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Feb. 25, 1930.

E. LAWRENCE, JR

1,748,356 ✓

APPARATUS AND METHOD OF EXTRACTING OIL FROM OLEAGINOUS MATERIAL

Filed June 3, 1925

9 Sheets-Sheet 1

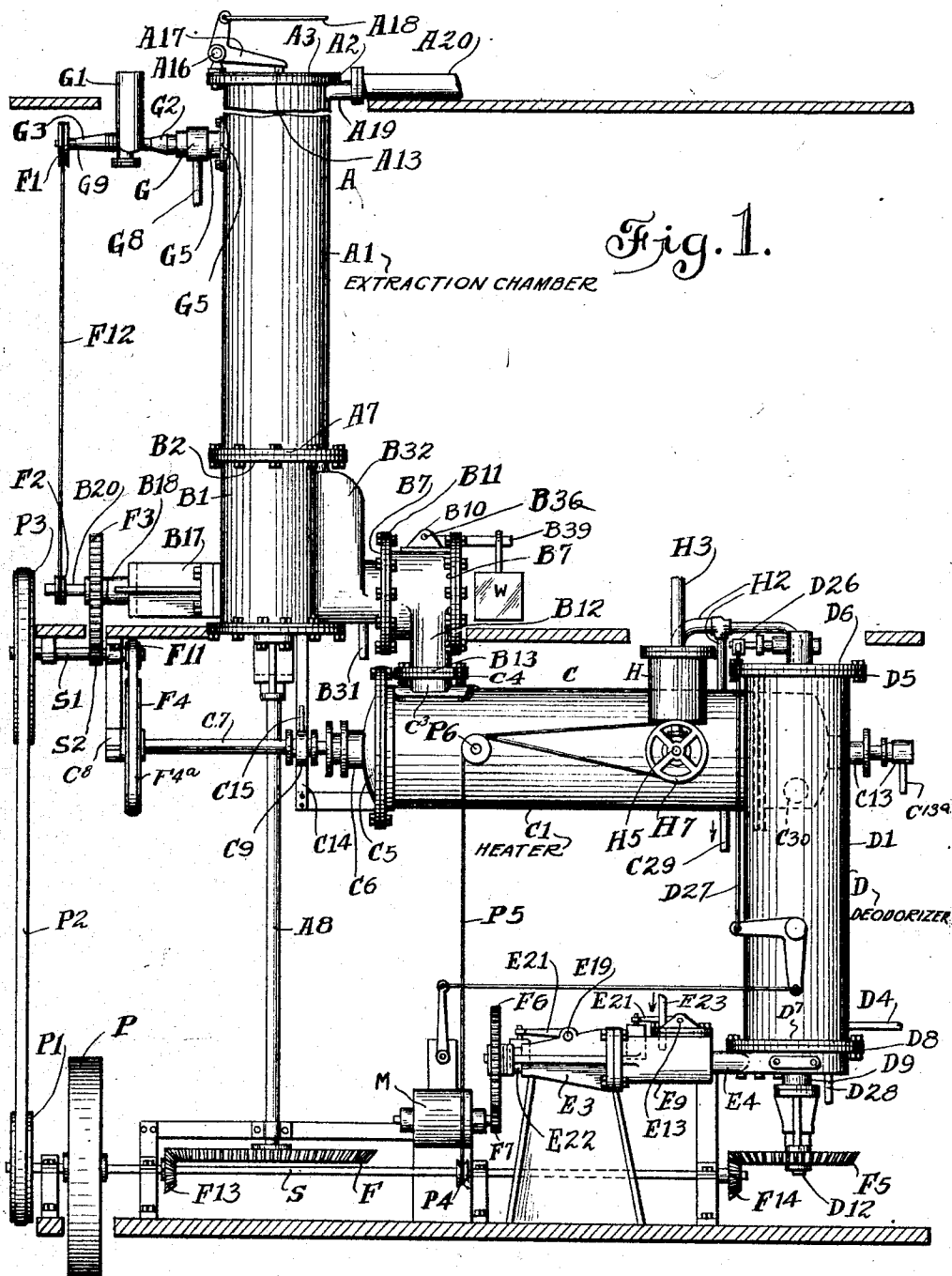


Fig. 1.

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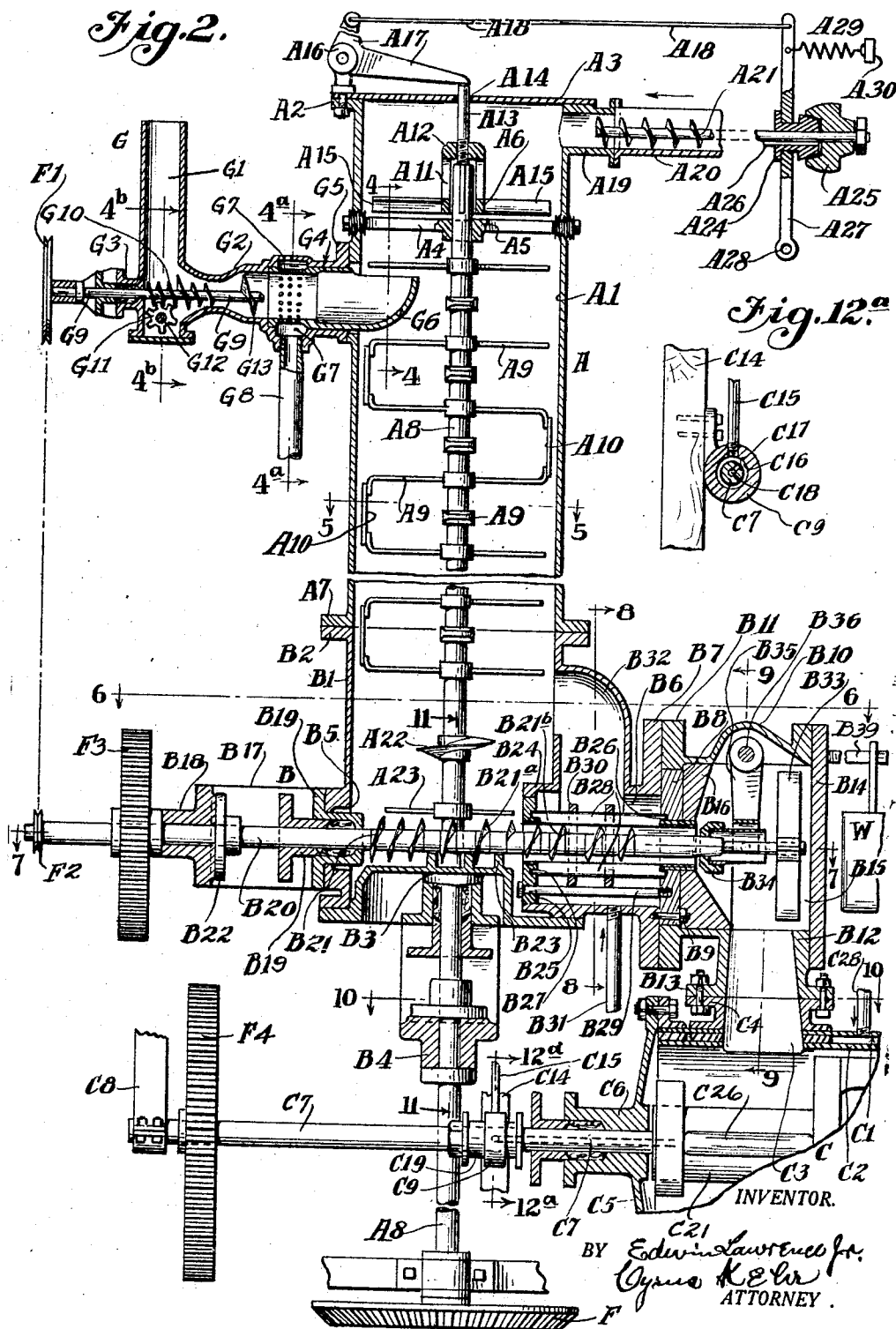
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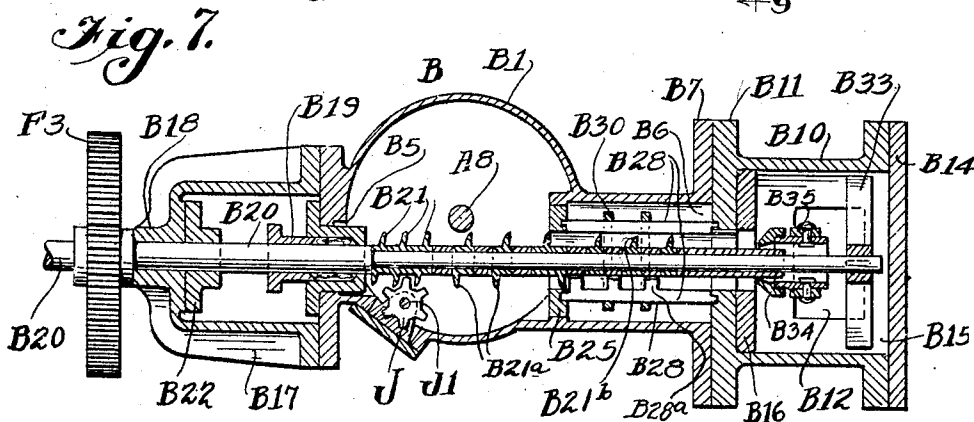
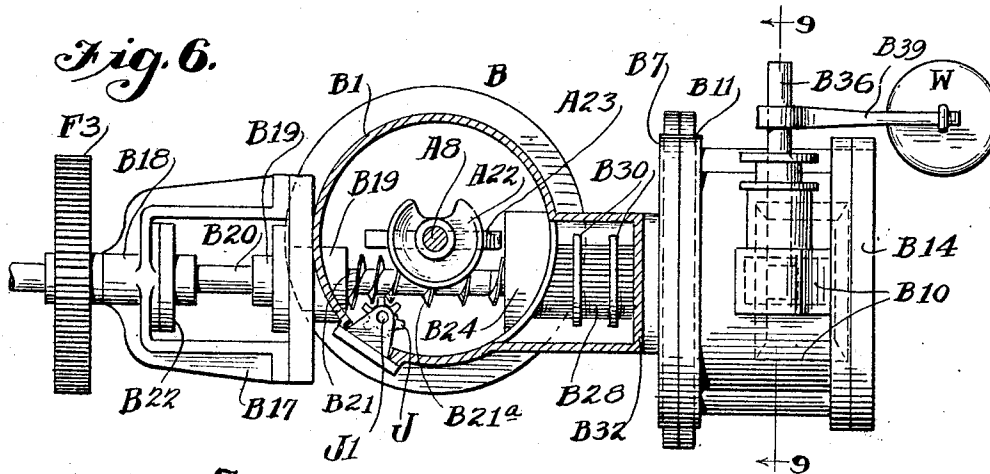
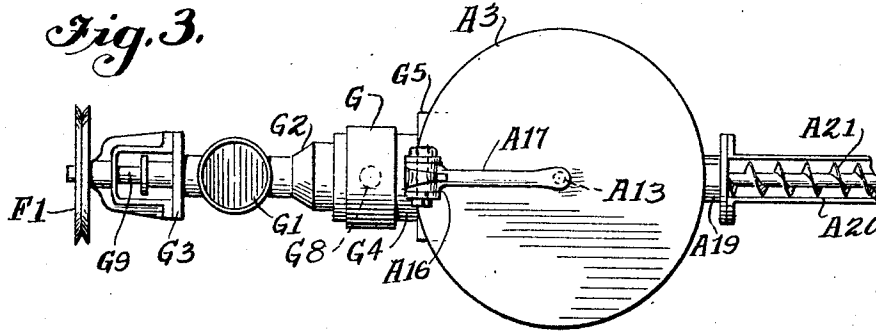
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APPARATUS AND METHOD OF EXTRACTING OIL FROM OLEAGINOUS MATERIAL

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9 Sheets-Sheet 3



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Fig. 4.

