Aug. 29, 1961 C. W. ZIES 2,997,943

MEANS FOR SOLVENT EXTRACTION

Filed March 20, 1957 4 Sheets-Sheet 1

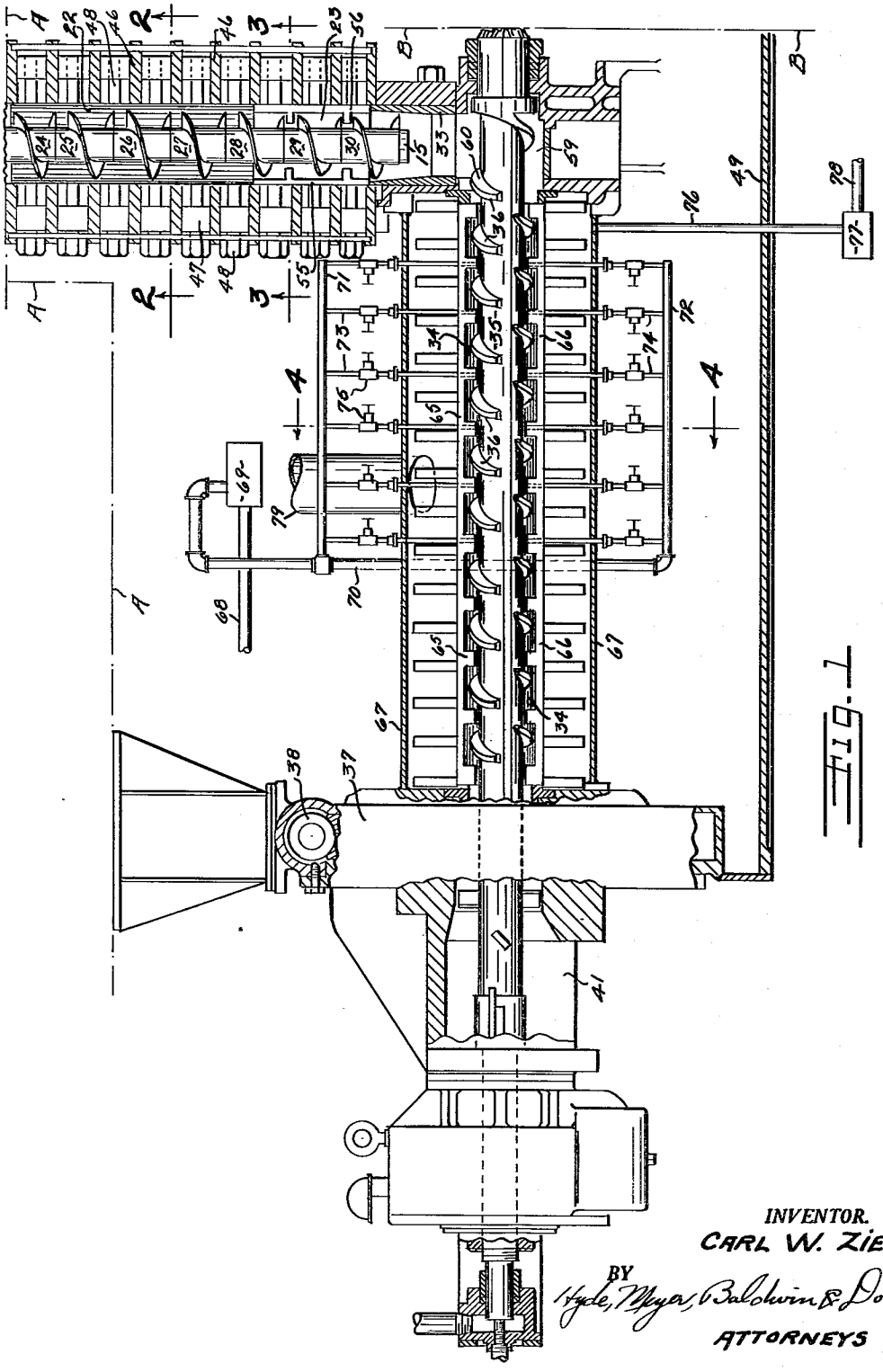


