April 3, 1951 J. D. HAMACHER ET AL 2,547,577

COUNTER-CURRENT EXTRACTION APPARATUS

Filed July 22, 1946 3 Sheets-Sheet 1

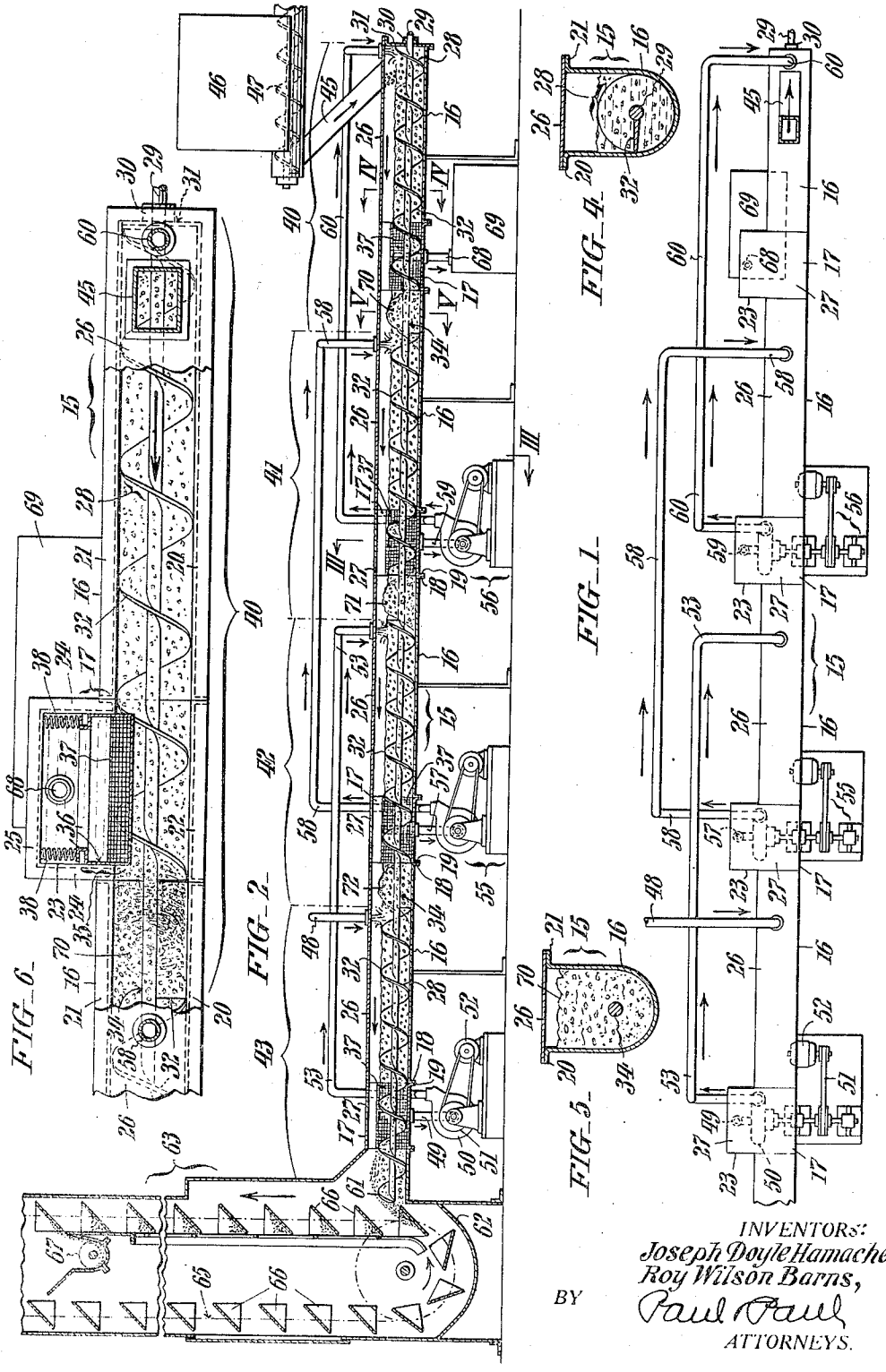


FIG. 6

FIG. 2

FIG. 1

FIG. 4

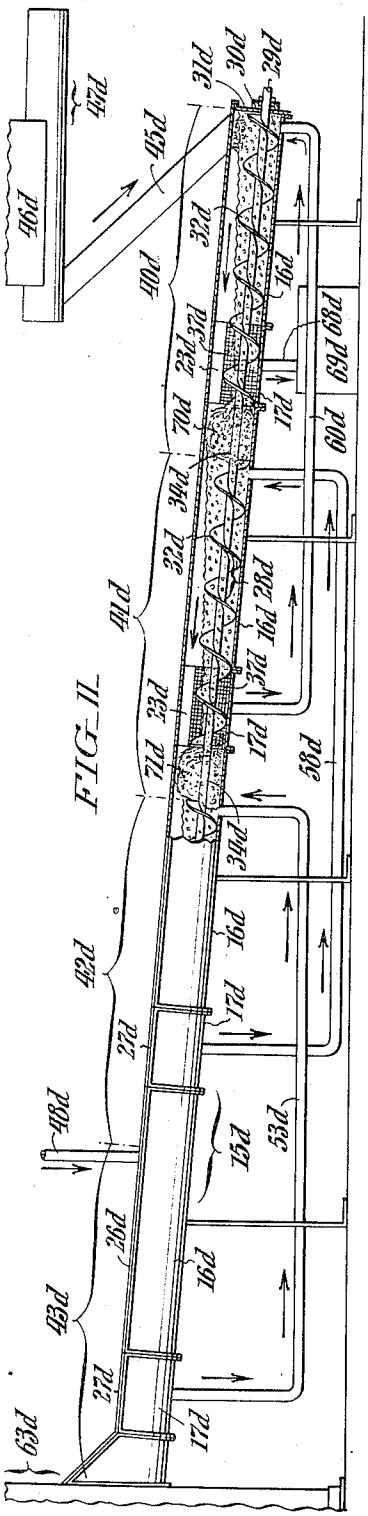
FIG. 5

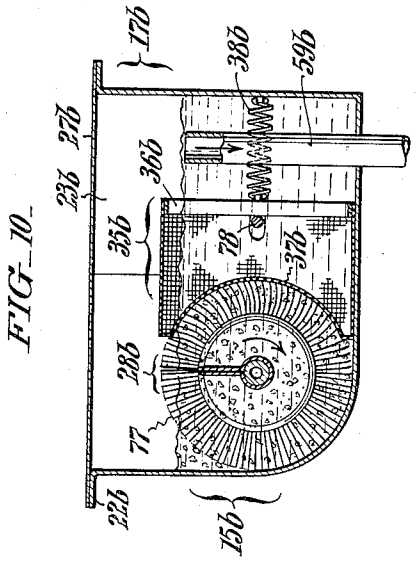
INVENTORS:
Joseph Doyle Hamacher &
Roy Wilson Barns,
BY Paul & Paul
ATTORNEYS.

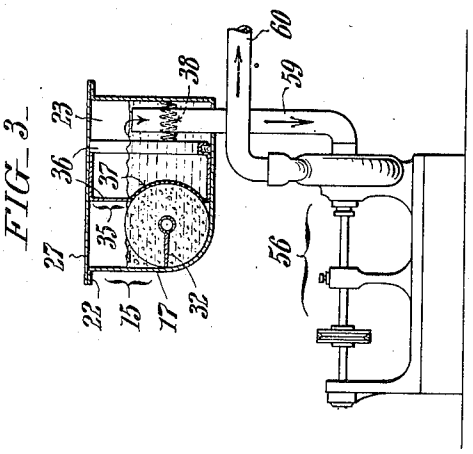
April 3, 1951 J. D. HAMACHER ET AL 2,547,577

COUNTER-CURRENT EXTRACTION APPARATUS

Filed July 22, 1946 3 Sheets-Sheet 2







INVENTORS:
Joseph Doyle Hamacher &
Roy Wilson Barns,
BY Paul & Paul
ATTORNEYS.