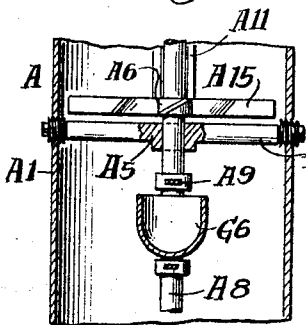


Fig. 4.^a

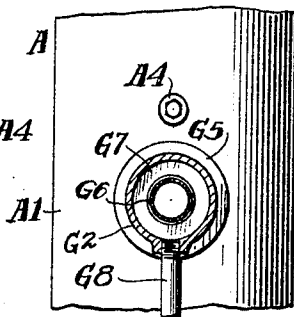


Fig. 4.^b

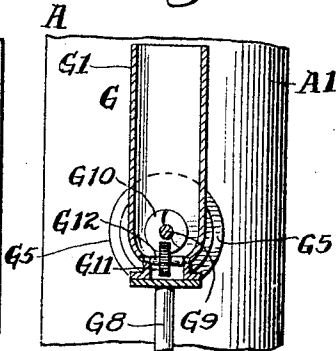


Fig. 5.

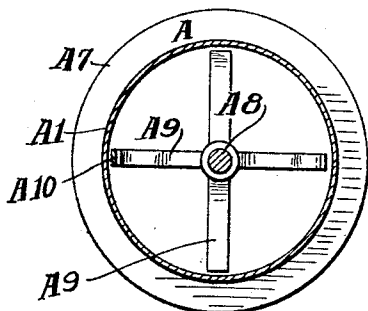
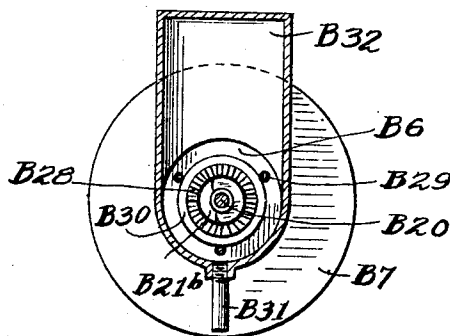


Fig. 8.



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Fig. 9.

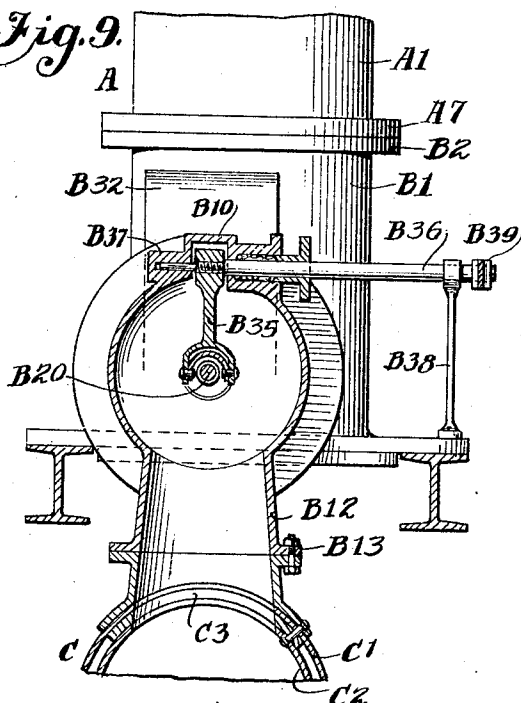


Fig. 11.

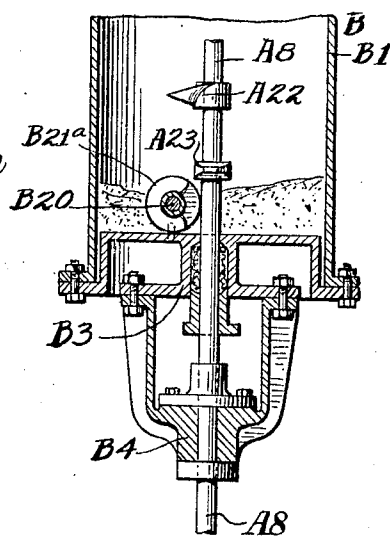
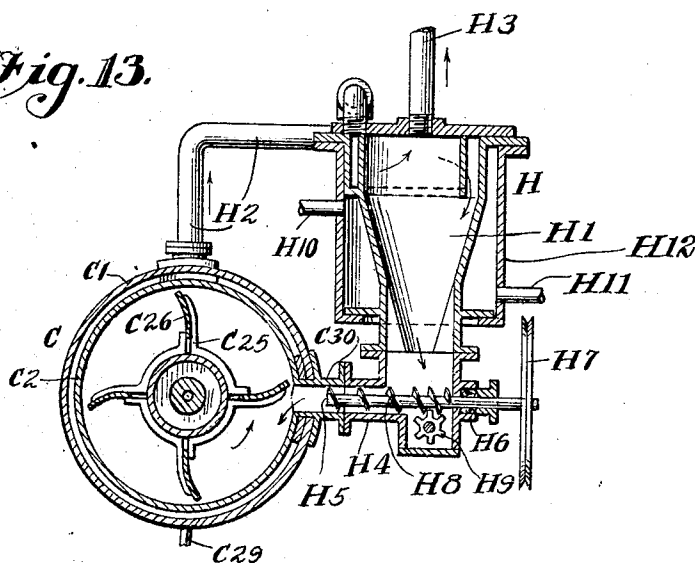


Fig. 13.



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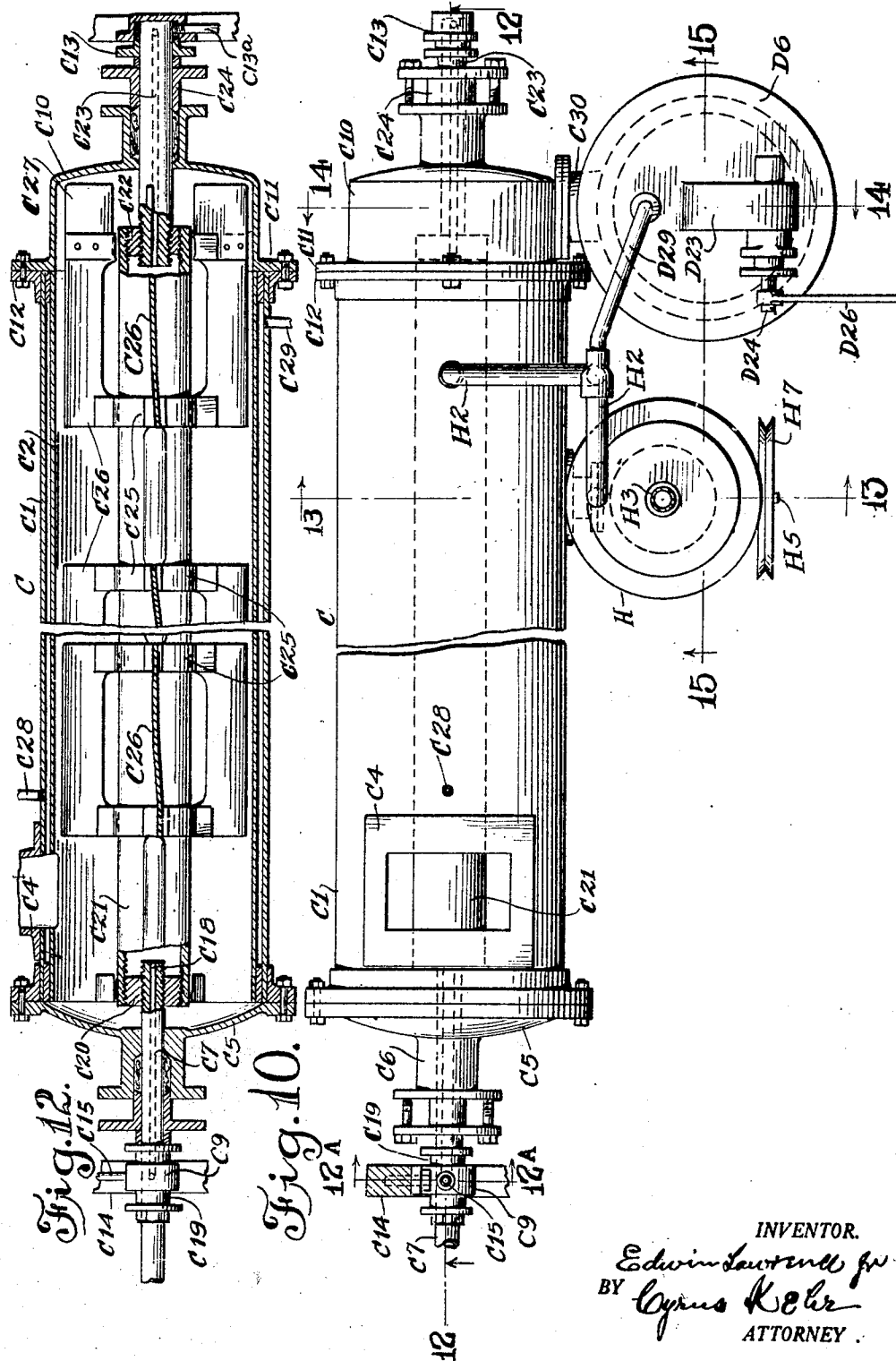
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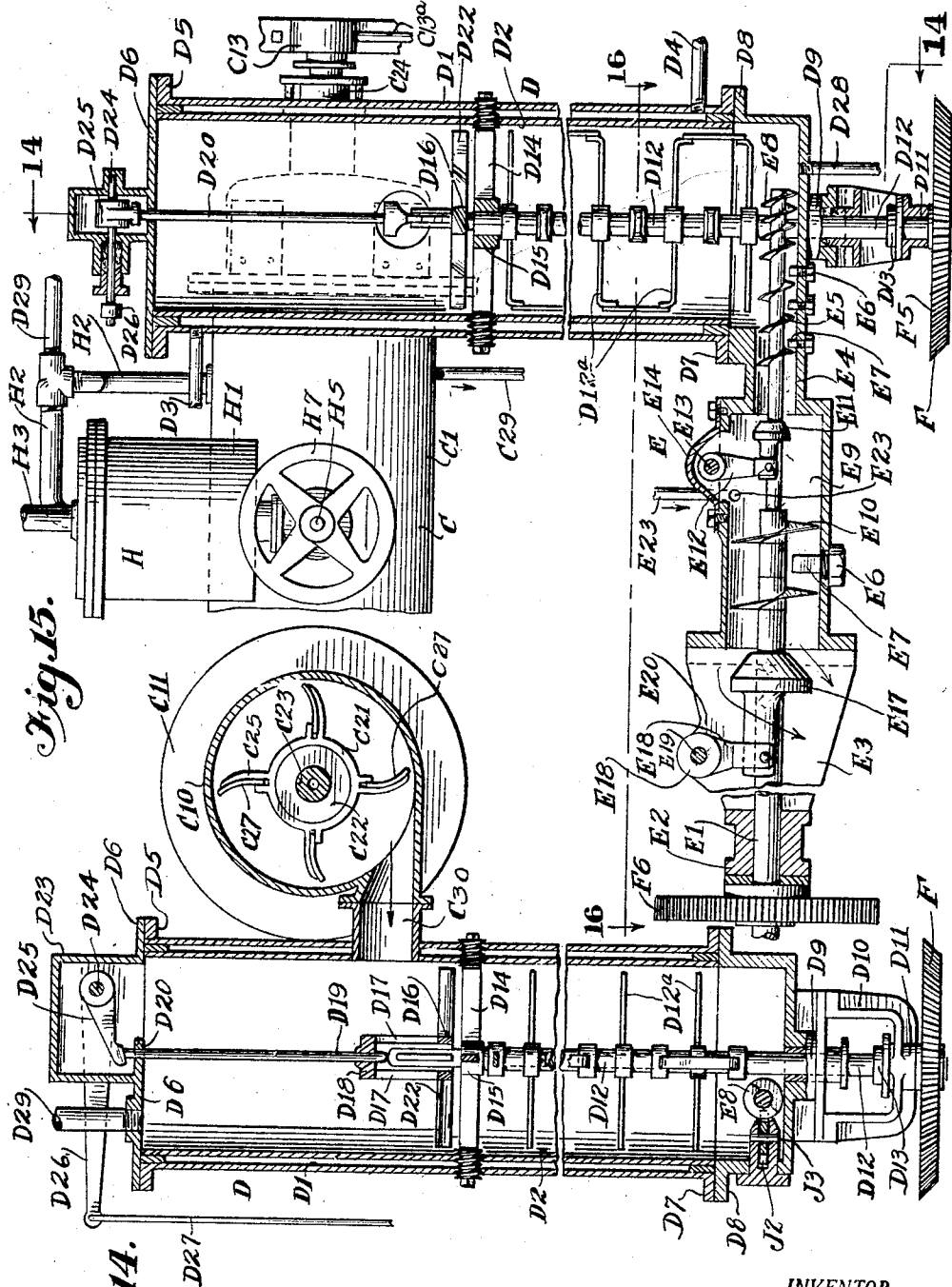
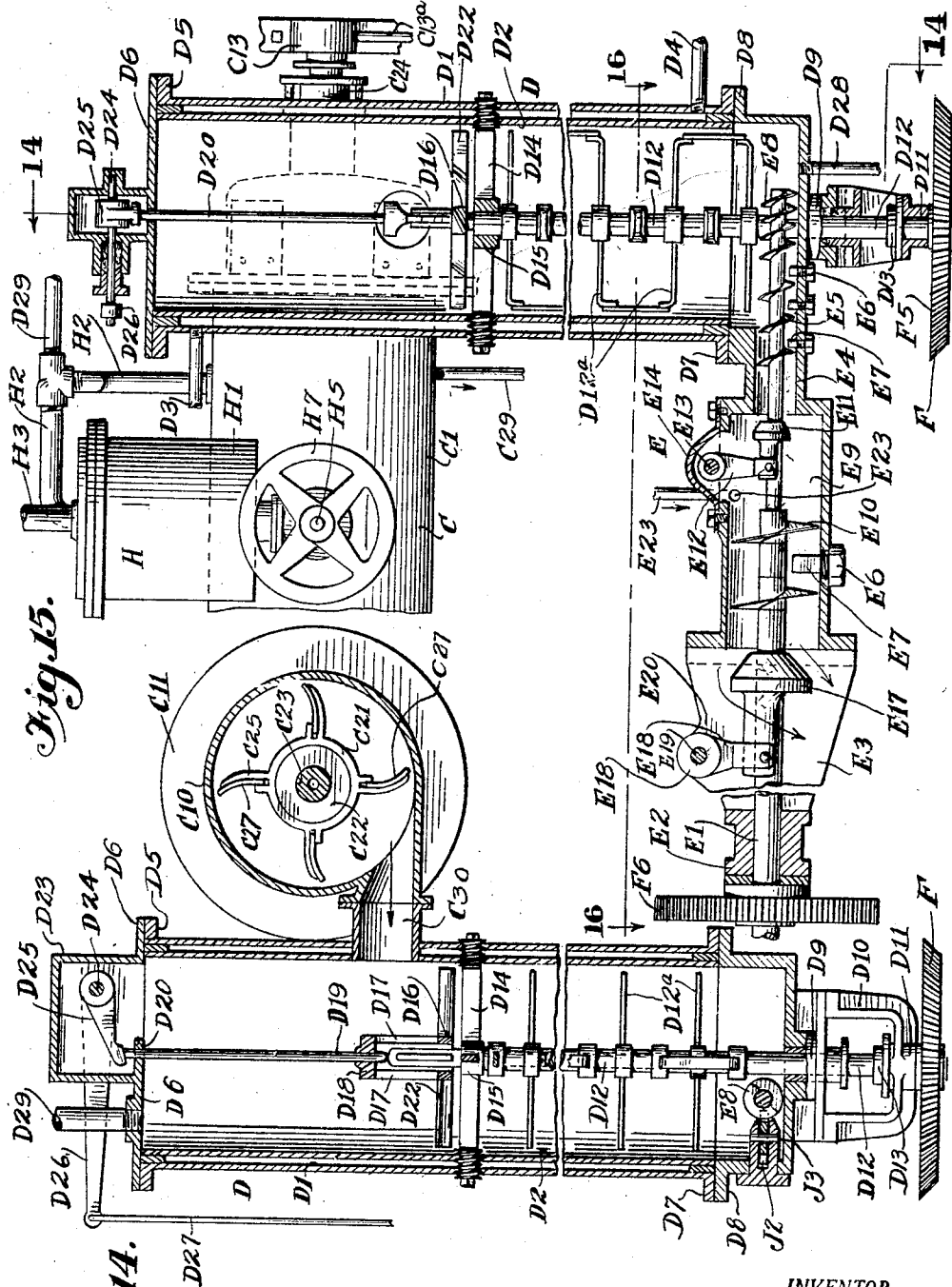
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APPARATUS AND METHOD OF EXTRACTING OIL FROM OLEAGINOUS MATERIAL

