June 2, 1964 A. J. HUNT 3,135,193

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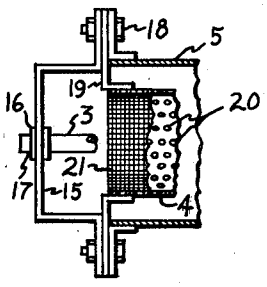


Fig. 3.

Fig. 2.

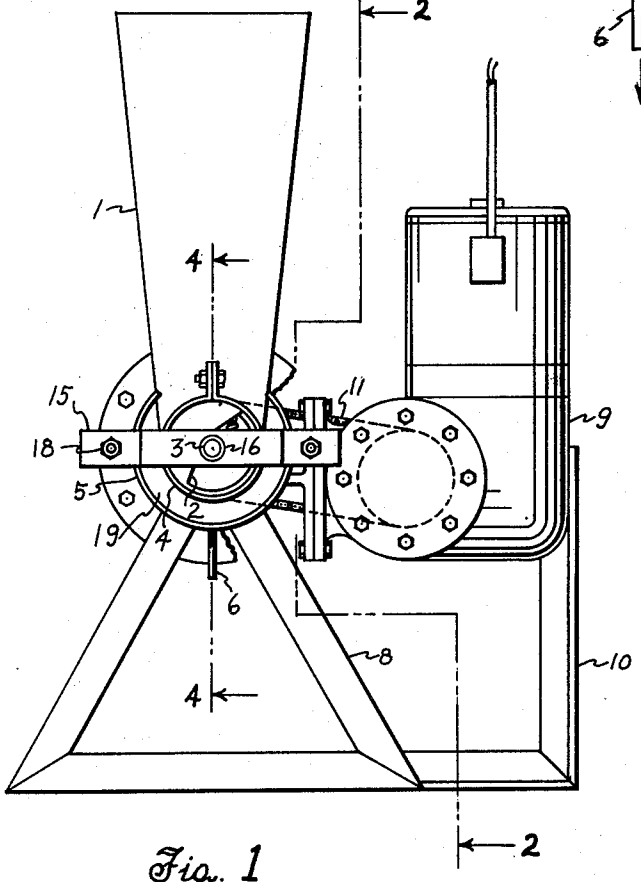


Fig. 1