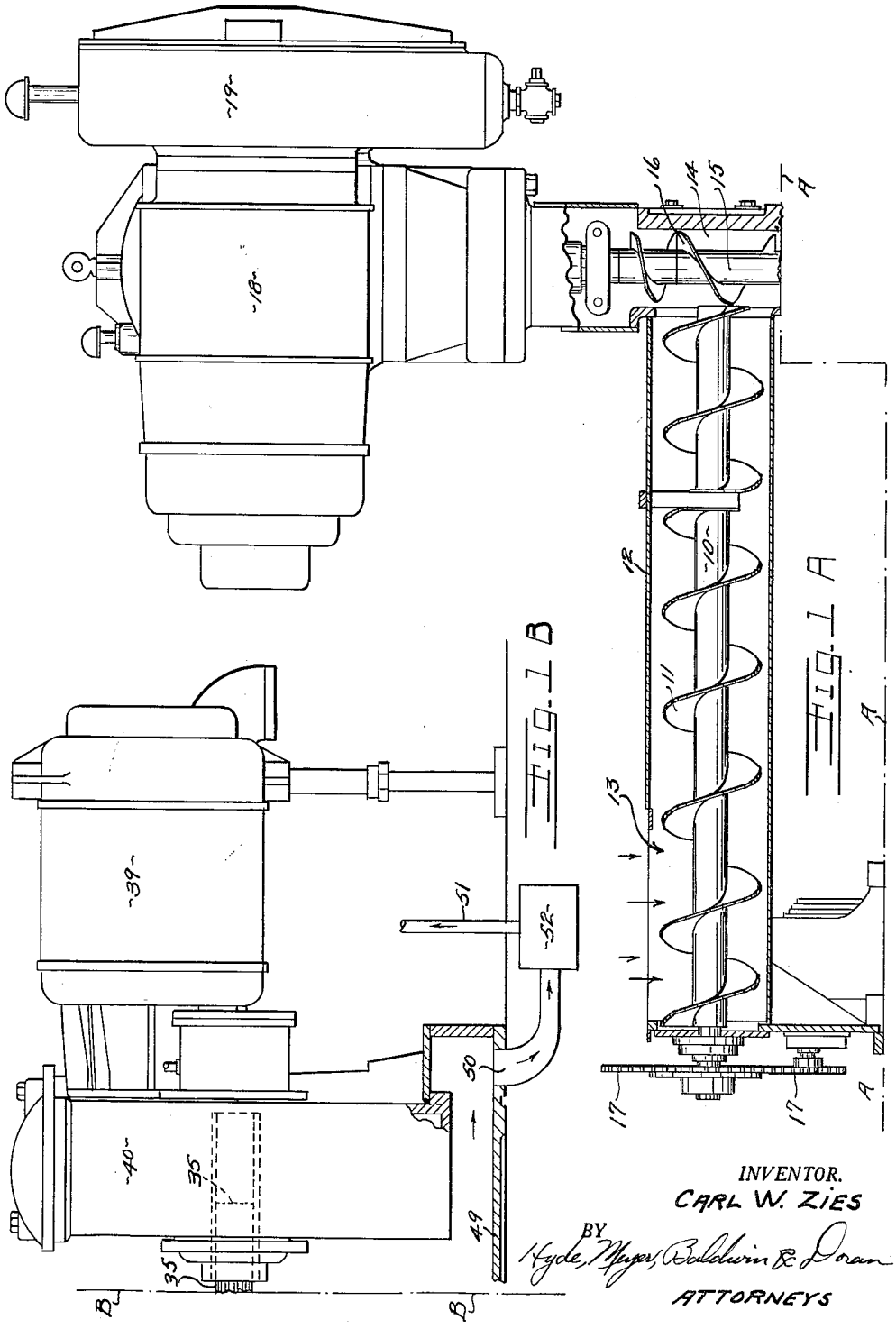
Fig. 1

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MEANS FOR SOLVENT EXTRACTION