April 3, 1951 J. D. HAMACHER ET AL 2,547,577

COUNTER-CURRENT EXTRACTION APPARATUS

Filed July 22, 1946

3 Sheets-Sheet 3

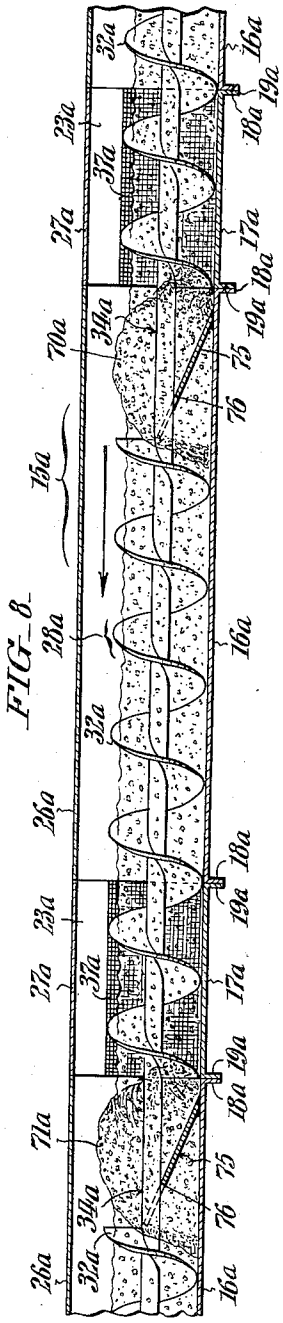


FIG. 6.

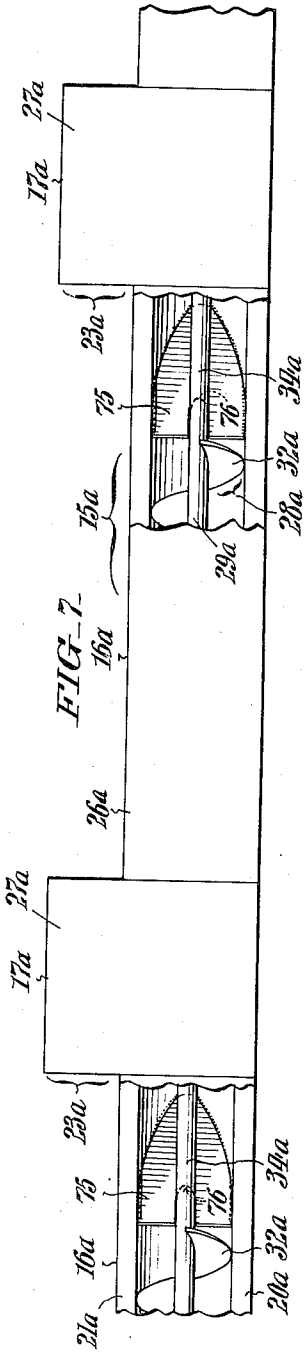


FIG. 7.

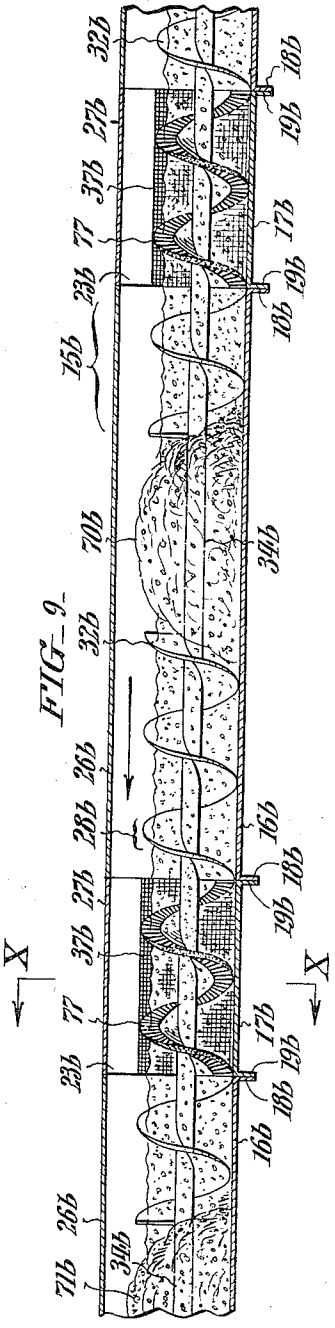


FIG. 9.