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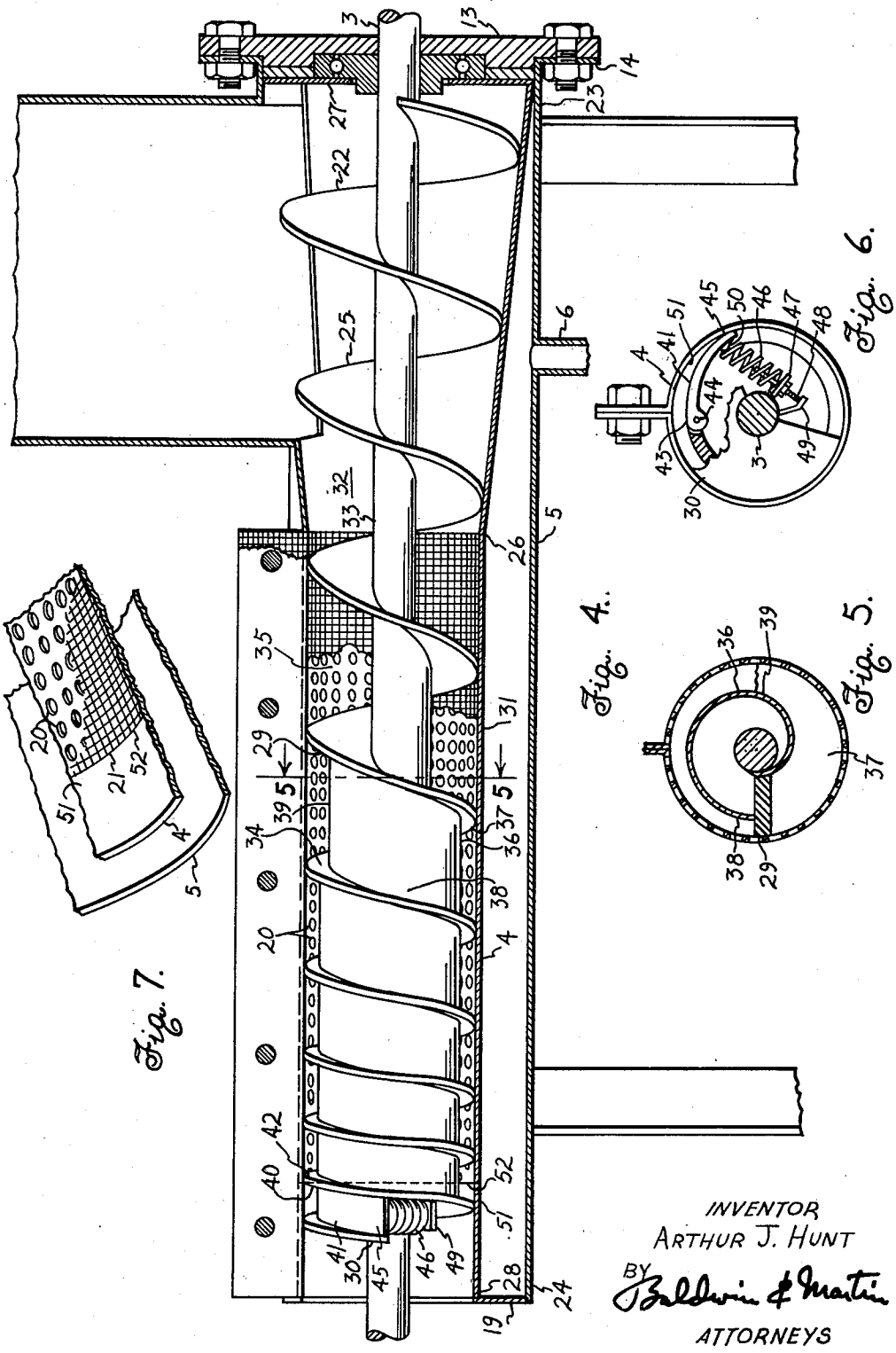


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

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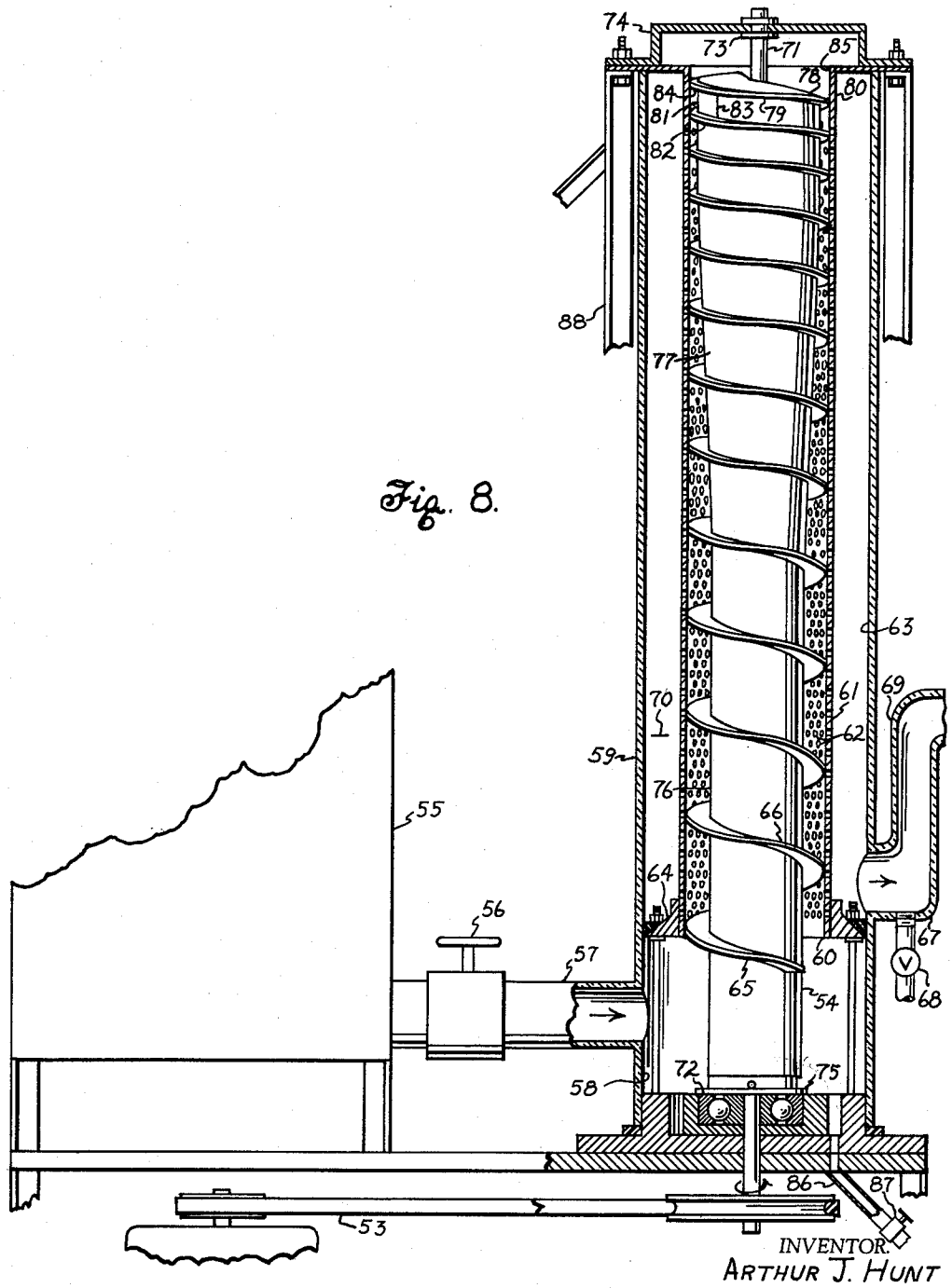


