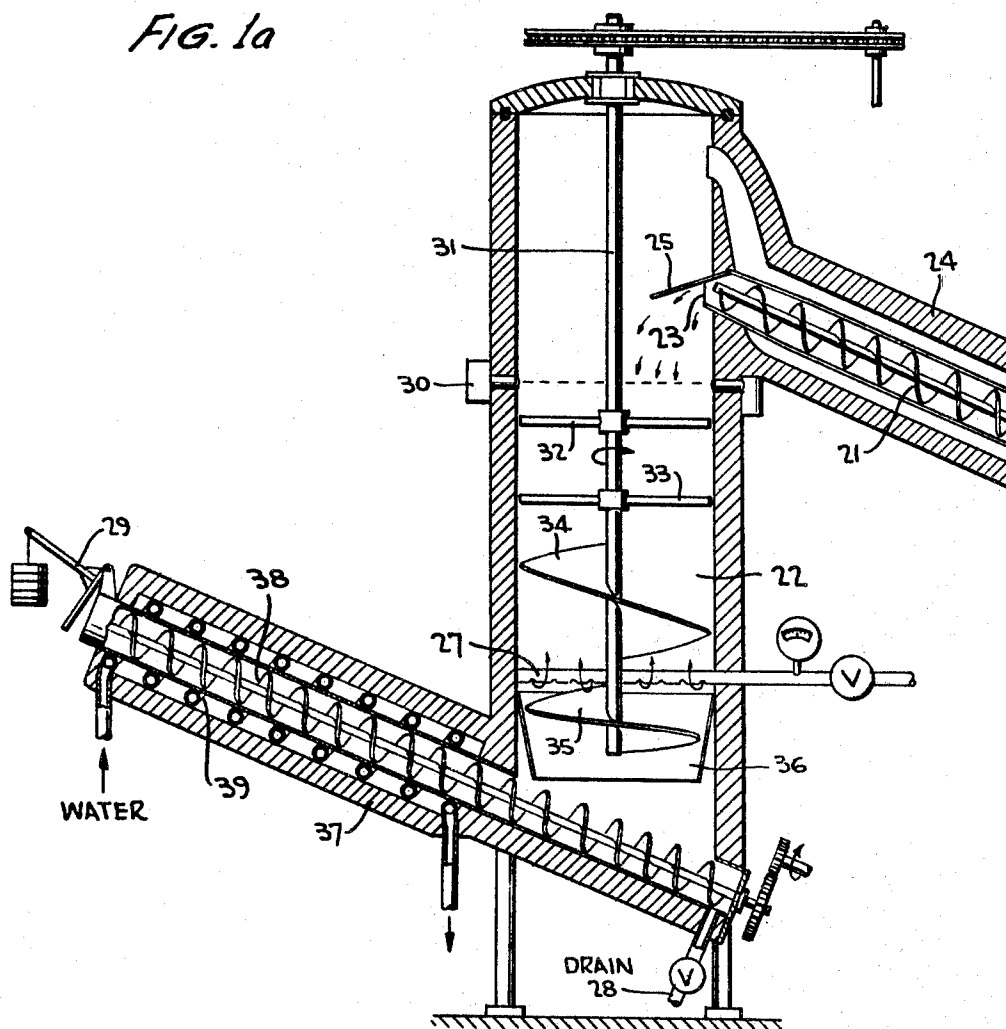
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OIL PROCESSING APPARATUS