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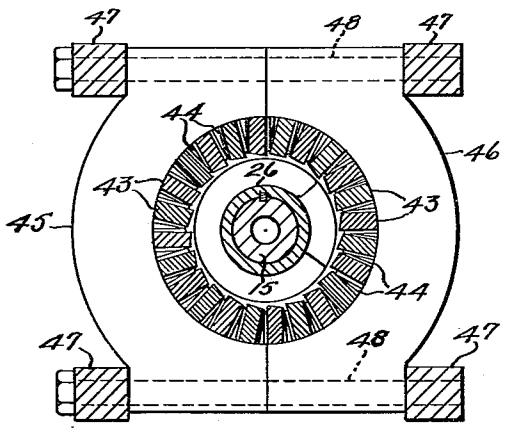


FIG. 2

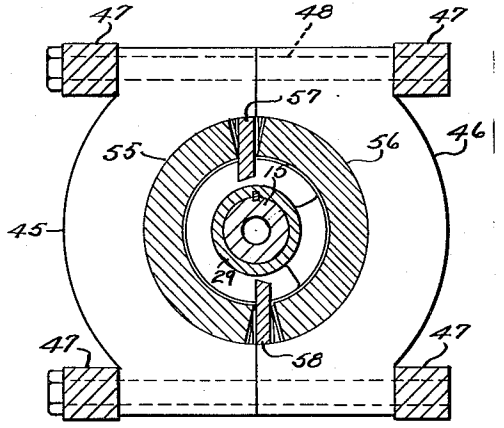


FIG. 3

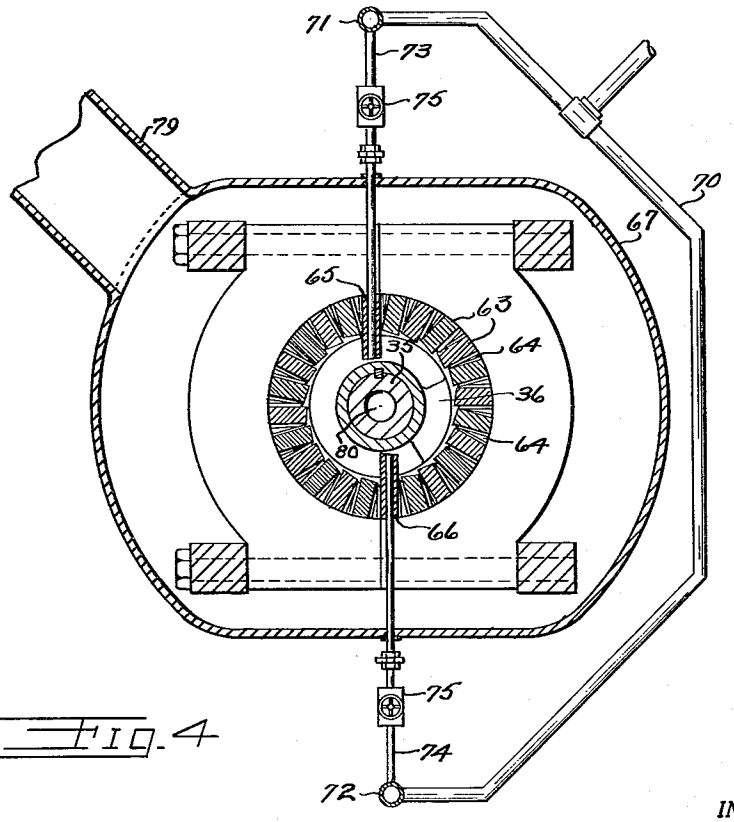


FIG. 4

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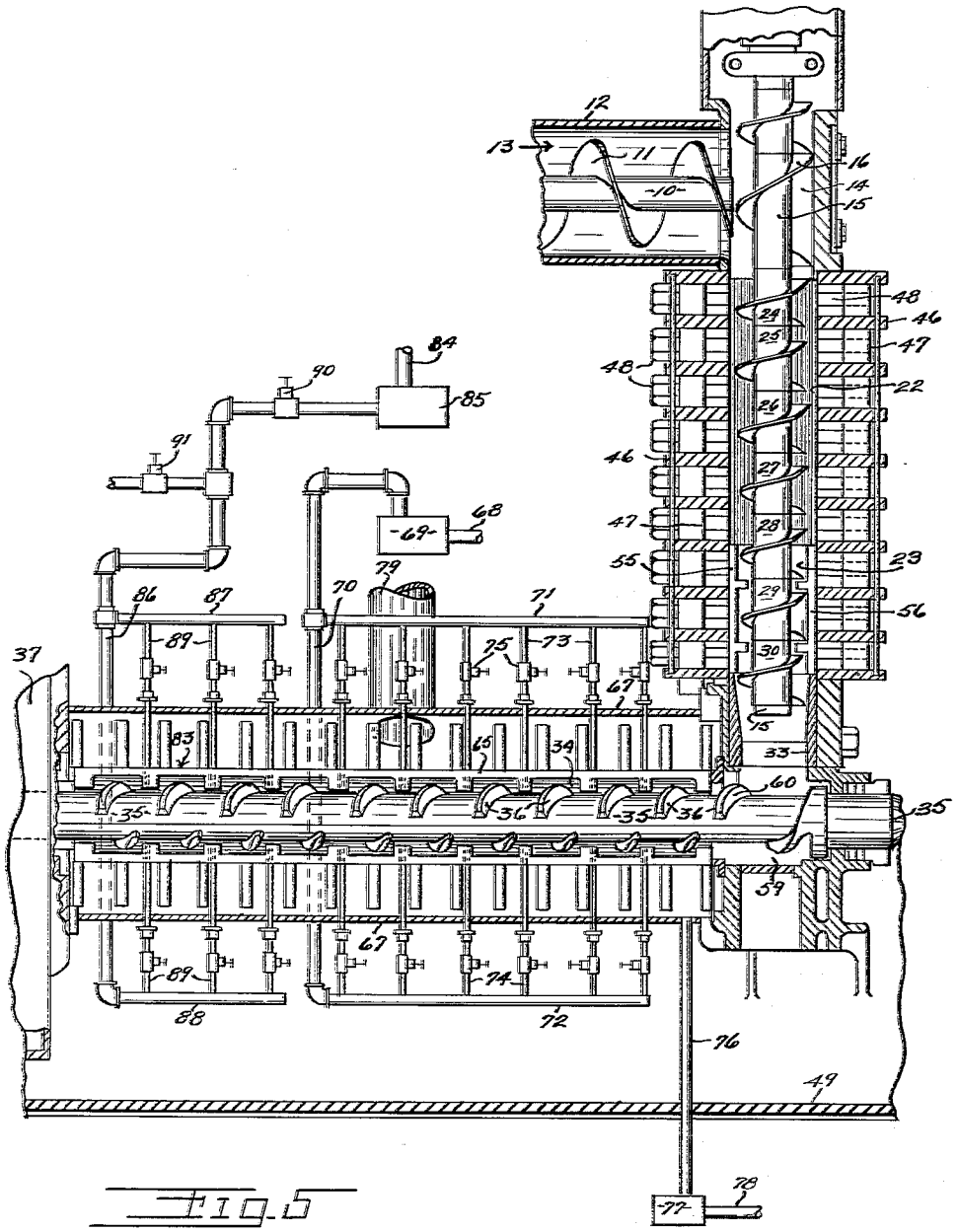


FIG. 5

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2,997,943

MEANS FOR SOLVENT EXTRACTION

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9 Claims. (Cl. 100—74)

This invention relates to novel and improved means for processing material in the barrel of a continuous screw press by injecting liquid under pressure thereunto, and subsequently removing liquid therefrom.

It is well known to those skilled in the art that continuous screw press machines constitute a practical means for expressing oil from oil-bearing seeds. It is further well known that oil may also be extracted from seeds by the use of solvents, the oil and solvent being later separated by well known methods, such as by fractional distillation or the like.

As a further development a material which has first been subjected to the action of a solvent may then be fed to a continuous screw press, and the oil-solvent mixture, usually termed miscella, can be squeezed out of the solids by heavy pressure. As another example pyrethrum flowers have been mixed with petroleum solvent and the mixture passed through a continuous screw press, the excess petroleum solvent and pyrethrum extract being then pressed from the solid residue.

Certain disadvantages are inherent in both the mechanical extraction and the solvent extraction methods.

The difficulty of removing liquid by mechanical extraction increases as the residual liquid decreases, requiring further increases in pressure, and with each type of extractable material a point is reached beyond which it is economically advisable to discontinue, thereby leaving a certain percentage of residual oil in the cake. It is nevertheless desirable to lower this residual oil by further recovery.