Fig. 8.

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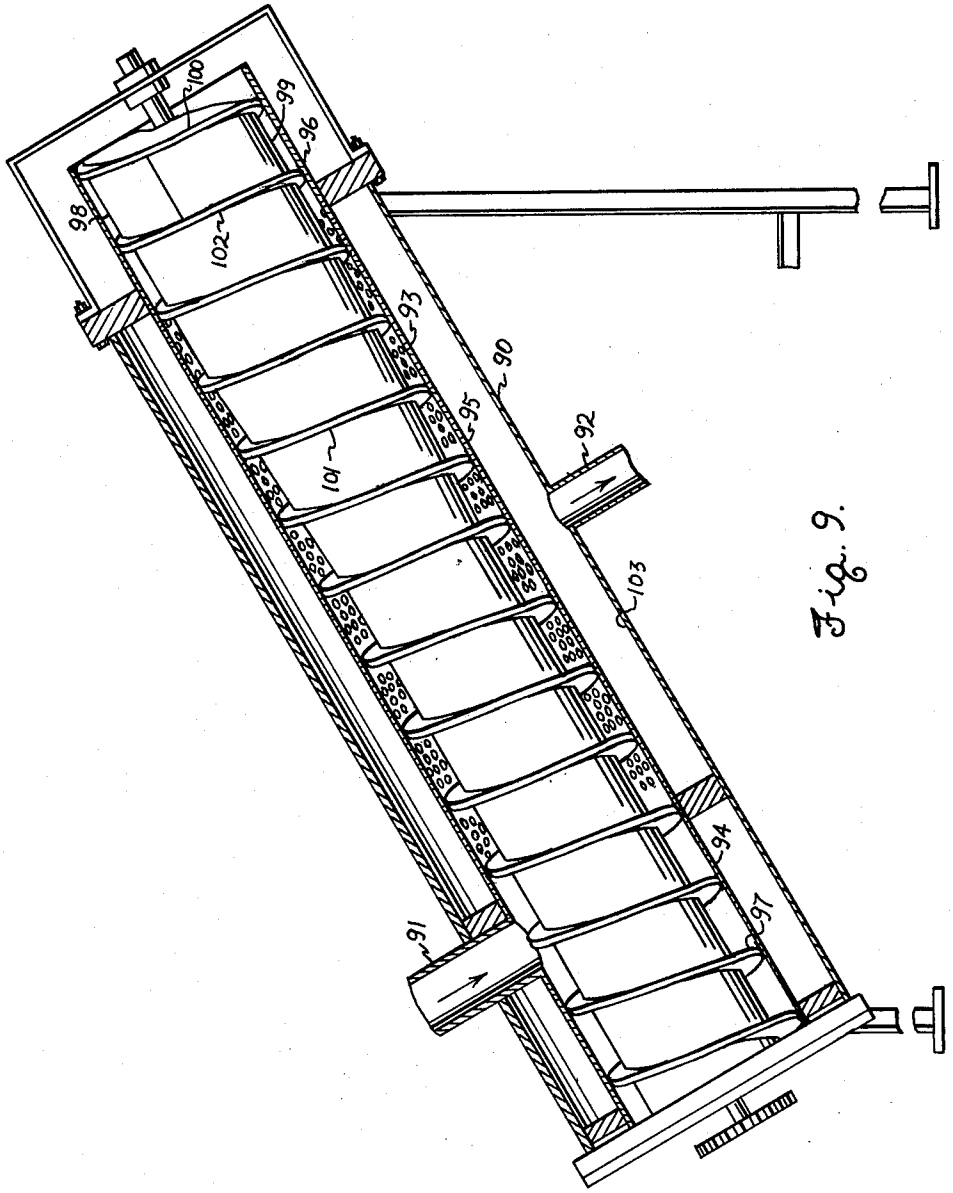