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2 Sheets-Sheet 1

FIG. 1a



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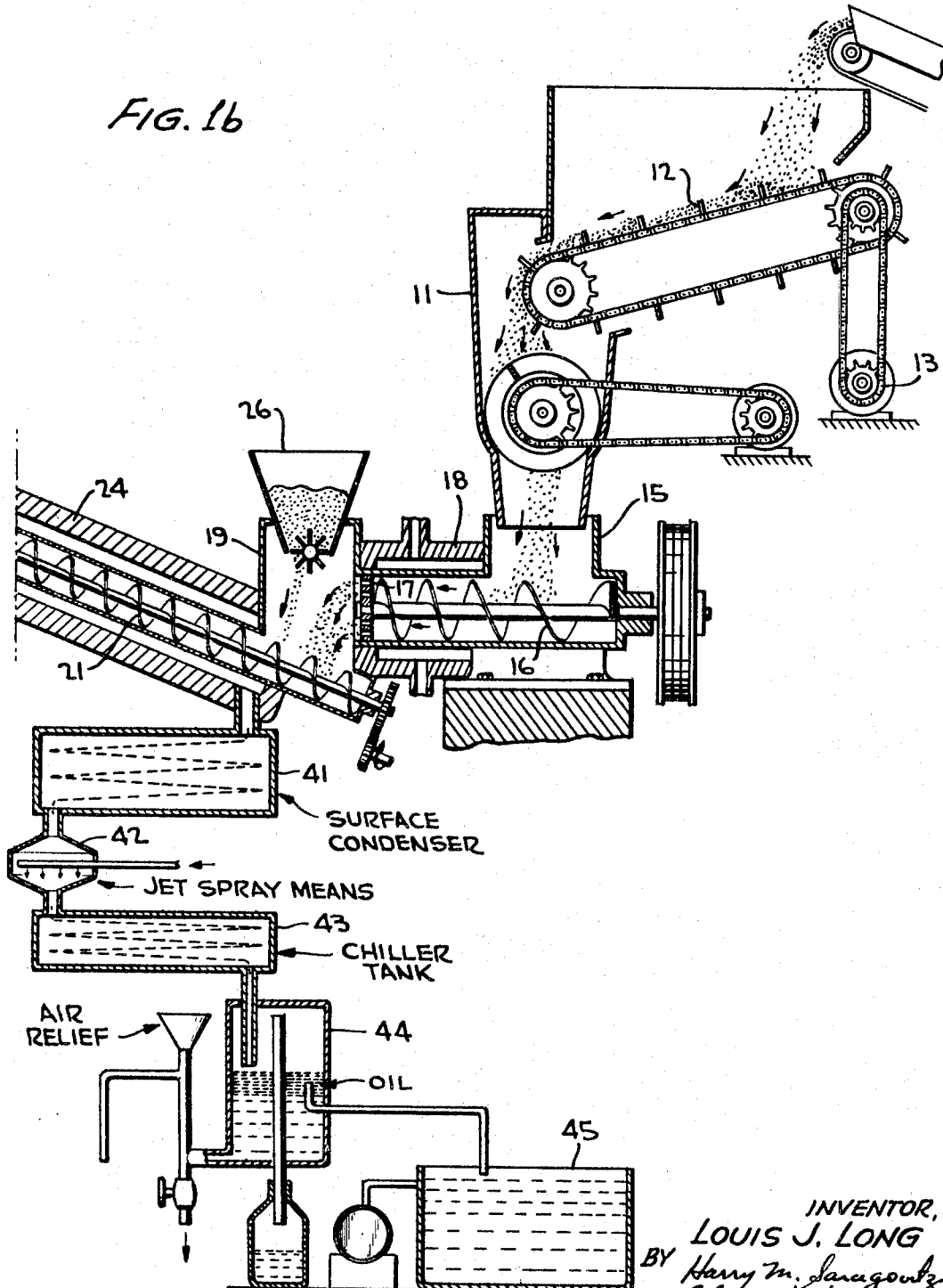
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2 Sheets-Sheet 2

FIG. 16



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3,381,390

OIL PROCESSING APPARATUS

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10 Claims. (Cl. 34-73)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment to me of any royalties thereon.

This invention relates in general to an apparatus for extraction of liquid compounds from carrier materials and in particular to an apparatus for obtaining liquids of the essential oil variety from conifer leaf materials.

Essential oils are obtainable from numerous natural sources and are utilized, generally as an additive product, in the manufacture of many items, for example, as an additive product for aromatic benefit. Although the use of essential oils is widespread, a relatively limited quantity is required and this has been readily obtainable heretofore. Upon review of the prior art extraction practice it is readily apparent that the prior art practice is quite laborious but, in view of the limited demand, it has been sufficient to meet the need for the product. This laborious aspect, has, however, necessitated that production be restricted to low cost labor areas. Consequently, the greater percentage of essential oils are now supplied by European markets notwithstanding the abundant supply of raw material available in the United States.