By improved solvent extraction processes the residual liquid can be lowered beyond that percentage resulting from practical mechanical pressure methods, but the miscella and the solid residue carry high percentages of dust or "fines," and the said residue was often put through a mechanical screw press to compact it into cake which could be sold.

The process about to be described and the apparatus whereby it can be accomplished produce a substantially liquid-free cake in a compacted condition in a single operating unit in which the desirable features of solvent extraction and mechanical expression are combined.

An object of the invention is to provide means for introducing operating liquids under pressure into the working confines of a screw press barrel.

A further object of the invention is to avoid the formerly required repetition of working steps by introducing the working liquid anew at several successive zones along the press barrel.

A further object of the invention is to accomplish the purposes of the two preceding paragraphs with greater economy of working fluid, such as volatile solvent or the like, than has heretofore been feasible with solvent extraction operations.

A further object of the invention is to carry out extractions which have previously been considered impractical because of the lack of a suitable solvent in sufficient quantity for commercial operation.

Since many solvents have heretofore been regarded as too costly when used in quantities sufficient for hitherto known extraction processes, a further object of the invention is to make it economically feasible to carry on operations with costly solvents.

Since in the heretofore-known practices of extraction

of vegetable oil by means of solvents it was customary to recover as much as possible of the solvents by various fractional evaporation steps, it is a present object to provide means for simultaneous extraction by solvents and evaporation of the solvents during or immediately after the extraction step, as part of the same operation.

A further object of the invention is to provide means for introducing a working solvent in a primary zone of a screw press barrel and evaporating the solvent in a succeeding zone of the screw press barrel.

A further object of the invention is to provide means for introducing a working solvent in a primary zone of a screw press barrel and mechanically extracting a miscella of solvent and product oil in a succeeding zone of the screw press barrel.

A further object of the invention is to provide means as defined in preceding paragraphs wherein water or steam can be introduced under pressure into end zones of a screw press barrel for final de-solventizing steps, and, if water is introduced, for converting said water to steam within said end zone by the development of high pressures and consequent high temperatures in the barrel.

A further object of the invention is to extract oil from oil-bearing materials by an aerosolizing step.

Other objects and advantages will be apparent from a study of the following description, in conjunction with the accompanying drawings in which;

FIG. 1 is a view partly in vertical section and partly in side elevation, showing a working assembly including vertical and horizontal screw press barrels and associated elements. For convenience in illustration, because the complete assembly is extensive, several parts of said assembly have been cut away and are shown in FIGS. 1A and 1B as follows:

FIG. 1A is a view, partly in section and partly in side elevation, showing feeding and driving mechanism for the vertical press barrel, the plane of separation between FIGS. 1 and 1A being along the broken line A—A in both said figures;

FIG. 1B is a view, partly in section and partly in side elevation, showing driving mechanism for the horizontal barrel, and other associated elements, the line of separation between FIGS. 1 and 1B being along the plane B—B in both said figures;

FIGS. 2, 3 and 4 are sectional views taken respectively on the lines 2—2, 3—3, and 4—4 of FIG. 1;

FIG. 5 is a view similar to FIG. 1, but showing a somewhat modified form of the invention.

The main structural features of a machine such as would be achieved by combining FIGS. 1, 1A, and 1B, are shown, for example in U.S. Patent No. 2,471,920, granted May 31, 1949 to Raymond T. Anderson.

Referring to the drawings, I show a screw press assembly wherein a material such as oil-bearing seeds may be processed for recovery of the product oil. Since the general type of apparatus is familiar to those skilled in the art, I will describe only briefly the broad function and purpose of some of the main elements of the structure.