Fig. 9.

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United States Patent Office 3,135,193 Patented June 2, 1964

3,135,193
SCREW PRESS

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Filed June 3, 1963, Ser. No. 285,109
12 Claims. (Cl. 100—117)

This invention relates to screw or worm presses, and particularly to presses for extracting liquids from liquid-containing solids or semi-solids, that is, for separating the liquid from mixtures or materials which will yield liquids and solids. The invention particularly relates to presses useful as food finishers, such as for the extraction of juice from pulp in fruits and vegetables, or for the separation of liquids from slurries, and for similar separations.

A general object of the invention is to provide an improved worm or screw press for extraction of liquids from solids or semi-solids.

A more particular object of the invention is to provide a continuous press operable to extract a large percentage of the liquids contained in the feed, to provide a solids output having a low percentage of liquids remaining therein, and a liquid output having a low percentage of solids.

A specific object of the invention is to improve the feeding characteristics of worm presses. It is also a specific object to improve the crushing efficiency of worm presses. It is the still further specific object to reduce the amount of solids contained in liquids separated in a screw press. It is another and further specific object to provide improved automatically operable means, in a screw press, for maintaining pressure against solids at or adjacent the delivery end of the press.

In accord with one aspect of this invention, a screw press is provided to which may be fed a slurry under a pressure of up to many atmospheres, for example, 1400 p.s.i, the solids being extracted and fed out of the press against atmospheric pressure, with the liquids being collected within the press at a pressure equal to the full or slightly less than the full elevated pressure, and the liquids being returnable to the external high pressure system by means of a circulating pump.

It is contemplated that the presses of this invention may be used to separate liquid and solids from a feed which may comprise a crushable solid of the type which contains liquid, such as apples, for example, or which may contain substantial amounts of free or nearly free liquid, of which tomatoes are an example, or which may be in the form of a soupy slurry, such as a flowable slurry of wood pulp as it emerges from digesters or from Jordan engines in the making of paper, or such as wet garbage.

The novel features which are believed to be characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIGURE 1 is an end elevation of a horizontal screw press in accord with the invention, a portion being broken away for clarity;

FIG. 2 is a sectional view of the screw press taken along line 2—2 of FIG. 1;

FIG. 3 is a fragmentary sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a sectional view of the press taken along line 4—4 of FIG. 1 shown on an enlarged scale;

FIG. 5 is a sectional view taken along line 5—5 of FIG. 4;

FIG. 6 is an end elevation of a portion of the screw press, showing the delivery end thereof, partially broken away and in section;

FIG. 7 is a detail view on an enlarged scale of fragmentary portions of the press showing a modified arrangement according to the invention;

FIG. 8 is a side elevation, shown partially broken away and in section, of a vertical screw press in accord with a modified embodiment of the invention; and

FIG. 9 is a side elevation partially broken away and in section, of a screw press in accord with another modified embodiment of the invention.