In recent years, many unique features of selected essential oils have been noted which have substantially increased their use prospect, especially in aerospace and military applications. More particularly, it has been found that several conifer leaf oils, in their pure state, are noncorrosive and are characterized by an extremely wide temperature range. One of the most useful applications of oils having such characteristics would be in low temperature hydraulic systems. As is well known, hydraulic systems afford one of the most reliable control means presently available, but performance at low temperature is largely determined by the temperature characteristic of the liquid medium. Despite their advantageous characteristics, the lack of a suitable domestic source of supply essential oils has, of course, seriously restricted the use of such oils in military hydraulic applications.

It has been recognized that a relatively unlimited, low cost, domestic source of supply of essential oils would be of considerable benefit, not only on a national economy basis but also in terms of greater general utility of the product in both military and civilian applications.

Accordingly;

It is an object of this invention to provide apparatus for the extraction of liquid compounds from carrier materials.

It is another object of this invention to provide a continuous process method and apparatus for the extraction of essential oils from carrier materials.

It is an additional object of this invention to provide apparatus for the extraction of essential oils which utilizes conifer leaf sections as the raw material.

It is a further object of this invention to provide a method and apparatus for extracting essential oils which produces a high quality end product.

It is still another object of this invention to provide a closed system process and apparatus for extracting essential oils which prevents escape of the more volatile fractions of the oil.

Other objects of the invention will become apparent upon a more comprehensive understanding of this inven-

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tion for which reference is had to the following specifications and drawings wherein;

FIGURES 1a and 1b comprise a cutaway showing of apparatus suitable for use in accordance with this invention.

Briefly, the method and apparatus of this invention is employed in the distillation variety for the extraction of natural oils from oil containing material which permits continuous operation and provides a relatively pure oil product.

Referring now to the drawings:

FIGURES 1a and 1b depict one preferred embodiment of this apparatus of this invention adapted to extract an essential oil, such as thuja oil, from northern white cedar leaf, or respective oils from materials such as fir, balsam, black spruce, white pine, black birch, etc. As shown in the drawing, the oil containing material is delivered to a container bin 11 by conventional bin loading means, such as the conveyor belt assembly 12, which is driven by variable speed drive means 13 to control the rate of feed of the oil containing material. It will be appreciated that many types of container bin loading means are available and that other types of bin loaders would be suitable for use in this process. It has been found, however, that "bridging" of the leaf material can be a problem in some instances and that care must be taken in the selection of the bin loading means with respect to the material being loaded to minimize such difficulty.

A spiral conveyor 14 having left and right hand spiral sections to carry the material to a selected central discharge point is disposed within the container bin section 11 such that the cut leaf material falls into the grinder 15 below.

In the illustrated embodiment, the grinder 15 includes a spiral conveyor 16 which is disposed beneath the selected discharge point of the container bin section 11 and is adapted to carry the cut leaf material to the grinder mechanism, indicated at 17. In a typical operation, the individual branch end sections should vary from 2 to 10 inches in length, but sufficient internal clearances are allowed to accommodate larger pieces to avoid "bridging" of the leaf material which might stop the flow thereof. It will be appreciated that while only one grinder mechanism is shown in the drawings, additional grinders may be provided to enable successive grinding operations of graduated degree, if desired. It has been found that multi-stage grinders are especially desirable when the longer length leaf material is utilized. For a typical raw material, white cedar leaf, the shear plate of the final grinder mechanism should incorporate a hole diameter of approximately $1\frac{1}{4}$ inch.

A steam jacket, indicated at 18, may be employed to heat the leaf prior to action by the grinder mechanism 17. It has been found that heating of the leaf at this stage facilitates a freer flow of the oil from the leaf sacs onto the leaf and twig surfaces and thus aids in the grinding and subsequent processing of the raw material.

The grinder 15 discharges into the input bin, indicated at 19, of another spiral conveyor, indicated at 21, where it is carried up an incline into the distilling retort 22 via an output port 23. In a typical embodiment the spiral conveyor 21 might be 5 inches in diameter and 9 feet long. The output port 23 is of lesser diameter than the conveyor 21, for example 3 inches, to provide a constriction which serves to compact the ground leaf material such that steam produced in the distillery retort 22 is prevented from passing down the inside of the spiral conveyor 21.