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9 Sheets-Sheet 7



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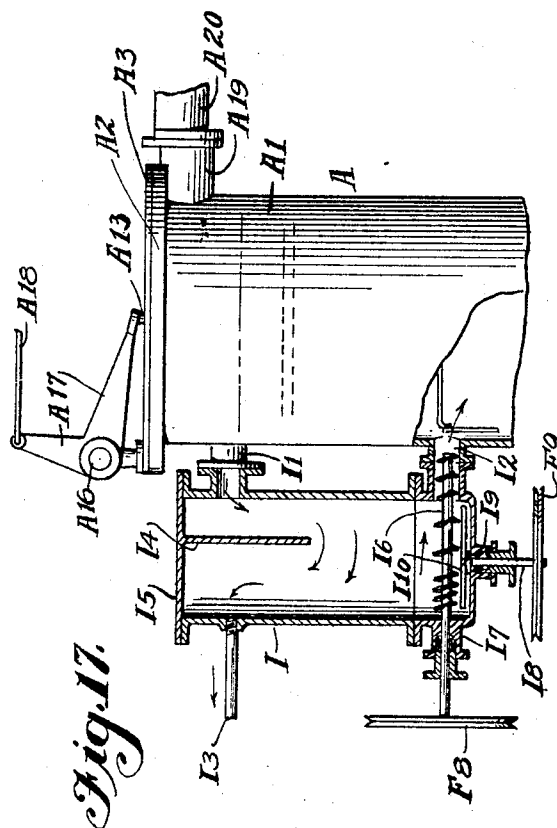
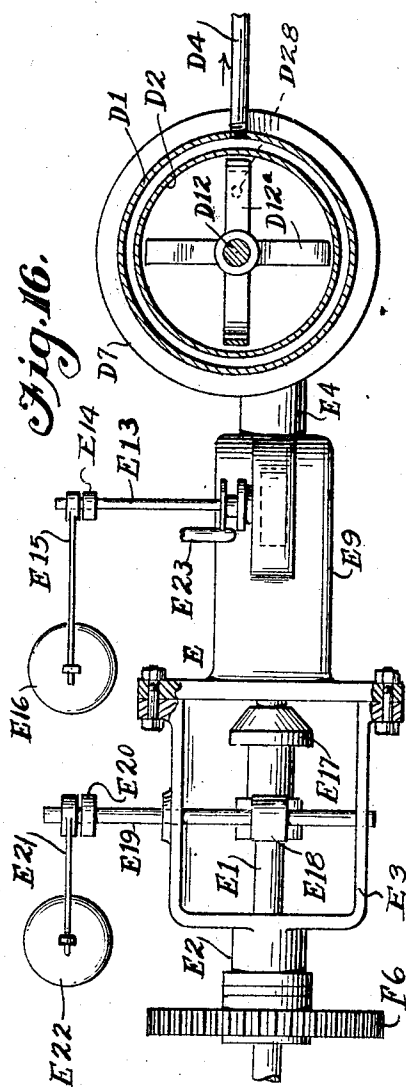
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APPARATUS AND METHOD OF EXTRACTING OIL FROM OLEAGINOUS MATERIAL

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9 Sheets-Sheet 8



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APPARATUS AND METHOD OF EXTRACTING OIL FROM OLEAGINOUS MATERIAL

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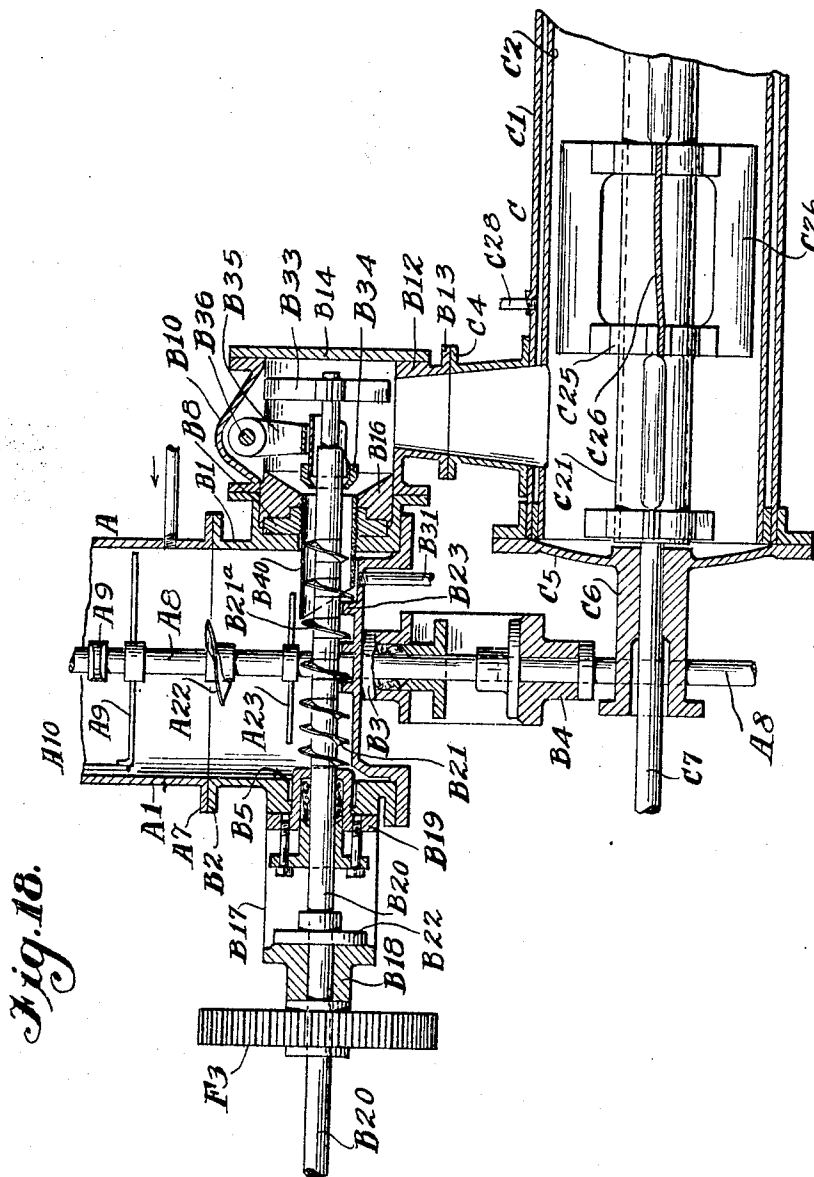


Fig. 18.