As seen in FIGS. 1 and 2, the screw press according to the invention comprises a feed tank or bin 1, a compressing screw 2, mounted on a shaft 3 and contained in a cylindrical sleeve 4. The press further includes a juice collecting shell or casing in the form of a trough 5 from which a drain 6 is arranged to carry away the collected juice or other liquid. The machine is supported on frame members 7 and 8 which are connected to the trough 5. A motor 9, mounted on an additional support member 10, is connected to drive the shaft 3 through a chain 11 connected between the motor and sprocket 12.

A plate 13 is bolted to end flange 14 of the trough 5 serving to close this end of the trough at the input end of the screw and to provide support for shaft 3 adjacent its driving sprocket 12. At the outlet end of the machine, a bracket 15 supports a bearing 16 in which the end portion 17 of shaft 3 is journaled. As seen in FIGURE 3 the bolts 18 which serve to attach bracket 15 to the trough 5 also serve, through the intermediary of mounting flange member 19, to support sleeve 4 within trough 5. Sleeve 4 is provided with multiple perforations 20 permitting the escape of liquids outwardly from the sleeve into the liquid collecting space in the trough 5.

The perforate sleeve 4 is preferably lined with a fine mesh screen 21, although the screen may be omitted as determined by the size of the perforations 20 and the desired operating characteristics for the particular materials to be handled. In the extraction of juice from tomatoes for use in the making of catsup, for example, with the screw operating at 135 r.p.m., the screen 21 may be found unnecessary, and a sleeve 4 having perforations of about 0.02 inch diameter may be employed, whereas, in extracting juice from apples, wherein a very small percentage of solids is desired, a screen 21 of from about 200 to 300 mesh has been found satisfactory. In extracting juice from grapes, wherein the solids are of substantial size and have little tendency to pass through small openings, an almost solid-free juice may be obtained with a 200 mesh screen 21 and with a sleeve 4 having openings 20 of the order of 0.1 inch.

It will be understood that the screen 21, when used in the machine, comprises a liner for the sleeve 4, and that the screen is supported by the sleeve and preferably extends throughout the perforated area of the sleeve.

Turning now to FIGURE 4 it will be seen that the shaft 3 carries thereon a spiral, helical or convolute rib or thread 22 providing a helical or spiral channel extending spirally from the feed end portion 23 to the solids delivery end portion 24 of the press. The thread includes a feed portion 25 disposed under the feed bin and extending between a neck 26 and end plate 27. The portion 25 of screw 2 is of gradually reducing outer diameter with distance from end plate 27 at the extreme end of trough 5 toward the neck 26. This portion 25 of the screw comprises a full 2½ turns of the thread. The thread radius in this 2½ turns, preferably decreases to a radius at the throat 26 of about one-third to one-half of the maximum thread radius adjacent end plate 27. From neck 26 to solids delivery end 28 of sleeve 4, the sleeve is preferably cylindrical, and the outer edge or crest 29 of the screw defines a helix engaging along the sleeve, or along the

sleeve liner screen 21 when the screen is used. The pitch of the screw, as measured in turns per unit of length, increases gradually from the end adjacent plate 27 to the last turn 30 at the delivery end. Furthermore, the depth of the channel defined between adjacent turns of the thread, as measured between crest and shank, reduces from the feed to the delivery end of the screw. An abrupt reduction in channel depth takes place beginning approximately one full turn of the screw from the throat 26 along the cylindrical portion 31 of sleeve 4. Specifically, it will be seen that the channel at 32 adjacent throat 26 is defined with a bottom or inner shank or spindle surface 33 corresponding to and constituting a portion of the shaft 3, whereas, within two turns, as at 34, the diameter of the inner wall of the channel, i.e. the root of the screw, is abruptly increased. The proportion between the cross-sectional area of the channel at 35 of the screw at the portion thereof within the cylindrical portion 31 of the sleeve immediately inwardly of throat 26 is at least three times the cross-sectional area of the channel at 34 at the next turn of the screw. The shank or spindle 36, of which the surface constitutes the root of the screw and forms the inner defining wall of the continuous channel, so increases in diameter, as shown in the sectional view of FIGURE 5, as to decrease within one turn of the screw the depth of the channel, measured from the crest 29 of the thread to the root at portion 37 of the screw to a depth at portion 38 in about the proportion three or four to one. The abrupt outwardly progressing portion 39 of the shank at the root of the screw thus comprises an inclined abutment which causes a heavy crushing force against the material being fed at this part of the screw. After the abrupt crushing by the portion of the shank 39, the channel remains substantially constant in depth through the following turns of the screw, of which there should be at least about three and preferably four or five, but the width of the channel as measured between adjacent portions of sequential turns of the thread gradually diminishes whereby the channel 40 at the delivery end of the screw is approximately one-third of the width of the channel at 34 and adjacent the abutment portion 39 of the shank.