In accordance with the invention, the spiral conveyor 21 is encompassed by an insulated steam jacket 24. In

the illustrated embodiment, the steam jacket 24 carries oil bearing steam from the retort such that the oil may be collected and the thermal energy of the steam may be utilized to preheat the ground leaf material within the spiral conveyor 21. It has been found that the insulated steam jacket 24 is especially advantageous in conifer leaf oil extraction, for example, wherein steam boiler capacity and condenser cooling requirements are relatively large. It will be appreciated that any practicable means which enables a reduction in boiler size or coolant requirement in such application is desirable.

The deflector 25 disposed immediately above the output port 23 of the spiral conveyor 21 is adapted to prevent contamination of the steam condensate by finite pieces of the ground leaf carried upward by the rising steam. While very little oil is lost by this updraft action, it will be appreciated that undue contamination of the steam does complicate the subsequent condensation and purification stages and should be avoided.

In the illustrated embodiment an additive hopper 26 is provided as an adjunct to the input bin 19. It has been found that oxidation and corrosion of the internal parts of the system can be minimized by the introduction of neutralizing agents. It will be appreciated that unneutralized acids can have a significant adverse effect on the color and/or purity of the end product of the system. In the case of conifer leaf material it has been found that ground limestone is useful in neutralizing the acetic and formic acids present in the leaf material. In addition, it has been found that ground limestone (calcium carbonate) or the like, has a slight scouring effect on the spiral conveyor 21 and thus helps to prevent packing and sticking of the leaf material on the internal spiral element.

Referring again to the retort 22 in which the ground leaf material is cooked to produce oil bearing steam, steam is introduced into the bottom of the retort by means of one or more perforated pipe sections, indicated at 27.

Care must be taken, of course, in the configuration and disposition of the pipe sections 27 to insure that the ground leaf material will flow downward without bridging or packing. U-shaped pipe sections with steam jets on the underside have been found satisfactory in actual operation of the system.

It will be noted that a stirring assembly including a drive shaft 31, a pair of spoke assemblies 32 and 33 and a pair of spiral blade elements 34 and 35 is adapted to continually distribute the raw material in the retort. This stirring assembly, which turns at a predetermined rate, (2 r.p.m., for example) serves several significant functions. First and foremost, it prevents the formation of blowholes or steam channels up through the steaming charge thus providing a more even distribution of steam flow up through the material. In addition the spiral blades 34 and 35 carry the material through a tapered section 36 and into an expeller conveyor 37 including a spiral section 38 which carries the oil separated material to a collection point, indicated at 39.

A tank drain, 28, is provided of the bottom of the retort 22 to drain off the condensate upon initiation of the process. It will be appreciated that if the condensate is not drained off at this initial stage, the leaf material may tend to float and as a consequence will not reach the expeller conveyor 37. Furthermore, it has been found that too high a condensate level will tend to soften the slug of the end of the expeller conveyor 37 which is normally established by the action of the weighted or spring loaded port cover, indicated at 29. If this occurs, the condensate and steam may depart the retort 22 via the expeller conveyor 37 rather than through the steam jacket 24, as previously described.

It will be appreciated that the type of expeller conveyor utilized should be determined by the nature and condition of the oil separated material. Normally, the oil separated material leaves the retort at the steam tempera-

ture, approximately 220° F., which precludes immediate stockpiling of the material or other conventional handling thereof. Consequently, it has been found advisable to cool the material as it is expelled and heat exchange coils, indicated at 39, adapted for coolant circulation are normally satisfactory for the purpose.

It has been found that the expelled oil separated material may be suitable as cattle feed, as an organic soil conditioner and nutrient, or otherwise, dependent upon oil extraction efficiency, mineral content, finite composition, etc.

In the exemplary case, the spiral expeller is adapted to turn at an r.p.m. proportional to the r.p.m. of the stirring assembly to insure that the flow through the retort of leaf material is continuous. It will be appreciated that it is within the purview of this disclosure to drive the spiral expeller, the several other conveyors and the stirring assembly in various speed relations by a common drive means and an appropriate gearing mechanism, not shown, if desired.