The screw press as seen in FIGS. 1–4, includes feeding means (FIG. 1A) comprising a horizontal rotatable shaft 10 carrying a helical worm 11, the shaft and worm being enclosed in a tubular housing 12 which has a feed opening 13 at the receiving end thereof. Oil-bearing material dropped through opening 13 as shown by the arrows is carried to the right and discharged into a vertical cylindrical chute 14 which likewise is provided with a rotatable shaft 15 having thereon screw flight means 16 adapted to force the material downwardly. Conventional drive means is provided for shafts 10 and 15. Shaft 10 is driven from cooperating sprockets 17 which in turn are driven by a motor, not shown. Drive of shaft 10 does not require much power since loose material

is merely being advanced laterally into chute **14** where incipient pressure begins to be applied. Shaft **15** is driven from motor **18** through a gear reduction train in housing **19**, and then through a worm and gear or a bevel gear and pinion to shaft **15**, this driving gear being conventional and therefore not shown.

Forming a downward continuation of chute **14** are a pair of successive vertical barrel sections **22** and **23** (FIG. 1) coaxial and coextensive with chute **14**. These barrel sections will be more explicitly described hereinbelow. Shaft **15** continues downwardly through barrel sections **22** and **23**, and carries thereon a plurality of hubs **24**, **25**, **26**, **27**, **28**, **29** and **30**, each having its respective helical screw flight thereon, the periphery of which closely approaches the inner face of the barrel wall.

At the lower end of the vertical barrel is an imperforate collar **33** within which the advancing material is compacted into a liquid-seal plug by gradually increasing downward pressure exerted by the screw flights.

The leading end of the plug is progressively forced into the right end of horizontal barrel **34** within which rotates a shaft **35** having interrupted helical screw flights **36** thereon. The purpose of this construction is to advance the material along barrel **34** towards its left end while gradually increasing the pressure thereon. This increase of pressure is achieved in various ways, all of them previously recognized in the art, for example by decreasing the pitch of screw flights **36** towards the left end, or by increasing the shaft root diameter towards the left, or by restricting the escape opening within an automatic choke assembly **37**. This automatic choke assembly is not shown in detail, but structural features of one suitable embodiment are well shown and described in U.S. Patent No. 1,752,054 to Raymond T. Anderson. Briefly, rotation of a worm **38** produces co-acting rotation of a peripheral gear which through the operation of further cooperating parts results in the constriction of inner peripheral parts so as to produce a change in the diameter of a choke aperture somewhat similar to the operation of the so-called "iris diaphragm" which is used in some optical elements, for example certain camera lenses.

The drive for shaft **35** is here located at its right end (FIG. 1B) and consists of a motor **39** and a train of reduction gearing in housing **40**.

Returning to FIG. 1, caked residue proceeds through the automatic choke and drops through port **41**.

The general structure of barrel zone **22** will be better understood by reference to prior patents to Raymond T. Anderson, including for example, U.S. Patent Nos. 1,722,882, and 1,773,771. This vertical barrel part is built up from an assembly of barrel bars **43**, lying side by side (FIG. 2) and all fitted together in keystone-like fashion, having V-shaped spring clips **44** therebetween, and tightly maintained by semicircular frame members **45** and **46** which in turn are clamped longitudinally by bars **47**, transversely retained by tie bolts **48**.

The barrel bars **43** are disposed in such close mutual lateral contact as to prevent solid material from escaping radially outwardly therebetween, but to permit liquid to be squeezed through the minute interstices when the pressure is heavy. The spaces between the barrel bars may be adjusted, depending on the oil-bearing material being pressed.

Assume that oil-bearing seeds are being forced downwardly through barrel zone **22**, as the pressure increases, a considerable portion of the oil is squeezed outwardly between the barrel bars, and it flows down into a trough **49** whence it proceeds to the right (FIG. 1B) and through a discharge port **50**, and it is then impelled through conduit **51** by a pump **52**. This oil is solvent free, and after a certain amount of fines is settled therefrom by means not shown, it proceeds to storage. This upper zone **22** of the vertical barrel is sometimes referred to as a "prepress" or "drainage" zone.

Zone **23** of the vertical barrel might be termed the "sealing" zone since no drainage occurs there, and the plug therein formed provides a vapor-tight seal for vapors originating in the horizontal barrel as will appear. Referring to FIGS. 1 and 3, the sealing zone **23** is obtained by assembling two semicylindrical portions **55** and **56**. At their registering longitudinal edges I have inserted opposed knife bars members **57** and **58** which extend radially inwardly in the spaces between screw flights so as to prevent compacted material from merely rotating with the shaft. The knife bar projecting portions force the material to move longitudinally towards the end of the barrel section. This sealing section could be formed by providing a completely cylindrical collar instead of semicylindrical halves, but the latter construction facilitates inclusion of the knife bars. I could also use barrel bars without spacers between them.