In accord with the invention, screw 2 carries a flipper 41 at or adjacent its delivery end 40. The flipper forms a swingable portion of the root or shank of the screw between the final two turns 42 and 30 of the screw rib or thread, or in the last turn of the screw. The flipper is pivotally supported at its leading edge 43 by a hinge or pivot pin 44 having a pivot axis extending generally parallel to the screw axis, or, more specifically, substantially perpendicular to and between the planes of the rib turns 42 and 30 at the pivot, whereby the trailing end portion 45 of the flipper is free to swing between rib turns 30 and 42 inwardly toward shaft 3 and outwardly toward sleeve 4. The flipper is urged by a spring 46 to swing on its hinge 44 in the direction to cause trailing end portion 45 to approach or engage the sleeve. Spring 46 thus urges the flipper end 45 to swing away from shaft 3, thereby tending to close the screw channel and to spring load the flipper against the materials being fed along by the screw. As the pressure in the screw channel increases, the material forces the flipper to swing inwardly against the force of the spring until the pressure of the material against the flipper balances the force of the spring. The spring 46 is seated against a nut and washer 47 engaged on a threaded shaft 48 carried by a stud or bracket 49 in fixed position on shaft 3. The spring seats on a knob 50 under the swinging end portion 45 of the flipper. Screwing nut and washer 47 along shaft 48 toward the flipper will increase the force of the spring against the flipper and tend to increase the resistance of the flipper against the materials being treated, while screwing the nut in the opposite direction will tend to reduce the back pressure of the flipper against the materials. Since the flipper is spring loaded, relatively large solid objects, such as stones, peach

pits, pieces of wood or other objects which may enter the hopper whether by design or by mistake, are permitted to pass the flipper without damaging the machine. It is contemplated that machines according to the invention would not normally be operated with solid objects as large as peach pits included in the feed, but such may be fed in by accident, but apricot pits, for example, may be readily tolerable under most circumstances. Any such solid seeds, for example, which are too large to pass the flipper when in its usual operative position, cause the flipper merely to swing a little further open momentarily as necessary to pass the seeds or other objects as they occur.

The screen 21 terminates at screw turn 42 and sleeve 4 includes an imperforate portion 51 extending between turns 42 and 30 and preferably somewhat beyond the end of the screw. The flipper, accordingly, works against a solid or imperforate portion of the sleeve. As shown in FIGURES 4 and 7, screen 21 terminates at 52 before reaching the flipper and just beyond the perforated area of the sleeve 4. Dependent upon the speed of the screw, the nature of the materials being processed, the size of the perforations 20 or the mesh of the screen 21, and the flipper force as adjusted by nut 47, the semi-solids remaining in the screw channel will form a plug in the channel extending back from the flipper for a part of one turn or for up to several turns. Since the flipper is spring loaded, the length of the plug, once the machine is properly operating, remains substantially constant.

The horizontal machine of FIGURES 1–7, which includes the abruptly decreasing channel at 34 provided by abutment 39, and being adapted for driving of the screw at about 150 to 200 r.p.m., has proven to be particularly suited to extraction of juice from fruits, including grapes, apples, pineapples, oranges and the like, and from vegetables, such as tomatoes. For fine finishing of materials fed as a slurry or the like, a higher speed machine has proved effective, and for a feed comprising hammer-milled fruits, i.e. a slurry of crushed apples, or for halved oranges, or to extract oil from orange peels, and for certain other types of feed, an upright or vertical machine as shown in FIGURE 8 has proven highly effective, and capable of extracting juice or other liquid from the fed materials comprising very small percent of solids, such as between ½ and 3%.