The apparatus of this invention is readily adaptable to automatic operation by the placement of sensing devices at selected points in the system which initiate corrective action in response to irregularities such as an improper quantity of oil bearing material. For example, the near infrared photoelectric sensing device, indicated at 30, may be adapted such that in charging the system (filling the retort 22) at the start of operation, the input conveyor 12 continues to function until material in the retort reaches the level of the sensing device 30, whereupon the input conveyor driving means 13 is responsive to the sensing device 30 and either stops or reduces speed, as necessary.

In accordance with the invention, the oil bearing steam partially condenses as it passes through the steam jacket 24 to the surface condenser 41 where additional condensation takes place. It will be appreciated that the size of the surface condenser 41 is largely determined by condensation efficiency of the steam jacket 24.

It has been found that the condensate from the surface condenser 41 may be at a temperature near 200° F., a temperature which may cause the loss of valuable aroma carrying esters. Consequently, it is generally advisable to quickly cool the condensate down to a temperature of approximately 120° F., by means of a jet spray means 42 and a chiller tank 43. At this point, the oil condensate is collected in a tank 44 and the separated oil which floats on the surface is transferred to an oil storage means 45.

While the process and apparatus illustrated herein is especially suitable for the extraction of conifer leaf oil, it will be recognized that the basic concept of this invention is applicable to any liquid compound which is separable from carrier materials by means of steam distillation, i.e., cedar wood shavings, peppermint, spearmint, lemon grass, etc.

It has been found that by use of the process and apparatus of this invention the savings in distillation costs, and in material handling costs, both before and after processing, are substantial. Likewise, by conversion of raw material residue into a useful and saleable product, operational costs are minimized since sale of the residue compensates for all or most of the raw material cost. In addition, a much higher quality oil with fewer impurities is obtained and this reduces subsequent refining costs.

It will be appreciated that various other modifications of the process and apparatus of the invention may be incorporated in selected applications. For example, ammonia or other additives may be introduced in the steam system to neutralize acids and/or to maintain a sufficient amount of oil in suspension to prevent polymerization and encrusting on the hot surfaces of the retort or heat exchangers.

Finally it is understood that this invention is limited only by the scope of the claims appended hereto.

What is claimed is:

1. An apparatus for extraction of liquid compounds from carrier materials comprising,
 - a carrier material container; means for loading said container with carrier material;
 - carrier material grinder means including first spiral conveyor input means for transporting said material to be ground;
 - means for dispensing said carrier material from said container;
 - said grinder means disposed with respect said container such that carrier material may be dispensed from said container into said first spiral conveyor input means;
 - upright distillation retort means including steam injection means;
 - second spiral conveyor input means adapted to transport ground carrier material from said grinder means to said distillation retort means;
 - said second spiral conveyor input means having an output port at the retort end thereof disposed to discharge ground carrier material into the upper portion of said upright retort means, said output port having a diameter less than the internal diameter of said second spiral conveyor, said second spiral conveyor having a tapered portion for guiding said carrier material to said output port thereof such that said ground carrier material is compacted as it passes through said output port;
 - means for collecting steam distillate from said retort means;
 - and means for removing said ground carrier material from said retort means after a predetermined time period therein.
2. An apparatus as defined in claim 1 wherein said grinder means is adapted to transform conifer leaf cuttings into ground material of selected degree.

3. An apparatus as defined in claim 2 wherein at least one of said first and second spiral conveyor means is heated.

4. An apparatus as defined in claim 3 wherein said second spiral conveyor means is at least partially enclosed by steam jacket heating means.

5. An apparatus as defined in claim 4 wherein said steam jacket means at least partially enclosing said second spiral conveyor means is a part of said means for collecting steam distillate and is adapted for the passage of steam distillate from said retort means.

6. An apparatus as defined in claim 5 wherein said retort means includes rotary stirring means for agitating said ground material.

7. An apparatus as defined in claim 6 wherein said means for removing said ground carrier material from said retort is a spiral conveyor means.

8. An apparatus as defined in claim 7 wherein the motive elements thereof are adapted to maintain a continuous flow of carrier material through the apparatus.

9. An apparatus as defined in claim 8 wherein condition sensing means are suitably disposed and adapted to control of motive elements thereof.

10. An apparatus as defined in claim 8 wherein means are provided for chemically supplementing the ground carrier material.

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