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UNITED STATES PATENT OFFICE

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APPARATUS AND METHOD OF EXTRACTING OIL FROM OLEAGINOUS MATERIAL

Application filed June 3, 1925. Serial No. 34,685.

My invention relates generally to the extraction of oil from oleaginous material and particularly to apparatus and methods for the extraction of oil from such materials by the use of solvents of such oil. In parts of the apparatus herein described, steam is used to aid the operation.

My invention is especially adapted for the treatment of cotton seed meal and the meals of other seeds for the extraction of oil from such meals.

The object of the invention is to produce an apparatus and method adapted to continuous and economical and complete operation for the extraction of oil and the recovery of the solvent used in the operation.

The solvent used in this work may be petroleum naphtha or other suitable volatile fluid which preferably is specifically lighter than the material from which the oil or fat is to be extracted. A solvent specifically lighter than the material from which extraction is to be effected is preferable, in order that there may be counter-flow of the solvent and material, the solvent being forced upward and the material going downward, by gravity, in the apparatus for removal from the apparatus.

Among the objects of the invention are providing an apparatus which is not costly for manufacture and which may be operated economically and safely relative to accidental igniting of inflammable solvents and the oils contained by the materials from which extraction is to be effected.

The operation of my apparatus is continuous and incremental and differs, in this respect, from extracting apparatus which operates intermittently on large batches or masses of material, such batches or masses being first mixed with the solvent and afterward heated or pressed in batch or bulk. Others have attempted incremental operation, but those cases lack important features of my invention.

In my apparatus, a stream of material moves substantially continuously through the apparatus and at places along its course receives treatment while so moving, the treatment being applied to limited quantities of

the material. The words, "substantially continuously", are used because provision is made in parts of the apparatus for automatically retarding or temporarily suspending movement of the material, this being for the purpose of maintaining uniformity of quantity in the flow or avoiding over-crowding of parts of the apparatus.

In its complete form, the apparatus includes an extractor, a heater, and a deodorizer. In the extractor, the material is intermingled with the solvent, and the solvent and the oil taken and carried by the solvent are conducted out of the extractor. The heater receives the material from the extractor. In the heater, the material is agitated and heated for the vaporizing of as much as may be of any remnant of solvent left in the material, and the resulting vapors are conducted away to a condenser. From the heater the material is delivered into the deodorizer and is there agitated or stirred and mingled with steam for the final elimination of any remnant of solvent. This is for the purpose of rendering the material suitable for feeding to live stock or to adapt it to be used as a food for people.

The term, "material", is used herein to designate crushed, ground or comminuted seeds or other material bearing oil or other oleaginous constituent to be extracted from the material.

In the accompanying drawings,

Fig. 1 is a sectional elevation illustrating an apparatus embodying my invention;

Fig. 2 is an upright section of the extractor and parts immediately associated therewith and a part of the heater;

Fig. 3 is a plan showing the upper part of the extractor;

Fig. 4 is an upright section on the line, 4-4 of Fig. 2, looking toward the right;

Fig. 4a is an upright section on the line, 4a-4a, of Fig. 2, looking toward the right;

Fig. 4b is an upright section on the line, 4b-4b, of Fig. 2, looking toward the right;

Fig. 5 is a horizontal section on the line, 5-5, of Fig. 2;

Fig. 6 is a horizontal section on the line, 6-6, of Fig. 2;

Fig. 7 is a horizontal section on the line, 7—7, of Fig. 2;

Fig. 8 is an upright transverse section on the line, 8—8, of Figs. 2 and 6, looking toward the right;

Fig. 9 is an upright transverse section on the line, 9—9, of Figs. 2 and 6, looking toward the left;

Fig. 10 is a horizontal section on the line, 10—10, of Fig. 2;

Fig. 11 is an upright section on the line, 11—11, of Fig. 2, looking toward the left;

Fig. 12 is an upright section on the line, 12—12, of Fig. 10;

Fig. 12a is an upright section on the line, 12a—12a, of Figs. 2 and 10, looking toward the right;

Fig. 13 is an upright transverse section on the line, 13—13, of Fig. 10, looking toward the right;

Fig. 14 is an upright transverse section on the line, 14—14, of Fig. 10, looking toward the left;

Fig. 15 is an upright section on the line, 15—15, of Fig. 10, omitting the cyclone separator;

Fig. 16 is a horizontal section on the line, 16—16, of Fig. 15;

Fig. 17 illustrates another mechanism, in upright section, for conducting oil and solvent from the upper part of the extractor;

Fig. 18 is an upright section illustrating another form of the transfer mechanism by means of which the material is transferred from the lower part of the extractor into the heater.

Referring to the drawings, A designates the extractor, B designates the mechanism for transferring the material from the extractor to the heater, C. D is the deodorizer. E designates the mechanism for delivering the material from the deodorizer.

A1 is the main part of the body of the extractor, A. The upper end of the part, A1, has an outward-directed flange, A2, on which rests the top plate, A3. In the upper part of the body is a spider, A4, comprising a central bearing, A5. The outer ends of the arms of the spider are suitably joined to the wall of the body. By this means, said bearing is immovably supported on the axial line of the extractor.

The lower end of this part of the extractor, A1, has an outward-directed flange, A7, which rests on a corresponding flange, B2, on the upper end of the casing, B1, for the transfer mechanism, B. In the floor of the casing, B1, is an upright bearing, B3, on the axial line of the extractor. A downward extension on the floor of the casing, B1, has a bearing, B4, in alignment with the bearings, B3 and A5. A shaft, A8, extends through the bearings, A5, B3 and B4, and is held against downward movement by a suitable thrust collar surrounding the shaft above and

below the bearing, B4. On the lower end of said shaft is a bevel gear wheel, F, which is driven by means to be described further on.

On the shaft, A8, are radial arms, A9, spaced from each other suitable distances. The alternate arms are in upright planes which are perpendicular to each other. The outer ends of a portion of the arms are connected by bars, A10. Immediately above the shaft, B20, two arms, A23, are fixed on the shaft, A8, and above those arms a spiral blade, A22, is fixed on the shaft, A8.

It is to be observed that the extractor may be of any desired height. Fig. 2 shows a portion broken out.

Immediately above the bearing, A5, a hub, A6, surrounds the shaft, A8, and is keyed thereto for up and down movement and to compel rotation on and with the shaft. Upright bars, A11, are supported rigidly on said hub and at their upper ends support immovably a cap, A12, into which is threaded or otherwise rigidly secured an upright stem, A13, which extends slidably through a bearing, A14, in the top plate, A3. On the hub, A6, are radial, slanting blades or arms, A15, which are similar to the blades of a wind wheel. The hub and the blades and the bars, A11, and the cap, A12, and the stem, A13, rotate in unison with the shaft, A8. On the top plate, A3, is a horizontal bearing, A16, which supports a bell crank, A17, having a horizontal arm resting on the upper end of the stem, A13. The other arm of the bell crank is upright and joined to a cord or wire, A18, which is connected with the cone clutch member, A24, on the shaft of the conveyor screw, A21, whereby material is delivered into the upper part of the extractor, as will now be described.

Near the top plate, a tubular, horizontal branch, A19, communicates with the interior of the extractor. To this branch is connected a horizontal or substantially horizontal conveyor trough, A20. In that trough is a conveyor screw, A21. Said trough leads from any source of supply of the material which is to be delivered into the extractor for treatment for the extraction of oil. Said trough may lead from an apparatus or mechanism for crushing or comminuting the seeds and also for heating and drying the seeds before or after crushing or comminuting. Such apparatus for preparing the material is not shown nor described, because such apparatus is known to this art and does not constitute a part of the present invention. The motor used for driving such preparation apparatus may also drive the conveyor screw, A21. The speed of that motor is to be controlled by the bell crank, A17, as will be described further on.

The cone clutch member, A24, is slidable endwise on the shaft of the conveyor screw. A longitudinal tongue, A26, on said shaft

compels the shaft to rotate with said clutch member. A loose pulley, A25, constituting a companion clutch member is held in position to be engaged by the clutch member, 5 A24, for transmitting motion from the pulley through the member, A24, to the shaft. A lever, A27, is fulcrumed at A28, and engages the clutch member, A24, for moving that clutch member into engagement with the pulley, A25. The upper end 10 of the lever, A27, is coupled to the cord or wire, A18. When the bell crank, A17, is tilted, that bell crank draws the cord or wire, A18, toward the upper part of the extraction chamber, whereby the clutch member, A24, is released from the pulley, A25, 15 whereby transmission from the pulley to the shaft is interrupted until the bell crank again resumes normal position after downward movement of the slanting blades, A15. A contracting spring, A29, is joined by one end to the lever, A27, and by the other end to a fixed support, A30. Said spring yieldingly acts to draw the lever, A27, and the clutch member, A24, toward the pulley. That 20 movement takes place whenever the bell crank returns to normal position.

A mechanism, G, is applied to the upper part of the upright wall of the extractor 25 to communicate with the extractor. This mechanism is to serve as an outlet for combined oil and solvent and has an inlet for filtering medium, as will be described further on. Said mechanism includes a T-form casting 30 comprising an upright arm, G1, and a horizontal arm, G2, directed toward the extractor, and a horizontal arm, G3, extending in the opposite direction. A part, G4, of the arm, G2, has a flange, G5, bearing 40 against and secured to the outer face of the adjacent part of the wall of the extractor. Opposite said flange the wall of the extractor is cut away. A tubular member, G6, telescopes into the part, G4, and is fixed therein 45 and extends into the extractor. The lower wall of the member, G6, is curved upward within the extractor far enough to bring the mouth of said member into a horizontal plane. A little way above the level of said 50 mouth are two arms, A9, adapted to sweep across said mouth and stroke or wipe horizontally filtering medium passing inward through the arm, G2, and issuing upward from said mouth. At the left hand end of 55 the member, G6, the wall of the part, G4, is extended outward to form an annular space, G7, between said part and the member, G6. Along said channel or space, the member, G6, is perforated to form a screened by-pass out 60 of the range of the main passage. The by-pass passage being for the passing of oil and solvent going from the extractor into the discharge pipe, G8, which is tapped into the wall of the part, G4. (Fig. 4a.) A 65 shaft, G9, extends horizontally through the

arm, G3, and into the arm, G2. At the arm, G3, said shaft is surrounded by a suitable packing or gland which is to prevent the outward passing of liquid. Within the structure, G, said shaft is surrounded by 70 spiral conveyor flanges, G10, and G13, which are adapted to crowd filtering medium from the interior of the upright arm, G1, through the arm, G2, and the inner member, G6. Below the shaft, G9, is a star 75 wheel, G11, mounted on a horizontal shaft, G12, seated in the upright walls of the upright arm, G1. (Fig. 4b). The arms of said wheel reach between the adjacent spiral flanges, G10, and prevent filtering medium 80 from adhering between said flanges and rotating with said shaft, the wheel being rotated by the flanges.