The last mentioned machine will be seen to comprise a drive 53 for turning screw 54 at relatively high speed, such as 1500 to 2500 r.p.m. A tank 55 may be provided to supply a slurry feed through valve 56 and conduit 57 into a lower feed chamber 58 forming the lower end of a housing 59. Chamber 58 communicates with the open lower end 60 of upright sleeve 61 such that the slurry in the chamber passes up into the sleeve. The sleeve is provided above its lower end with multiple perforations 62 opening through the sleeve into extracted liquid collecting chamber 63 which is separated from the feed chamber by a flange or wall 64 adjacent the lower end of the sleeve.

The slurry in chamber 58 may tend to rise into the lower end of the sleeve under gravitational pressure from tank 55 depending upon the slurry level therein, and it may be helped to do so by a small portion 65 of the rib or thread 66 of screw 54. Once having entered the sleeve and being located in the screw channel, the heavies, which will normally be the liquids, in the slurry will tend to be thrown outwardly toward and through the perforations of the sleeve into chamber 63, while the solids are carried upwardly by the screw.

A liquid outlet 67 is connected to the housing opening from chamber 63 immediately above the bottom of the chamber. The outlet may be arranged to drain substantially all liquid from the chamber by opening a valve 68, but for most purposes, particularly with slurries, it is desirable that a riser portion 69 be included in the outlet which extends to a height above the lowermost perfora-

tions a distance of about one or two turns of the screw or about one-tenth to one-quarter of the total length of the perforate portion of the sleeve. The riser will thus permit liquid to drain from the chamber **63** only down to a level **70** and liquid is retained around the lower part, between **70** and **64**, of the sleeve. A considerable amount of compaction of the solids and separation of liquids occurs below the liquid level **70**, and it has been found that clogging of the sleeve perforation is minimized as a result.

It will be understood that, while the sleeve **61** is shown as perforated and unlined, a screen such as screen **21** will in many cases be desirably included to line the sleeve **61**.

The screw **54** is mounted on shaft **71** which rotates in bearings **72** and **73**, bearing **73** at the top being supported by a narrow bracket **74**, similar to bracket **15** of the first described machine, and lower bearing **72** being protected by a suitable liquid-tight seal **75**.

The screw comprises a substantially cylindrical untapered spindle portion **76** extending for about the lower half of the perforate portion of the sleeve, and a gradually increasing diameter tapered portion **77** extending from the cylindrical portion to the outlet end **78** of the screw. Helical or spiral rib or thread **66** extends from its end portion **65** in the feed chamber along the spindle terminating in a final turn **79** in an upper imperforate portion **80** of sleeve **61**. A spring-loaded flipper **81** is arranged between the last turn **79** of the screw rib and the next-to-last turn **82** pivoted at its leading edge **83** and tending to close off the last turn or flight **84** of the screw channel.

In the machine of FIGURE 8, the channel depth varies from a maximum at the lower end of the sleeve of about ⅓, or as much as ½, of the radius of the sleeve to about 1/6 or ⅛ of the sleeve radius just before the flipper is reached near the upper end of the screw and sleeve. The pitch of the screw increases in about 1:4 to 1:6 ratio between the lower and upper ends of the screw. That is, the distance from one to the next turn of the rib at the lower end is about 4 or 5 or 6 times as great as the distance between turns **82** and **79** at the top of the screw. The channel area, which is thus reduced both in depth and breadth upwardly along the screw, may be at the top of the screw only about one-twelfth, or between about one-eighth and one-twentieth as great as the area at the bottom of the screw where it enters the lower end **60** of the sleeve.

By the time that the solids have been raised, centrifuged and compressed against the plug which forms in front of the flipper, the solids will have been effectively compacted and very little liquid will remain. These nearly dry solids, as they escape past flipper **81**, pass out of the open upper end **85** of sleeve **61** and are suitably collected.

A drain **86** closed by a valve **87** may be arranged for draining out all materials from the feed chamber. Frame members, such as member **88**, are suitably arranged for mounting the several parts of the machine.