At the junction of the vertical and horizontal barrels there is a relatively small space **59** where the material movement changes direction, under the motive influence of worm flight **60**. The material thereupon is forced to the left by rotation of shaft **35** as hereinabove mentioned. Horizontal barrel **34** is similar in construction to the drainage portion **22** of the vertical barrel, its cross sectional construction being shown in FIG. 4 which shows shaft **35**, screw flights **36**, barrel bars **63**, and spacers or clips **64**. In the present embodiment this structure runs the full length of the barrel. A pair of opposed knife bars **65** and **66** are provided, which are perforated at spaced longitudinal points for a purpose soon to appear.

The horizontal barrel is surrounded by a housing **67** which is liquid leak-proof and vapor leak-proof. I have provided means for injecting liquid into about the right half portion of the horizontal barrel, such means comprising a pipe **68** from a supply source (not shown), a pump **69**, an end header **70**, a top manifold **71**, a bottom manifold **72** and branch pipes **73** and **74** constituting injection nozzles. This liquid may be any suitable solvent for oil, and as examples of such solvents I may mention methylene chloride, trichlorethylene, or heptane. Each branch pipe feeds into a respective aperture extending radially inwardly through a knife bar, the disposal being such that the liquid is discharged into the barrel near the shaft surface. Each branch pipe is provided with a valve **75** for possible individual control. The right portion of the horizontal barrel of this embodiment may therefore be termed the solvent extraction portion.

Continuing the present exemplification in which volatile solvent is to be used for providing a solvent extraction effect on the seeds being compressed, the solvent is introduced under pressure near the shaft, between screw flights, and as the cake and solvent are advanced into the next worm flight, the pressure of the worm forces the solvent to move through the cake towards the outside of the barrel. As the solvent moves through the cake, it picks up the oil which remained in the cake and together they are pressed out of the barrel. As shown in the drawing the six injection zones represented by the six upper-lower branch nozzles, cause this solvent extraction operation to be repeated five times. This, of course, could be multiplied as many times as seems advisable or desirable.

The conditions in this solvent extraction section of the barrel are selected judiciously, having in mind the physical properties of the solvent, such as critical temperature, boiling point, viscosity, and solvent capability, and are selected in conjunction with suitable pressures and temperatures in this part of the barrel so that as the mixture of solvent and oil approaches the outer portion of the barrel, the solvent will flash off the cake at the barrel bar interstices with sufficient force to aerosolize the remaining portion of the oil. The aerosolized oil particles condense within housing **67**, or on the inner wall of the housing.

The miscella, comprising the condensed drops and the liquid squeezed out, leaves the housing by pipe **76** and pump **77** sends it through pipe **78** to suitable separation means where any solvent in the miscella is stripped and recovered.

Vaporized solvent in housing **67** proceeds outwardly through a conduit **79** to a scrubber (not shown) for removal of any small entrained oil particles, and then to condensation means. The system is a completely closed one, and practically no solvent is lost.

The cake continues onwardly in the barrel towards the automatic choke **37** and the discharge point **41**. In its trip through the horizontal barrel it has been simultaneously exposed to mechanical expression and solvent extraction, and each effect supplements the other. By controlling the temperature within the barrel, which can be done by pressure control and/or supplemental heating means, much of the solvent can be vaporized immediately upon issuance from the barrel. Steam or heated gas can be passed through the hollow bore **80** in shaft **35**, for example by a feed pipe arrangement such as is shown in U.S. Patent No. 2,149,736 to Hiller, FIGS. 1, 28 and 31, reference numerals 192 and 193. As will appear in the next embodiment, now to be described, further treating means can assist in the desolventizing of the cake.