WITNESSES

Hubert Fuchs

Thomas W. Kerr Jr.

INVENTORS:

Joseph Doyle Hamacher &

Roy Wilson Barns,

BY Paul & Paul

ATTORNEYS.

Patented Apr. 3, 1951

2,547,577

UNITED STATES PATENT OFFICE

2,547,577

COUNTERCURRENT EXTRACTION APPARATUS

Joseph Doyle Hamacher and Roy Wilson Barns, Detroit, Mich., assignors to Detrex Corporation, Detroit, Mich., a corporation of Michigan

Application July 22, 1946, Serial No. 685,406

5 Claims. (Cl. 23—270)

1

This invention relates to methods of solvent extraction or washing and also to apparatus suitable for carrying out such processes. More specifically, it is concerned with methods and apparatus useful in extracting oils and fats from divided materials containing or having such substances associated with them, for example, vegetable oils from crushed or flaked soya beans, corn germs (dry or wet process), milk weed seeds, copra, sunflower seeds, cotton seeds, peanuts, linseed, tung and other nuts, mustard seeds, etc.; or animal fats from comminuted meats and bones.

The chief aim of our invention is to make it possible to carry out such processes on a commercial scale by what may be termed a "continuous batch procedure" in which the extraction or washing is caused to take place without interruption in successive stages with the particles or flakes (as the case may be) of the material under gentle agitation and free to move about, some submerged and others afloat in the solvent liquid in each of the several stages for maximum exposure of their surfaces to the action of the solvent while being continually advanced through the apparatus, solvent being continually introduced into and transferred between adjacent stages so as to flow in the direction in which the material is progressed, and the contaminated liquid or miscella continuously withdrawn from the last stage, all with a view toward obtaining a maximum yield of the entrained or associated oils or fats in the shortest possible time.

A further aim of our invention is to provide a simple, relatively inexpensive and efficient apparatus suitable for expeditiously carrying out extraction or washing under the above principle.

How the foregoing and other objects and advantages may be readily realized in practice will appear from the following detailed description and the attached drawings, wherein Fig. 1 is a fragmentary view in top plan of an extraction apparatus conveniently embodying our invention in one form.

Fig. 2 shows the apparatus in longitudinal section.

Figs. 3, 4 and 5 are detail cross sectional views taken as indicated by the angled arrows III—III, IV—IV, and V—V in Fig. 2.

Fig. 6 is a fragmentary broken out view in plan of the feed-in end of the apparatus drawn to a larger scale.

Figs. 7 and 8 are fragmentary views corresponding to Figs. 1 and 2 showing a modified embodiment.

Figs. 9 and 10 are fragmentary views corresponding to Figs. 2 and 3 respectively showing another modification; and

Fig. 11 is a view corresponding generally like Fig. 2 showing still another alternative embodiment.

2

In the form illustrated in Figs. 1–6, our improved extraction or washing apparatus comprises an elongate horizontal channel trough 15 which is made up of a plurality of aligned sections 16 and 17 with abutting connecting end flanges 18 and 19. The longer component sections 16 of the trough are U-shaped transversely as shown in Figs. 4 and 5, and provided with outwardly extending longitudinal flanges 20 and 21 at their tops. Each shorter trough section 17 is rounded at the bottom at one side as shown in Fig. 3 to correspond with the transverse contour of the sections 16, and provided at that side with a longitudinal top flange 22 in continuation of the longitudinal flanges 20 of the sections 16 contiguous thereto (Fig. 6). The smaller sections 17 are moreover laterally offset as at 23 with resultant formation of pockets having end and longitudinal flanges 24, 25 in continuation of the longitudinal flanges 21 of the adjacent sections 16. In practice the channel trough 15 may be constructed throughout from sheet metal and is closed by removable cover plates 26 and 27 of like material removably secured over its component sections 16 and 17 respectively.