On the outer or left hand end of the shaft, G9, is fixed a pulley, F1. 85

In the left hand wall of the casing for the mechanism, B, is an opening, B5. At the right of said casing is a similar, but larger opening, B6, around which is a circumferential, upright flange, B7. Extending across 90 said opening and reaching over a part of said flange is a head plate, B8, which is secured to the flange, B7, by means of stud-bolts, B9. At the right of the flange, B7, is a horizontal 95 casing, B10, which has an upright, annular flange, B11, surrounding the head plate, B8, and bearing against the flange, B7, and secured thereto by bolts or screws not shown. The casing, B10, has a tubular downward extension, B12, at the lower end of which is a 100 horizontal annular flange, B13. At the right, the casing has a large opening, B15, over which is placed a removable upright plate, B14. The head plate, B8, is centrally apertured. At the right of said plate and lying 105 against it is a filling member, B16, which is apertured the same as the head plate, B8.

A bracket, B17, extends leftward from the opening, B5, and its outer part is extended 110 leftward to form a bearing, B18. A stuffing box, B19, with a gland is seated over and in the opening, B5. A shaft, B20, rests in the bearing, B18, and in the gland, B19. Said bearing and said gland and the aperture in the head plate, B8, are on a horizontal line which 115 is a little forward of the shaft, A8,—far enough to make room between the two shafts for the spiral flanges on that shaft. A thrust collar, B22, extends around and is fixed to the shaft, B20, and bears against the bearing, B18, to hold said shaft against leftward 120 movement. At the left of the bearing, B18, a spur gear wheel, F3, surrounds and is fixed to the shaft, B20, and its hub bears against said bearing and serves to prevent rightward 125 movement of said shaft. At the left of the wheel, F3, a small pulley, F2, surrounds and is fixed to said shaft.

Within the lower part of the extractor, the shaft, B20, is surrounded by flanges or spiral 130

blades fixed on said shaft for rotation therewith. Beginning at the left there is first the continuous spiral blade, B21, making approximately three turns around the shaft. Next there are two separate blades, B21a, each making about three-fourths of a turn and separated from each other to leave clear space entirely around the shaft. Next there is a group of such blades, B21b, surrounding said shaft in the press structure to be described further on. These blades also make only about three-fourths of a turn on the shaft, and they are separated to leave between them parts of the shaft entirely clear.

A star wheel, J, is supported by a bearing, J1, on the wall, B1, in position to cause one arm of the wheel to reach between two of the turns of the flange or blade, B21. (See Figs. 6 and 7.) With the rotation of the shaft, B20, the flange, B21, acts screw-fashion on the arms of the star wheel and turns said wheel. The function of said star wheel is to prevent packing of material between the turns of the flange, B21, said wheel preventing rotating of material on the shaft past the plane of the wheel. It may be said that the wheel acts in this respect like a rotary scraper. Thus forward movement (movement toward the right) of the material is insured. The bottom cover of the transfer mechanism casing reaches almost to the flanges, B21 and B21a. On said bottom, near the shaft, A8, are three upward-directed lugs, B23, which reach almost to the shaft, B20, at clear spaces on said shaft. The function of said lugs is to avoid the packing of material between the flanges, B21, and rotating with the shaft, B20, and not being driven forward (toward the right) by the flanges, B21a, as will be more fully described further on.

What I term the press structure will now be described.

From the upright wall, B1, of the transfer mechanism casing, a short tube or sleeve, B24, extends horizontally toward the left on the axial line of the shaft, B20. A ring, B25, is fitted into the sleeve, B24. The head plate, B8, has on its inner face and near the aperture in said plate an annular channel, B26. The ring, B25, has on its right hand face a similar channel, B27. Bars or staves, B28, have their ends seated in said channels and are spaced from each other to make a grating or screen or curb which will permit the passing of liquids but substantially prevent the passing of solid material. The ring, B25, is joined to the head plate, B8, by means of three bolts, B29. Thus the head plate, B8, and the ring, B25, and said bars are made to constitute a straining or press structure which may be removed when the plate, B14, the arm, B35, and filling member, B16, and the nuts of the stud bolts, B9, have been removed. The spiral flanges, B21b, are in the space enclosed by the group of bars, B28. Lugs,

B28a (Fig. 7), extend from one or more of the bars, B28, toward the shaft, B20, and between the adjacent spiral flanges, B21b, said flanges, as above stated, extending only partially around the shaft, B20, in order that space may be left for said lugs. The function of said lugs is to avoid the packing of material between said flanges. Rings, B30, surround the bars, B28, to prevent outward bending of the bars.

The cylindrical group of bars, B28, is surrounded by a space, the cylindrical tube formed by the walls of the casing, B1, being of larger diameter than the diameter of the group of bars. An inlet pipe, B31, is tapped into said wall below said group of bars. Said bars and the shaft, B20, with its spiral flanges, B21b, form a press wherein the material is compressed while being moved out of the extractor into the heater, C. This compression and two others to be described effect the elimination of the greater part of the solvent and any remaining non-extracted oil from the material.

Above said group of bars is a by-pass, B32, forming communication between the compartment occupied by the press structure and the lower part of the extractor. The function of that passage will be described further on.

The shaft, B20, is extended rightward into the chamber formed by the casing, B10, and reaches almost to the removable plate, B14. Adjacent said wall or plate, agitator wings, B33, are fixed on said shaft. A valve body, B34, surrounds said shaft in position to cover or partially cover the outlet around said shaft through the head plate, B8, and the filling body, B16. Said valve body is coupled to a forked arm, B35, which is hung for oscillation on a rock shaft, B36, which rests in bearings, B37 (Fig. 9). One of said bearings is on a support or standard, B38, located outside of the casing, B10. A horizontal arm, B39, is fixed on the outer end of said shaft and supports a weight, W. The arm, B39, is directed toward the right, so that the weight, W, tends to move the arm, B35, toward the left and press the valve body, B34, toward the passage leading from the casing, B10.

Turning now to the heater, C, C1 is an outer horizontal cylindrical metal shell. C2 is an inner cylindrical metal shell spaced from the shell, C1, to leave a steam space between said shells. The left hand end of the heater is placed under the casing, B10, and a branch, C3, communicating with the interior of the heater rises to meet the flange, B13, of the casing, B10. Said branch has a flange, C4, which bears against the flange, B13, and is secured thereto by suitable bolts. On the left hand end of the heater is a head, C5, secured by suitable bolts. On the axial line of the heater said head has a bearing, C6, in which rests the horizontal shaft, C7. Said

bearing is provided with a packing gland. Near its outer end said shaft extends through a bearing, C8; and at the right of said bearing a pulley, F4, surrounds and is fixed on said shaft.

5 On the right hand end of the heater is a cylindrical head, C10, having a circumferential flange, C11, bearing against a corresponding flange, C12, on the body of the heater, the two flanges being suitably secured
10 to each other, as by means of bolts. On the axial line of the heater, the head, C10, has a bearing, C13, provided with a packing gland, C24.

15 At the left of the bearing, C6, a sleeve, C9, surrounds the shaft, C7. Said sleeve is suitably secured to an upright member, C14, to prevent rotation of the sleeve. A steam delivery pipe, C15, is tapped into the upper
20 part of said sleeve to communicate with an annular channel, C16, formed along the inner face of said sleeve. In the plane of said channel and said pipe, the shaft is provided with a port, C17, which communicates with an axial
25 bore, C18, leading from said port rightward through the shaft, C7. A packing gland, C19, surrounds the shaft and enters each end of the sleeve, C9, to prevent the escape of steam from the sleeve excepting through the
30 port, C17.

The right hand end of the shaft, C7, extends through a head, C20, which is fitted into a drum, C21, of relatively small diameter extending rightward nearly to the right hand
35 end of the heater. Into the right hand end of said drum is fitted a head, C22, into which is fitted a short shaft, C23, which is bored from end to end and which extends through the bearing, C13, and the gland, C24. The outer
40 end of said shaft communicates with a discharge pipe, C13a, which leads to a steam trap or similar device (not shown) for preventing escape of steam through said pipe and permitting the passing of condensation water.

45 At intervals, arms C25, are placed radially on the drum, C21. Agitating or stirring tumbling blades, C26, are placed slightly diagonally to the drum and attached to said arms in position to nearly reach the inner
50 face of the inner heater shell, C2. (Figs. 12 and 13.) Adjacent the head, C10, short auxiliary blades, C27, are secured to the adjacent arms, C25.

Near the right hand end of the heater is a
55 separating structure, H, which includes a cyclone separator, H1, of well-known form adapted to discharge solid material downward and discharge vapor or gases upward. (Fig. 13.) A pipe, H2, leads from the interior of the heater upward and then horizontally into the upper part of the separating
60 structure for communication with the cyclone. A pipe, H3, leads from the upper part of the cyclone, H1, to carry vapor or
65 water and solvent in vapor form to a con-

denser for the separation of solvent from the water. From the lower end of the separating structure, a tubular duct, H4, leads into the adjacent side of the heater. A feed shaft, H5, is placed into said duct, the shaft
70 resting in a bearing, H6. On said shaft are spiral blades, H8, similar to the blades, on the shaft, B20, already described. On said shaft is a pulley, H7, to be rotated for turning said shaft. Particles of material falling
75 from the cyclone, H1, are driven forward by the feed shaft back into the heater. A star wheel, H9, like the star wheel, J, is applied to the spiral blades, H8. The shaft, H5, does not reach to the discharge end of the duct, H4. Thus there is left a space in which material
80 accumulates to form a plug which prevents the passing of air or vapor. To maintain in the interior of the separator a sufficiently high temperature to prevent condensation of steam and vaporized solvent, an outer wall, H12, forms a space into which
85 hot steam is to be delivered through an inlet pipe, H10, and that steam, or a condensation thereof, withdrawn through a pipe, H11, leading from said wall. Thus a steam jacket
90 is formed for maintaining heat in the interior of the separator.

Near the left hand end of the heater, a pipe, C28, is tapped into the upper part of
95 the outer heater shell, C1, for the delivery of steam into the space between that shell and the shell, C2. Near the right hand end of the heater a pipe, C29, is tapped into the lower part of the outer heater shell, C1, for
100 the egress of steam condensation. This pipe is to communicate with a suitable trap for preventing the escape of steam.

The deodorizer, D, is placed upright adjacent the right hand or discharge end of the heater to receive the heated material from the heater. The deodorizer has an upright
105 outer cylindrical shell, D1, and an inner cylindrical shell, D2, spaced from the outer shell a sufficient distance to form a steam space between the two shells. A steam inlet pipe, D3, is tapped into the upper part of the outer shell; and a steam condensation outlet pipe, D4, is tapped into the lower part of said shell
110 and leads to a steam trap not shown. A passage, C30, leads from the lower part of the heater, C, into the deodorizer for the delivery of material from the heater by the action of the auxiliary blades, C27, into the deodorizer. On the upper end of the deodorizer is an outward-directed, horizontal
120 flange, D5, on which rests a head, D6. At the lower end of the deodorizer is an outward-directed, horizontal flange, D7, against the lower face of which flange rests a flange, D8, formed on the body of the discharge structure, E. On the bottom wall of said structure is a bearing, D9, and below said bearing is a bracket, D10, on which is a bearing, D11. An upright shaft, D12, extends
130

through the bearings, D11 and D9, and to about the height of the passage, C30, from the heater. Above the bearing, D11, a thrust collar, D13, surrounds and is fixed to said shaft to prevent downward movement of said shaft. Below said bearing is a bevel gear wheel, F5, which has a hub resting against the bearing, D11, and serving to prevent upward movement of the shaft, D12. Within the deodorizer, the shaft, D12, has any desired number of radial arms, D12a, adapted to stir material in the deodorizer during rotation of the shaft.