FIG. 5 shows a portion of a unit similar to that shown in FIG. 1 including a horizontal barrel **83** having the previously described solvent injection system **70**, **71**, **72**, **73**, etc. In the present embodiment I show a water or steam injection system near the discharge end of the barrel for further desolventization, and by "desolventization" I mean removal of residual solvent still remaining in the cake, and possibly carrying some oil in solution or entrained therein. The process may be operated either with steam or water depending on the material being processed. Water is selected for desolventizing the cake of relatively oil-free materials which develops large quantities of heat dut to high pressure and friction in the barrel. The injection of water cools the cake, produces steam in the barrel and desolventizes the cake in a single operation. This is accomplished as shown in FIG. 5.

Water from supply pipe **84** is advanced by pump **85** to end header **86**, and thence through upper manifold **87** and lower manifold **88** through branch pipes **89** and the nozzle inlet portions of the knife bars. In this operation water valve **90** is open and steam valve **91** is closed.

Steam is used for materials which are difficult to desolventize and which do not spontaneously develop sufficient frictional heat to vaporize water and develop the desolventizing steam within the barrel itself. In either method, starting with water or steam at any desired degree of superheat, substantially the last vestiges of the solvent are driven out of the barrel in vapor phase.

What I claim is:

1. Apparatus for the extraction of oil from oil-bearing seed or nut material comprising an elongated barrel having an entry end and a discharge end, means for feeding said material into said entry end, means for applying pressure on said material and for advancing it towards said discharge end, means for injecting volatile solvent through the wall of said barrel near said entry end whereby to constitute a solvent extraction zone, there being aperture means in the wall of said barrel permitting escape of liquids but preventing escape of solids, a portion of said barrel comprising means providing a desolventizing zone between said solvent extraction zone and said discharge end for removal of a substantial portion of residual solvent between said solvent extraction zone and said discharge end, and means in said desolventing zone for causing such removal of residual solvent including means for raising the temperature of said material in said desolventizing zone.

2. Apparatus as defined in claim 1 wherein the means for raising said temperature in said desolventizing zone includes steam injection piping whereby to discharge steam through the wall of the barrel in said desolventizing zone.

3. Apparatus as defined in claim 1 wherein said residual solvent removal means including means for injecting water inwardly through the barrel wall in said desolventizing zone.

4. Apparatus as defined in claim 1 wherein the means for injecting volatile solvent includes a plurality of solvent liquid injection nozzles spaced longitudinally along said barrel wall in said solvent extraction zone.

5. Apparatus for the extraction of oil from oil-bearing seed or nut material comprising a vertical barrel and a horizontal barrel, each barrel having an entry end and a discharge end, the lower end of the vertical barrel being the discharge end thereof and being in material flow communication with the entry end of the horizontal barrel, means for feeding said material into the entry end of the vertical barrel and for advancing it successively through said vertical barrel and said horizontal barrel towards the dicharge end of the horizontal barrel, said means being also effective to apply pressure to the material in each barrel, the upper end of said vertical barrel having liquid-escape apertures in the wall thereof to permit escape of pressure-expressed oil, the lower end of said vertical barrel being imperforate whereby to permit packing of material therein in a vapor-impervious plug which material is progressively expelled into the horizontal barrel, means for injecting volatile solvent through the wall of said horizontal barrel near the entry end thereof whereby to provide a solvent extraction zone, the horizontal barrel wall in said solvent extraction zone having liquid escape apertures therein to permit escape of oil and solvent therethrough, a portion of said barrel comprising means providing a desolventizing zone between said solvent extraction zone and said discharge end for removal of a substantial portion of residual solvent between said solvent extraction zone and said discharge end, and means in said desolventizing zone for causing such removal of residual solvent including means for raising the temperature of said material in said desolventizing zone.

6. Apparatus as defined in claim 5 wherein the means for raising the temperature in said desolventizing zone includes steam injection piping whereby to discharge steam through the wall of the horizontal barrel in said desolventizing zone.

7. Apparatus as defined in claim 5 wherein the means for injecting volatile solvent includes a plurality of solvent liquid injection nozzles spaced longitudinally along the horizontal barrel wall in said solvent extraction zone.

8. Apparatus as defined in claim 6 wherein said steam injection piping is provided with a plurality of steam nozzles spaced longitudinally along the horizontal barrel in said desolventizing zone.

9. Apparatus as defined in claim 5 wherein said residual solvent removal means including means for injecting water inwardly through the horizontal barrel wall in said desolventizing zone.

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