Within the trough 15 is a rotary screw conveyer 28 which serves to advance the divided material undergoing extraction leftward in the trough, as indicated by the arrows in Figs. 1 and 2, in flowing solvent liquid, said conveyer having its shaft 29 extending out through a fluid-tight bearing 30 in the right-hand end wall 31 of said trough for connection to a suitable drive means (not illustrated). As shown, the conveyer 28 has solid thread segments 32 respectively within the confines of contiguous trough sections 16, 17, and relatively short intervening voids 34 immediately ahead of the pockets 23 of the trough 15 as considered with respect to the direction of the advance of the material, except at the very left-hand end of the trough where the segment 32 at that region is continued beyond the pocket.

Fitting into the offset pockets 23 of the trough sections 17 are removable filter or strainer units 35 each of which, as best seen from Figs. 3 and 6, comprises a frame 36 fashioned from sheet material and having attached to it a curved flexible screen diaphragm 37 preferably of relatively fine wire mesh with which the forward end portion of a screw segment 32 of the conveyer wipes as the latter rotates. Springs shown at 38 in Figs. 3 and 6 press against the filter units 35 so that the screens 37 are caused to yieldingly hug the conveyer threads. As a consequence of this construction and arrangement, extraction is caused to take place in a manner hereinafter set forth in successive stages within the limits of the divisions indicated by the brackets 40, 41, 42 and 43 in Fig. 2.

The divided material to be processed in the ap-

paratus is constantly fed into the extraction trough 15 at the right-hand end in Figs. 1 and 2 through the inclined delivery spout 45 of an overhead supply hopper 46 under control of a rotary screw 47 for advance in said trough by the conveyer 28 from right to left, as previously pointed out.

The liquid solvent used in the extraction is continually introduced into the trough 15 near the left-hand end thereof at the beginning of the last stage 43 of the series, by way of a pipe 48 which leads from a suitable source of supply (not shown), and the contaminated liquid is withdrawn from the screen pocket at the terminal end of that stage through an overflow stand pipe 49, by a rotary pump 50, which, through a belt connection 51 is driven from an electric motor 52. By the action of the pump 50, the liquid so withdrawn is delivered through another pipe 53 which discharges into the trough at the beginning of the third subdivision 42. By similar duplicated pump means 55 and 56 liquid is constantly transferred from the rear end of the third stage 42 to the second subdivision 41 through pipes 57 and 58, and from the second subdivision 41 to the first subdivision 40 through pipes 59 and 60. In the last subdivision 43, the conveyer 28 has a solid thread end portion 61 which delivers the processed material into a sump 62 at the bottom of a vertical housing 63 which encloses an endless chain 65 with drain buckets 66 by which the material is elevated to a horizontal screw 67 for transfer to a drier or other apparatus for further treatment. The miscella or oil-laden solvent overflows from the screen pocket 23 at the first extraction subdivision 40 by way of the standpipe 68 at that region into a collecting receptacle 69 beneath the trough 15. From the receptacle 15, the liquid may be transferred, by a suitable pump means (not shown), to a still or the like for separation of the extracted matter from the solvent and for recovery and purification of the solvent for reuse in the apparatus.