Below the passage, C30, a spider, D14, is supported by the inner shell, D2, and supports a bearing, D15, through which the shaft, D12, extends. Immediately above the bearing, D15, a hub, D16, surrounds and is keyed to the shaft, D12, so as to be controlled for up and down movement and to compel rotation on and with the shaft. Two upright bars, D17, are supported rigidly on said hub and at their upper ends support immovably a cap, D18, into which is threaded or otherwise rigidly secured an upright stem, D19, which extends slidably through a bearing, D20, in the top plate or head, D6. On the hub, D16, are radial, slanting blades or arms, D22, which are similar to the blades of a wind wheel. The hub and the blades and the bars, D17, and the cap, D18, and the stem, D19, rotate in unison with the shaft, D12. On the top plate, D6, is a housing, D23, in which is a horizontal rock shaft, D24, resting in bearings in said housing. Within said housing, an arm, D25, is fixed on said shaft and has its free end bearing on the upper end of the stem, D12. One end of said shaft projects through said housing and supports a horizontal arm, D26. Said two arms extend in the same direction, so that force applied to the arm, D26, to bear it downward causes the arm, D25, to bear downward on the stem, D19. A cord or chain, D27, leads from the arm, D26, downward to a variable speed motor to be described further on.

Adjacent the shaft, D12, a steam delivery pipe, D28, is tapped into the lower wall of the discharge structure, E. A pipe, D29, is tapped into the top plate, D21, and connects with the pipe, H2, leading into the cyclone as already described. Thus vapors and particles of solid material carried by said vapors pass from the upper end of the deodorizer into the cyclone.

The discharge structure, E, is horizontal. Its function is to discharge the material from the lower end of the deodorizer without permitting air to enter from outside and without permitting the escape of steam or vaporized solvent or any other constituent in the form of a vapor or gas. A horizontal shaft, E1, is on an axial line which is a little forward of the upright deodorizer shaft, D12. The outer or left hand end of said shaft rests in a

bearing, E2, which is at the outer end of a yoke, E3. Adjacent the upright shaft, D12, the shaft, E1, is surrounded by a continuous spiral blade, E8, to which is applied a star wheel, J2, supported in a bearing, J3, (Fig. 14) and operating like the star wheel, J, (Fig. 6). At the lower portion of the body of the deodorizer, the discharge structure has a throat, E4. At the entrance to said throat said shaft is surrounded by spiral blades, E5. Those blades make only a fractional turn and are separated or interrupted to clear the blades, E7, supported on bolts, E6, seated in the adjacent wall of the discharge structure. The functions of those blades and the star wheel, J2, are the same as the functions of the star wheel, J, and the lugs, B23. (Figs. 2 and 6). At the left of the throat, E4, is a larger cylindrical chamber, E9. In said chamber two fractional spiral blades, E10, surround the shaft, E1. Said blades are separated sufficiently to make room for a blade, E7, supported on a bolt, E6, threaded into the wall of said chamber. Immediately at the left of the throat, E4, a valve, E11, slidably surrounds the shaft, E1, and is adapted to bear rightward toward and over the discharge end of said throat to resist material moving through the throat into the chamber, E9. Said valve is controlled by an oscillating arm, E12, supported on a rock shaft, E13, which has bearings in the walls of the chamber, E9, and in a standard, E14. On the outer end of the shaft, E13, is an arm, E15, on which is a weight, E16, which tends to turn the shaft, E13, in the proper direction to press the valve, E11, toward the throat, E4. At the discharge end of the chamber, E9, the shaft, E1, is surrounded by a similar valve, E17, which is adapted to bear against material issuing from said chamber. Said valve is controlled by an oscillating arm, E18, which is supported on a rock shaft, E19, which has bearings in the yoke, E3, and in the support, E20. A horizontal arm, E21, is fixed on the outer end of the shaft, E19, and supports a weight, E22, which tends to draw the arm, E21, downward and turn the rock shaft in the proper direction to press the valve, E17, toward the chamber, E9. The valve, E17, and the arm, E18, are in the open, because the discharge end of the chamber, E9, communicates directly with the atmosphere. But the valve, E11, and the arm, E12, are enclosed by the chamber, E9, because that chamber into which the throat, E4, discharges is isolated from the atmosphere.

A steam delivery pipe, E23, is tapped into the wall of the chamber, E9, for the delivery of steam into said chamber for a purpose to be described further on. At the left of the bearing, E2, a spur gear wheel, F6, surrounds and is keyed to the shaft, E1, and meshes with a smaller spur gear wheel, F7, on the shaft of a motor, M. (See Fig. 1.)

Referring now to the alternate form illustrated by Fig. 17, I is an upright cylindrical chamber communicating with the upper part of the extractor, A1, through an upper connecting pipe, I1, and a lower pipe or passage, I2. At the upper part of said chamber is an outlet pipe, I3, for the discharge of oil and solvent from said chamber. Between the pipes, I1 and I3, is a baffle plate, I4, extending downward from the top plate, I5, of the chamber, I. A screw conveyor shaft, I6, extends through a bearing, I7, and into the passage, I2. On the outer end of said shaft is a pulley, F8, which is to be driven from any source of power. On the axial line of the chamber, I, and in the lower wall of said chamber is an upright bearing, I9, in which is an upright shaft, I8, which extends into the space between said lower wall and the conveyor shaft, I6, and there supports radial agitating or stirring blades, I10. On the lower end of said shaft is a pulley, F9, which receives power from any source. Oil and solvent move outward from the extractor through the pipe or passage, I1, into the chamber, I, and pass thence downward around the baffle plate and outward through the discharge pipe, I3. Particles of material carried with the oil and solvent are deposited by gravity into the lower part of said chamber and conveyed thence by the conveyor shaft, I6, through the passage, I2, back into the extractor.

The alternate form illustrated by Fig. 18, of the drawings differs from the structure shown by the lower part of Fig. 2, only in the omission of the by-pass, B32. The cylindrical press formed by the bars, B28, and associated parts being changed to a tubular perforated body, B40, seated in the wall of the casing, B1, and in the plate, B8, and the filling member, B16, the conveyor shaft, B20, extending through said perforated tubular member.

A main drive pulley, P, is used for transmitting power to several parts of the mechanism as will now be described. Said pulley surrounds and is fixed on a main horizontal shaft, S, resting in bearings supported from the main or ground floor. On said shaft is a pulley, P1. A belt, P2, is applied to the pulley, P1, and to the pulley, P3, which surrounds and is fixed on the horizontal shaft, S1, which bears a small spur gear wheel, S2, which meshes with the larger spur gear wheel, F3, which is mounted on the shaft, B20, as already described. On the shaft, S1, is a pulley, F11, which drives the pulley, F4, on the shaft, C7, of the heater, as above described, by means of a belt, F4a. As already described, a small pulley, F2, is fixed on the shaft, B20, and another pulley, F1, is fixed on the shaft, G9. A belt, F12, is applied to said two pulleys for transmitting motion from the shaft, B20, to the shaft, G9. On

the main shaft, S, is fixed a bevel gear wheel, F13, which meshes with the bevel gear wheel, F, which is fixed on the lower end of the shaft, A8, which, as already described, extends upward through the extractor. On the main shaft, S, is also fixed a small pulley, P4, to which is applied a belt, P5, which extends over a guide pulley, P6, and is applied to the pulley, H7, which is on the conveyor shaft, H5, of the separating structure, H, which, as already described, communicates with the heater and with the deodorizer. On the right hand end of the main shaft, S, is a small bevel gear wheel, F14, which meshes with the bevel gear wheel, F5, which has already been described as being fixed on the lower end of the shaft, D12, which extends upward through the deodorizer.

The transmission of motion from the main drive pulley, P, to the shafts, G9, B20, C7, A8, H5 and D12, may now readily be traced.

The manner of transmitting motion to the conveyor shaft, A21, and the discharge shaft, E1, has already been described, the speed of the shaft, A21, being controlled by the height of material in the extractor and the speed of the shaft, E1, being controlled by the height of material in the deodorizer.

It is to be noted that my apparatus includes two conveying mechanisms for feeding the material forward and that each of those mechanisms has associated with it, a speed regulating mechanism which is dependent upon the quantity of material in the adjacent portion of the stream of material.

In addition to this regulation of velocity of conveying mechanisms, there are three yielding pressed valves for resisting the movement of the stream of material for the purpose of forming sealing plugs.

The operation is as follows:—

Liquid solvent is introduced under pressure into the extractor through the pipe, B31, the solvent flowing around and through the press formed by the bars, B28, and associated parts and through the by-pass, B32, until the extractor is filled with the solvent to the height of the mouth of the member, G6.

The oleaginous material is delivered along the trough, A20, by the conveyor screw, A21, through the neck or branch, A19, into the upper part of the extractor. There the material moves downward by gravity through the liquid solvent which rises as high as the mouth of the member, G6. The conveyor screw, A21, is formed to drive the material into the branch or neck, A19, to form in said branch a plug of sufficient density to prevent the admission of air into the extractor and to prevent the outward passing of vapors or liquids. The material accumulates in the lower part of the extractor and then masses higher and higher until it reaches the blades, A15, of the regulating mechanism whereby the velocity of the conveyor screw,

A21, is controlled, as already described, the object being to limit the height of the material in the extractor to approximately the height of the blades, A15, when they are in their lower or normal position.

This mass of material in the extractor (the extractor being higher than shown in the drawing—the drawing showing a part broken away) causes considerable downward pressure upon the material in the lower end of the extractor. This is aided by the action of the spiral blade, A22, on the shaft, A8. Thus we have one stage of compression of the material; and that pressure co-operates with the spiral conveyor blades, B21, which are on the horizontal shaft, B20, and adjacent the upright shaft, A8, to drive the material toward said press. Thus a second stage of compression of the material is effected. Within said press, the press blades drive the material forward through the space enclosed by the bars, B28, against the frictional resistance of said bars and against the resistance of the valve, B34. The weight, W, is to be adjusted on the horizontal arm, B39, to adjust the resistance of said valve to condense the material in front of the valve sufficiently to attain the desired density of the material immediately in front of the valve to make such resistance to forward movement as will cause the compression of the material in the press sufficiently to expel from the material and through the space between the bars, B28, the greater part of the solvent and any remaining non-extracted oil. The solvent and any oil as expelled from the press, pass upward through the by-pass, B32, into the slowly upward moving body of solvent in the extractor. Some of the solvent and any remaining unextracted oil are expelled from the material by the first and second compressions before the press is reached, and flow upward into the upper part of the extractor. The spiral blades, B21 and B21a, are made of larger capacity than the blades, B21b, in the press, in order that there may be a crowding or pressing or condensing of the material before the material enters the press. Such pressing or condensing serves to expel some of the solvent and any remaining unextracted oil from the material and prevents the accumulation of sloppy material which the screws could not grip or hold and force forward, around the entrance to the press. Or, otherwise stated, the press screws, B21a, will not grip and force forward a liquid mass, hence it is absolutely necessary to have the first and second compressions prior to the final pressing, in order that a less moist material may be produced for screws, B21a and B21b to handle efficiently.

As already described, the original solvent is introduced under pressure through the pipe, B31, into the space surrounding the press, so that the flow of the solvent is around the press. This flow tends to carry away from

the press any particles of material which pass outward between the bars, B28, from the interior of the press. Thus accumulation of such particles sufficient to clog the apparatus is avoided. The plug of material formed by the packing in front of the valve, B34, prevents the escape of solvent through the end of the press at which the valve is located.