Operation

For the proper operation of the apparatus it is to be understood that the rate of infeed of the divided material from the supply hopper 46, the rate of withdrawal of the processed material by the bucket conveyer 65, and the rotative speed of the screw conveyer 28 in the trough 15 are all so regulated and controlled that the particles are free to move about in the solvent within several extraction subdivisions 40—43 for maximum exposure of their surfaces to the action of the solvent whereof the level is at all times maintained at, or near, the top of the screw conveyer threads as determined by the standpipes in the several screen pockets 23. The divided material is advanced leftward in the first extraction subdivision 40 by the action of the rigid thread segment 32 of the screw conveyer 28 in said subdivision with the solvent until it reaches the end of said segment where it accumulates and piles up as indicated at 70 ahead of the first screen 37 due to the void 34 there in the conveyer screw, with consequent formation of a dam of the material which will prevent direct flow of solvent from said first extraction subdivision into the second subdivision 41. In a like manner similar dam piles will be formed and maintained at 71 and 72 beyond the remaining screen pockets (the last one excepted) in the direction of progression of the material in the trough 15 and so prevent direct flow of solvent between the second and third extraction subdivisions 41, 42 and between the third and last extraction subdivisions 42 and 43. In each extraction stage, the solvent moves along in the same direction with the material being extracted, the fresh solvent being introduced at the beginning of the fourth or last stage 43, and, after having traversed that stage, is transferred to the beginning of the immediately preceding stage 42 and so on throughout the length of the trough 15 until it is finally drained off as miscella from the rear end of the first stage. By reason of being circulated in this way, the solvent liquid gains in oil content as the stagewise extraction proceeds. Accordingly, we are able to obtain maximum yield of the extract from the material continuously and expeditiously, the leached material being removed without interruption after discharge from the delivery end of the extraction trough 15 by the elevator 65 and the screw 67 at the top of the elevator housing 63. Due to being continually wiped by the conveyer threads, the screen diaphragms 37 are kept clear of adhering particles or flakes of the material so that the solvent can freely pass through them with assurance against interruption of solvent flow in any of the several extraction subdivisions.

In the embodiment illustrated in Figs. 7 and 8, rearwardly and upwardly inclined plates 75 are placed in the extraction trough 15*a*, to assist in the formation and maintenance of the dams 70*a*, 71*a* immediately beyond the filter sections 37*a* in the direction of the general advance of the divided solid material in the apparatus. As shown, the plates 75 are suitably configured to fit the trough bottom whereto they are welded or otherwise secured and reach up to a level of or above the screw shaft 29*a*—i. e., somewhat below the top of the conveyer thread so that the material can be floated over them—being cut out centrally of their tops as at 76 to clear said screw shaft. In all other respects, the construction here is exactly like that of the first embodiment, wherefore, in order to preclude the necessity for repetitive description, the corresponding parts not specifically referred to are identified by the same reference characters previously used except for the addition in each instance of the letter "*a*" for convenience of more ready distinction. In operation, the inclined plates 75 offer sufficient resistance to too rapid advance of the flaked material to insure piling at the indicated regions without preventing progression of the flakes in a free and unrestricted state in the solvent between dams. The modified arrangement is particularly advantageous in connection with the treatment of finely divided materials such as soya bean or nut flakes.

The modified construction illustrated in Figs. 9 and 10 is in turn generally similar to that of the first described embodiment except in that the conveyer segments 32*b* have interposed in them spiral portions 77 composed of brush bristles to wipe against the screens 37*b* in the filter pockets. The brush bristles may be of any suitable flexible material such as tampico, nylon, or stainless non-corrosive material. Another difference will be noted here, in the construction of the filter unit 35*b* which has the form of a box entirely of screening with an open rear end stiffened by a perimetric re-enforcing band 36*b* and is provided with stops, such as the one indicated at 78, which limit movement of the unit inwardly toward a brush portion 77 of the conveyer 28*b* under the pressure of springs 38*b*.

In the alternative embodiment of our invention illustrated in Fig. 11, the extraction trough 15*d* is inclined somewhat in respect to the horizontal, i. e., slopes upwardly from the right-hand or feed-in end of the apparatus at the material supply hopper 46*d* to the delivery end at the elevator housing 63*d*. The construction of the screw conveyer 23*d* is identical with that described in connection with the embodiment shown in Figs. 1 and 2 and is operative to form dams 70*d*, 71*d* etc. for establishment of the successive extraction stages 40*d*, 41*d*, 42*d* and 43*d*. Due to the slope of the trough 15*d* we are here able to dispense with the use of pumps in the piping 53*d*, 59*d* and 60*d* by which solvent is transferred between adjacent extraction stages through gravitation. It is to be particularly noted that the liquid level in the respective extraction stages is determined by the standpipes in the corresponding screen pockets 23*d*. Here as in the other embodiments the advance of the material in the trough 15*d* is from right toward the left, and the flow of the solvent directionally with the material in each extraction stage. It is to be understood that the modified constructions featured in Figs. 7, 8 and in Fig. 9 may be incorporated in the alternate embodiments of Figs. 1 and 11 if found desirable or necessary.