While the material is moving downward after delivery into the extractor from the trough, A20, into the body of liquid solvent, the shaft, A8, is constantly rotated, whereby the arms, A9, on said shaft constantly stir the material and the solvent, whereby the solvent is intimately mingled with all parts of the material. Thus the solvent acts with counter-flow efficiency upon all parts of the material for the release of oil from the material. When the upper surface of the solvent and oil is above the mouth of the member, G6, the solvent and oil together flow into the member, G6, and outward through the perforations in said member, and through the annular passage, G7, into the discharge pipe, G8. This outward flow through the member, G6, is through the filtering medium introduced through the upright arm, G1, and carried through the arm, G2, and the member, G6, into the extractor chamber, the movement of this filtering medium being at such speed and density as will best serve to allow the outward passing of the oil and solvent and prevent the outward passing of material. From the discharge pipe, G8, the oil and solvent are carried to apparatus for separating the oil and solvent, the oil becoming a commercial commodity and the solvent being again delivered into the extractor through the pipe, B31. As already herein stated, the filtering medium is wiped or swept away from the mouth of the member, G6, by the arms, A9, which are located immediately above the level of said mouth. This involves sweeping away any extraction material lodging on the filtering medium in said mouth. The filtering medium may be wheat bran or other similar light and dustless material which when discharged from the member, G6, will sink in the solvent along with the extraction material and be mixed with the extraction material without making the latter unfit for consumption by animal or man.

To aid in comprehension of the filtering above described, reference is made to filtering a liquid by passing the liquid through a stationary mass of sand or similar material. First let it be supposed that the member, G6, is filled with a stationary body of sand or crushed charcoal, this mass being in form to permit the solvent and extracted oil to pass through the mass and leave in said mass particles which are to be separated from the solvent and oil. Next suppose that this mass is slowly moved through the member, G6, and discharged into the main chamber,

A, that movement being accomplished by means of the spiral blades, G10 and G13, on the shaft, G9, the mass being thus constantly maintained, new sand or charcoal taking the place of the sand or charcoal discharged into the main chamber, A, the purpose of this change in the filtering mass being to avoid having the mass become filled and clogged with particles of solid matter carried with the solvent and oil into the mass. Use of sand or crushed charcoal or some similar material might serve my purpose if merely the function of filtering needed consideration. But it is undesirable to discharge sand or crushed charcoal into the main chamber to be mingled with the extraction material and remain mingled with that material at the final discharge from the apparatus. To make said material fit for use as food, I use a filtering medium which does not unfit the discharged extraction material for use as a food. The filtering medium is preferably a food element, such as wheat bran, as above described. By the movement described, the filtering medium is made self-replenishing, and the extraction material separated from the solvent and oil is returned into the main chamber to again become a part of the extraction material in said chamber.

It will now be seen that I have made provision for substantially continuous flow of material into the upper part of the extractor and downward in the extractor and out through its lower part, while liquid solvent is pumped or forced through the extractor in the opposite direction.

As already indicated, the regulating arms, A15, are the first of a train of mechanism for reducing the velocity of the conveyor shaft, A21, when the mass of material in the extractor rises sufficiently to press the blades, A15, upward during their revolution.

After the material passes the valve, B34, it falls by gravity through the tubular extension, B12, into the left hand end of the heater and is there stirred and tumbled into small particles by the blades, C26, and advanced toward the right hand end of the heater. This heating is for the purpose of vaporizing the greater part of the solvent not eliminated before the material passes the valve, B34. As already described, the vapors freed by the heater go through the separating structure, H, and thence through the pipe, H3, to a condenser and thence to a separator wherein the solvent and any water, such as results from moisture from material in the heater or from live steam coming from the deodorizer mentioned later, are separated.

From the right hand end of the heater, the material is discharged through the passage, C30, into the deodorizer. There the material falls by gravity into the lower part of the deodorizer and accumulates to the height of the blades, D22. When the material

rises higher and causes the lifting of the blades during their revolution, the velocity of the motor, M, is increased for increasing the velocity of the shaft, E1, in order to increase the action of the conveyor blades on said shaft for the more rapid removal of material from the deodorizer through the throat, E4. Thus a substantially uniform mass of the material is kept in the deodorizer, and said mass is stirred or agitated by the arms, D12a, on the shaft D12.

Steam of high temperature passes through the intake pipe, D28, and through the mass of material and out through the upper pipe, D29, into the pipe, H2, into the separator structure, H, and thence through the pipe, H3, as already described. In the cyclone separator, any particles of material arriving with these vapors are precipitated into the lower part of the cyclone, H1, into engagement with the conveyor screw, H8, and thence back into the heater, C.

While the plug formed at the left of the valve member, B34, as above described (Fig. 2) aids in expelling solvent and any remaining unextracted oil from the material, said plug also serves to seal against the passing of vapor from the heater into the extractor. The loose plug formed in the passage, C30, forms a seal at the discharge end of the heater and prevents steam from the deodorizer passing to the heater.

In the discharge structure, E, a plug of material is formed in the throat, E4, and another plug of material is formed in front of the last valve, E17. Steam is introduced through the pipe, E23, into the chamber between those two plugs. This is for the purpose of preventing the entrance of air from the atmosphere around or through the plug at the valve, E17, and the valve, E11.

To make certain that such admission of air is prevented, it is well to make pressure of the steam through the pipe, E23, sufficient to constantly cause a little escape of steam into the atmosphere at the valve, E17. On seeing this escaping steam, the operator will know that no air is entering at said valve.

One reason for preventing the admission of air into the deodorizer is to avoid mingling air with the inflammable solvent and making an explosive mixture which might explode. The same reasons apply for seeking to avoid the admission of air into other compartments of the apparatus. This observation is especially pertinent because some of these compartments may be operated under partial vacuum. Then avoiding admission of air to the deodorizer reduces work to be done by the vacuum pump.

The purpose of the treatment of the material in the deodorizer is to eliminate from the material the last remnant of solvent from the material. This is done by the aid of steam passing upward in counter-flow through the

deodorizer. This final elimination of the solvent is to deprive the material of all odor or taste of the solvent. Thus the material is made a fit feed for cattle and may, in some cases, such as soy beans, become a feed for people.

It is to be observed that the temperature of the steam introduced into the deodorizer need be no higher than is necessary to avoid condensation in the deodorizer and in the passage leading from the deodorizer. Here it is to be noted that there is only limited tendency toward cooling said steam, because the heater has steam between its jackets and in the tubular member, C21. Thus the insoluble material is hot when delivered into the deodorizer, and the heat of that material is maintained through the heating of the deodorizer by means of steam circulating through the space between the two walls of the deodorizer.

It is to be noted that if a solvent were used which is heavier than the insoluble material, the counter-flow would have to be reversed, the solvent introduced into the upper part of the extractor and the material introduced into the lower part of the extractor. In that case, there would be absence of the pressure exerted upon the discharge end of the column of material in the extractor as herein described relative to the apparatus shown by the drawings. In the apparatus as shown by the drawings, the bottom or floor wall of the extractor makes a foundation or abutment against which the lower part of the material is pressed by the action of gravity and by the weight of material above the lower part of the material. If the heavy solvent were used and the counter-flow reversed, there would be no such base or abutment against which the material can be pressed, and pressure due to the action of gravity upon the upper part of the material is substantially absent. Then the material rising to the upper part of the extractor will merely float loosely with no action toward condensing or packing and freeing oil from the material. Thus there is an absence of the first and second stages of compression of the material which I have mentioned.

To facilitate operation, the material and the solvent should both be heated before introduction to the extractor. If that is done, the action of the solvent in the extractor will be facilitated. Furthermore, the operation in the heater will be facilitated if the material is hot when delivered into the heater. By taking that course, the heater may be made of smaller capacity than would be required if the material were delivered into the heater at lower temperature. If the material is hot when delivered into the heater, the amount of steam delivered into the heater through the pipes, C28 and C7, will be less.

Furthermore, the material should in any

case be dried before delivery into the extractor, this being for the elimination of water, the presence of which would retard solvent action. That drying may as well be done by heating immediately before delivery of the material into the extractor, thus delivering the material into the extractor hot.

Attention is invited to the practical importance of treating the material incrementally instead of large bulk. The material is moved forward through the apparatus in practically a constantly moving stream through which the counter-flowing solvent is intimately mingled for the extraction and carrying away of the oil; and the pressure exerted for expressing solvent and any remaining unextracted oil and for forming and maintaining seal plugs at different places is incremental—that is to say, the spiral blades which move the material forward add small quantities of material to the bodies of material already compressed and slowly moving forward. Not only can incremental application of pressure produce higher and more uniform density, but the operation can be carried on by the application of less power.

As an example of the efficiency of incremental compression, reference is made to the baling of cotton by the progressive laying and pressing of thin sheets or layers of cotton fiber, whereby a high density not possible to produce by bulk compression of the cotton is attained.

But it is to be observed that in the practice of my method it is not desirable to so operate as to attain the highest possible compression in the press at the base of the main chamber, A (Fig. 2). For very high compression would form a plug too hard for movement to and past the valve, B34, or, if it passes said valve, to break into sufficiently loose form to fall into the heater, C, and be adapted to be moved through the heater and to be penetrated by heat and allow escape of oil and solvent vaporized by the heat. In other words, the compression or density of the material in said press is to be high enough to substantially prevent the discharge of free oil and free solvent past the valve, B34, and low enough to allow the movement of the material past said valve into the heater and there permit the action of the heat above described. The fact that some solvent and some oil remain in the material when passing the valve, B34, is not objectionable; for the heater and the deodorizer function efficiently and economically for the elimination of the oil remnant and the solvent remnant from the material.

Here attention is again asked to the fact that my aim is to substantially completely eliminate the oil and solvent from the material and leave the material in form for use as food for animals or man. This use of the residual material is also a matter of economy.

That use calls for the elimination of the solvent to such extent as to avoid offensive taste. It is further a part of my method to economically use the solvent, provision being made for retaining the solvent in the apparatus for repeated use.

Attention is also invited to the fact that the practice of my invention includes the use of a solvent which is non-corrosive. Use of a corrosive solvent would render the apparatus inoperative. Heretofore, in this art, it has been proposed to use carbon-tetrachlorid as a solvent. But that solvent, in the presence of water moisture and appropriate temperature, forms muriatic acid. That acid would destroy the metal of the apparatus and damage the extraction material. In this connection it is to be remembered that I use steam in the deodorizing chamber and the extraction material may contain water moisture when it enters the apparatus.

By way of summary, let it be noted that in the operation of my apparatus there are three main courses of movement or progression, such movement or progression being continuous or substantially continuous. One of these courses is traversed by the extraction material from the upper part of the main chamber, A, to the final discharge at the lower end of the deodorizer. The second of these courses is traversed by the main flow of solvent and extracted oil upward from the lower end of the main chamber, A, and through the filter at the upper end of said chamber. The third of these courses is traversed by the filtering medium through the passage formed by the chamber, G1, and the members, G2 and G6, into the main chamber, A. There is also a continuous flow of solvent and oil, in small quantity, from the heating chamber and from the deodorizer. There is also continuous flow of vaporized solvent and oil and light particles of extraction material from the upper end of the deodorizer. There is also continuous flow of steam and steam condensation through the space between the heater walls; and there is similar flow of steam and steam condensation through the space between the walls of the deodorizer.

On these courses traversed by the extraction material and the filter medium, some of the movement is so controlled as to cause gradually increasing pressure, whereby that material or medium is subjected to progressive compression. That is especially the case with the extraction material at the upper entrance to the main chamber, A, and to and through the discharge from that chamber. At said entrance, the material in the trough, A20, is driven forward with increasing or progressive compression to give the material in the passage, A19, sufficient density to prevent the outward passing of vaporized or liquid solvent or oil. Downward through

the main chamber, A, the weight of the material causes progressively increasing density or compression; and at the base of said chamber, the spiral blades on the shaft, B20, cause gradual condensation or compression of the material toward and into the press and against the yieldingly resisting valve, B34. In the deodorizer, the weight of the material causes progressive increase of pressure from the upper end to the lower end of the chamber; and then the spiral blades on the shaft, E1, and the yielding valves, E11 and E17, cause a gradual or progressive compression of the material.

For the sake of clearness, it is here stated that in the claims, "insoluble material" applies to the insoluble material which carries the oil. This applies through the several stages from the delivery of said material into the upper part of the extraction chamber, A, until the final discharge from the apparatus, the quantity of oil carried by the insoluble material diminishing from the beginning to the final discharge. During portions of the treatment, solvent is also carried by the insoluble material. That fact is ignored in applying the term, "insoluble material".

Furthermore, the term, "oil", is used generically to designate such oils and fats as are to be extracted from insoluble material by means of my apparatus and method.

I claim as my invention:

1. In an apparatus for extracting oil from finely-divided oil-bearing animal and vegetable insoluble materials, the combination of walls forming an upright closed extraction chamber, an inlet for the oil-bearing material and an outlet for oil and solvent, both located in the upper part of said chamber, means in the lower part of said chamber for expressing remaining solvent and oil from the solid residue of the solvent extraction and for discharging said solid residue from said chamber, and means for introducing oil solvent into said chamber around and in contact with said expressing means and for directing the expressed solvent and oil from said expressing means toward the upper part of the chamber.

2. In an oil extraction apparatus, the combination of walls forming an upright closed extraction chamber, means for feeding finely-divided oil-bearing insoluble material into the upper end of said chamber, means controlled by the height of the column of said oil-bearing material in the chamber for regulating said feeding means, means for delivering oil solvent into the lower part of said chamber, means for withdrawing a stream of solvent and extracted oil from the upper part of said chamber, and means in the lower part of said chamber for expressing remaining solvent and oil from the oil-bearing material and progressively discharging said insoluble material from said chamber.

3. In an oil extraction apparatus, the combination of walls forming an upright closed extraction chamber, means for feeding finely-divided oil-bearing insoluble material into the upper part of said chamber, means for delivering oil solvent into the lower part of said chamber, means forming a passage leading laterally from the upper part of said chamber for withdrawing a stream of solvent and extracted oil and particles of said insoluble material from the upper part of said chamber, screw feeding means for feeding filtering medium into and through said passage into said chamber in counterflow to the oil and solvent stream for returning said particles of insoluble material into said chamber, a pipe leading from said passage for conducting oil and solvent from said passage, and means in the lower part of said chamber for expressing remaining solvent and oil from the insoluble material and progressively discharging said insoluble material from said chamber.

4. In an oil extraction apparatus, the combination of walls forming an upright closed extraction chamber, means for feeding finely-divided oil-bearing insoluble material into the upper part of said chamber, means for delivering oil solvent into the lower part of said chamber, walls at the upper part of said chamber forming an outlet passage for a stream of oil and solvent and particles of the insoluble material, said passage having within said chamber an upward-directed lip reaching to the upper part of said passage, means for feeding filtering medium into and through said passage into said chamber in counterflow to the oil and solvent for returning said particles into the extraction chamber, means for separating and withdrawing the extracted oil and solvent from the filtering material and said particles, and means in the lower part of said chamber for expressing remaining solvent and oil from the insoluble material and progressively discharging said insoluble material from said chamber.

5. In an extraction apparatus, the combination of walls forming an upright closed extraction chamber, means for feeding finely-divided oil-bearing insoluble material into the upper end of said chamber, means for delivering oil solvent into the lower part of said chamber, means forming a passage leading laterally from said chamber for withdrawing a stream of solvent and extracted oil and particles of said insoluble material from the insoluble material at the upper part of said chamber, screw feeding means for feeding filtering medium into and through said passage into said chamber in counterflow to the oil and oil solvent stream for returning said particles of insoluble material into said chamber, means forming along said passage a screened by-pass out of the range of flow of

said filtering medium, means for conducting oil and solvent from said by-pass, and means in the lower part of said chamber for expressing remaining oil solvent and oil from the insoluble material and discharging said insoluble material from said chamber.

6. In an apparatus for separating oil from finely-divided oil-bearing insoluble material, the combination of walls forming an upright closed extraction chamber, means for delivering said material into the upper part of said chamber, a continuously-operating screw press located in the lower part of the chamber and arranged to discharge compressed insoluble material from said chamber and having limited lateral openings for outward movement of expressed oil and oil solvent, means for delivering solvent into said chamber and around said press and thence upward in said chamber, and means for conducting a stream of oil and oil solvent from the upper part of said chamber.

7. In an apparatus for separating oil from finely-divided oil-bearing insoluble material, the combination of walls forming an upright closed extraction chamber, means for feeding said material into the upper part of said chamber, means controlled by pressure of said material within said chamber for automatically regulating said feeding means, a continuously-operating screw press located in the lower part of the chamber and arranged to discharge compressed insoluble material from said chamber and having limited lateral openings for outward movement of expressed oil and solvent, means for delivering oil solvent into said chamber and around said press and thence upward in said chamber, and means for conducting a stream of oil and solvent from the upper part of said chamber.

8. In an apparatus for separating oil from finely-divided oil-bearing vegetable and animal insoluble material, the combination with a closed extraction chamber and a closed heater, of means for delivering insoluble material into the upper part of the main extraction chamber, means for delivering oil solvent into the lower part of said chamber, means for withdrawing solvent and oil from the upper part of the extraction chamber, means in the lower part of said chamber for expressing remaining solvent and oil from the solid residue of the solvent extraction and for discharging said solid residue from said chamber into the heater, means in the heater for conducting the insoluble material through the heater, heating means adjoining and isolated from the heater, a separator, means for conducting solvent vapor and particles of insoluble material from said heater into the separator, means for conducting solvent vapor from the separator, and means for discharging insoluble material from the separator.

9. In an apparatus for separating oil from

finely-divided oil-bearing vegetable and animal insoluble material, the combination with a closed extraction chamber and a closed heater, of means for delivering insoluble material into the upper part of the main extraction chamber, means for delivering oil solvent into the lower part of said chamber, means for withdrawing solvent and oil from the upper part of the extraction chamber, means in the lower part of said chamber for expressing remaining solvent and oil from the solid residue of the solvent extraction and for discharging said solid residue from said chamber into the heater, means in the heater for conducting the insoluble material through the heater, heating means adjoining and isolated from the heater, a steam-jacketed separator, means for conducting solvent vapor and particles of insoluble material from said heater into the separator, means for conducting solvent vapor from the separator, and means for discharging insoluble material from the separator.

10. In an apparatus for by continuous operation separating oil from finely-divided vegetable and animal oil-bearing insoluble material and producing solid residuum suitable for food, the combination of walls forming an upright closed extraction chamber, a closed heater, a closed deodorizer chamber, means for delivering said oil-bearing material into the upper part of the extraction chamber, means for delivering oil solvent into the lower part of the extraction chamber and means for intermingling said solvent and said insoluble material, means forming an outlet passage for the solvent and extracted oil at the upper end of the extraction chamber, means in the lower part of said chamber for expressing remaining solvent and oil from the solid residue of the solvent extraction and for discharging said solid residue from said chamber into the heater, means in the heater for conducting the insoluble material through the heater into the deodorizer, heating means adjoining and isolated from the heater, a separator, means for conducting solvent vapor and particles of insoluble material from said heater into the separator, means for conducting vaporized solvent and steam from the separator, means for conducting precipitated particles of insoluble material from the separator back into the heater, means in the deodorizer for agitating the insoluble material, means for conducting hot steam through the deodorizer for eliminating any remnant of solvent, means for conducting steam and particles of insoluble material from the deodorizer into said separator, and means for discharging solid material from the deodorizer.

11. In an oil extraction apparatus, the combination of walls forming an upright closed extraction chamber, means for feeding finely-divided oil-bearing insoluble ma-

terial into the upper part of said chamber, means for delivering oil-solvent into the lower part of said chamber, means forming a passage for withdrawing a stream of solvent and extracted oil and particles of said oil-bearing material from the upper part of said chamber, means associated with said passage for feeding filtering material into said passage in counterflow to the stream of withdrawn solvent and extracted oil for filtering from said stream particles of said oil-bearing material and returning said particles into said extraction chamber, means for separating and withdrawing the extracted oil and solvent from the filtering material and said particles, and means in the lower part of said chamber for expressing remaining solvent and oil from the insoluble material and discharging said insoluble material from said chamber.

12. In an oil extraction apparatus, the combination of walls forming an upright closed extraction chamber, means for feeding finely-divided oil-bearing insoluble material into the upper part of said chamber, means for delivering oil solvent into the lower part of said chamber, means forming a passage for withdrawing a stream of solvent and extracted oil and particles of said oil-bearing material from the upper part of the chamber, means on the length of said passage for moving a filtering material into and in counterflow through said stream into the extraction chamber whereby said particles are returned into the extraction chamber, means for separating and withdrawing the extracted oil and solvent from the filtering material and said particles, and means in the lower part of said chamber for expressing remaining solvent and oil from the insoluble material and discharging said insoluble material from said chamber.

13. In a method of extracting oil from finely-divided animal and vegetable oil-bearing insoluble material, the steps which consists in conducting the oil-bearing material downward and conducting an oil solvent upward, the solvent being lighter than said material, and intimately intermingling said material and said solvent and conducting from the upper part of the body of mingled insoluble material and solvent and extracted oil a stream of solvent and extracted oil and particles of the insoluble material and moving into and through said stream in counterflow into said body a filtering medium consisting of an edible substance for carrying said particles of insoluble material back from the solvent and extracted oil stream into the downward-moving insoluble material stream whereby the solvent and extracted oil are made ready for separation, and in the lower part of the insoluble material stream expressing remaining solvent and oil from the solid residue of the solvent extraction, said residue then being

an edible body consisting of animal and vegetable material and said edible substance filtering medium.

14. In a method of extracting oil from finely-divided animal and vegetable oil-bearing insoluble material, the steps which consist in conducting the oil-bearing material downward and conducting an oil solvent upward, the solvent being lighter than said material, and intimately intermingling said material and said solvent and conducting from the upper part of the body of mingled insoluble material and solvent and extracted oil a stream of solvent and extracted oil and particles of the insoluble material and moving into and through said stream in counterflow into said body a filtering medium consisting of a food substance for carrying said particles of insoluble material back from the solvent and extracted oil stream into the downward-moving insoluble material stream whereby the solvent and extracted oil are made ready for separation, and in the lower part of the insoluble material stream expressing remaining solvent and oil from the solid residue of the solvent extraction, said residue then being an edible body consisting of animal and vegetable material and said food substance filtering medium.

15. In a method of extracting oil from finely-divided animal and vegetable oil-bearing insoluble material, the steps which consist in conducting the oil-bearing material downward and conducting an oil solvent upward, the solvent being lighter than said material, and intimately intermingling said material and said solvent and conducting from the upper part of the body of mingled insoluble material and solvent and extracted oil a stream of solvent and extracted oil and particles of the insoluble material and moving into and through said stream in counterflow into said body a filtering medium consisting of an edible substance for carrying said particles of insoluble material back from the solvent and extracted oil stream into the downward-moving insoluble material stream whereby the solvent and extracted oil are made ready for separation, and in the lower part of the insoluble material stream expressing remaining solvent and oil from the solid residue of the solvent extraction, and then agitating and heating said insoluble material for vaporizing and eliminating therefrom any solvent remnant, said residue then being an edible body consisting of animal and vegetable material and said edible substance filtering medium.

In testimony whereof I have signed my name, this 11th day of May, in the year one thousand nine hundred and twenty-five.

EDWIN LAWRENCE, JR.