In all cases the solvent used will depend upon the character of the material which is to be processed. For the purposes of oil or fat extraction, hydrocarbon solvents, for example, trichlorethylene or trichlorethane, may be employed to advantage in carrying out our improved method in apparatus such as hereinbefore disclosed. In addition to the several instances already mentioned, the apparatus may also be utilized in the extraction treatment or washing of other materials including asphalt paper and metal powders.

While for convenience of illustration herein, we have shown apparatus with four extraction stages or subdivisions, the invention is not to be regarded as so limited since the number of stages may, within the scope of the appended claims, be increased or decreased to suit special cases or in accordance with the degree of thoroughness which is to be attained in the extraction or leaching.

Having thus described our invention, we claim:

1. In solvent extraction apparatus, a substantially horizontal elongate round-bottomed extractor chamber containing treating liquid; a conformative screw conveyer in the chamber with a solid thread portion and a thread portion in continuation of the solid thread portion formed of bristles for advancing divided solid matter in the liquid; a filter pocket laterally offset from the chamber adjacent the bristle portion of the conveyer; and a filter unit in said pocket comprising a screen and a shiftable supporting frame therefor, and spring means influential upon the frame to maintain the screen yieldingly engaged with the bristle portion of the conveyer.

2. In solvent extraction apparatus, a substantially horizontal elongate extractor chamber containing treating liquid; a series of conformative screw conveyer sections in the chamber for advancing divided solid matter in the liquid, each such conveyer section comprising a solid thread portion and a thread portion of bristles in continuation of the solid thread portion; and spring regulated filter units adjacent the bristle portions of the conveyer sections.

3. In solvent extraction apparatus, a substantially horizontal elongate round-bottomed extractor chamber containing treating liquid; a series of conformative screw conveyer sections for advancing divided solid matter in the liquid, each such conveyer section comprising a solid thread portion and a thread portion of bristles in continuation of the solid thread portion; filter pockets laterally offset from the chamber adjacent the bristle portions of the respective conveyer sections; and spring regulated filter units in the respective pockets.

4. In solvent extraction apparatus, a substantially horizontal elongate round-bottomed chamber containing treating fluid; means for continually introducing divided solid matter into the chamber at one end and for continually removing it from the other end; a conformative rotary screw conveyer in the chamber for advancing the material in the liquid, said conveyer having a series of sections comprising solid thread portions at their front ends as considered with respect to the direction of advance of the material in the apparatus, and spirally continuing thread portions at their rear ends formed of bristles, and said conveyer sections being separated by voids whereat dam piles of the material are formed and constantly maintained to set apart a series of individual extraction subdivisions in the chamber; filter units with screens bearing against the brush portions of the respective conveyer sections; and means for continually drawing liquid from the filter unit of one subdivision and continually discharging it into the front end of a preceding subdivision of the series.

5. In solvent extraction apparatus, a substantially horizontal elongate round bottomed chamber containing treating fluid; means for continually introducing divided solid matter into the chamber at one end and for continually removing it from the other end; a conformative rotary screw conveyer in the chamber for advancing the material in the liquid, said conveyer having a series of sections comprising solid thread portions at their front ends as considered with respect to the direction of advance of the material in the apparatus, and spirally continuing thread portions at their rear ends formed of bristles, and said conveyer sections being separated by voids whereat dam piles of the material are formed and constantly maintained set apart a series of individual extraction subdivisions in the chamber; filter units with screens bearing against the brush portions of the respective conveyer sections; and means for continually introducing fresh liquid into the rear end of the last subdivision of the series and for continually discharging it from the rear end of the first subdivision of the series.

JOSEPH DOYLE HAMACHER.
ROY WILSON BARNS.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
554,960	Scott	Feb. 18, 1896
979,362	Wiegand	Dec. 20, 1910
1,628,787	Kennedy	May 17, 1927
2,181,404	Koppity	Nov. 28, 1939
2,227,605	Swallen	Jan. 7, 1941
2,273,557	Bonotto	Feb. 17, 1942
2,355,091	McDonald	Aug. 8, 1944
2,447,845	Dinley	Aug. 24, 1948