The vertical machine of FIGURE 8, with a 4 inch diameter screw operating at about 2000 r.p.m., when fed wtih orange peel, operates to extract the skin oil with a minimum of other peel liquids, a highly desirable and heretofore difficult to achieve result.

The machine of FIGURE 9 differs from those of the above described embodiments of the invention in that the screw pitch changes very little from end-to-end of the screw, the depth of the screw channel, as measured from the crest to the root of the screw, changes much less from end-to-end of the screw, and the screw and sleeve of the machine are, preferably, inclined upwardly from input to outlet end at an angle of between about 30° and 45° from the horizontal.

As seen in FIGURE 9, this third embodiment of the invention comprises an outer housing **90** provided with an inlet conduit **91** and a liquid outlet **92**. Cylindrical sleeve **93** comprises an unbroken imperforate feed portion **94** extending for one or two or a few turns of the screw and into which the inlet **91** opens, a perforate, preferably screen-lined, area **95** and finally an imperforate outlet end portion **96** extending for the final two turns of the screw **97**. A flipper **98** is hinged to the screw spindle **99** and disposed between the last turn **100** of the rib **101** of the screw and the next to last turn **102** within the imperforate portion of the sleeve. Means are provided as previously described for mounting and rotating the screw, and for spring loading the flipper in a direction toward closing off the screw channel.

The machine of FIGURE 9 is particularly applicable to extraction of liquids from slurries which contain highly compactible solids, such as digested wood pump, and in such uses, it has been found that, with a 4 inch internal diameter sleeve, a screw having a spindle 3 inches in diameter throughout the inlet end portion and up to about half way along the perforate portion of the sleeve and gradually increasing thence to a diameter of about 3⅜ inches at the outlet end, and with a screw pitch which is constant throughout, or increases by only up to 10 or 15 percent in the last half of the perforate portion of the sleeve, is better suited than the screws of the first and second embodiments. In order further to reduce excessive packing of the solids in the early turns when used with paper pulp slurries, the screw and sleeve are inclined at an angle of from about 30° to 45° to the horizontal whereby the liquid drains generally laterally from the sleeve screen into the liquid collection chamber **103**, and the force to push the materials along the length of the screen is less than would be required in a vertical machine. The flipper spring is adjusted in this instance to provide typically a plug in the last three turns only, extending back from the flipper or vane **98** not more than about one turn into the perforate portion of the sleeve. The pulp is, with such adjustment, wrung out to have only a very small percentage of liquid, i.e. liquor or wash liquid. The screw may in this example be driven at about 200 r.p.m.

It will be understood that the description given in connection with FIGURES 1–8, insofar as it is compatible with the specific description given in connection with FIGURE 9, amplifies the latter.

While only certain preferred embodiments of this invention have been shown and described by way of illustration, many modifications will occur to those skilled in the art and it is, therefore, desired that it be understood that it is intended in the appended claims to cover all such modifications as fall within the true spirit and scope of this invention.

What is claimed as new and what it is desired to secure by Letters Patent of the United States is:

1. In a screw press, a relief valve for solids at the outlet end of the screw comprising a gate element disposed in the channel between adjacent turns of the thread, said element having a leading edge portion and a trailing edge, means hingedly securing said leading edge portion to the body of said screw for swinging of said member on an axis extending generally longitudinally of said screw, said leading edge portion being disposed radially inwardly of the crests of said thread turns, and a resilient element urging said gate element to swing on said axis in a direction to move said trailing edge radially outwardly.

2. In a screw press comprising a sleeve and a screw therein having a spiral thread disposed on a shank defining a spiral path along said screw from an input end to an outlet end, a flipper element having a leading edge portion and a trailing edge portion and being hingedly connected at its leading edge portion to and substantially flush with said shank, said element being disposed between two adjacent turns of said thread spaced along said screw from the input end thereof, said sleeve having perforations in a portion thereof between said input end and said two adjacent turns of said screw, and spring means urging said element to pivot on its hinged connection in a direction to swing said trailing edge portion outwardly

toward said sleeve thereby yieldably to restrict passage of materials along said path.

3. A screw press comprising an elongated sleeve of circular cross section having an input end and an output end and a perforate portion between its ends, a material conveying screw for conveying material in the direction from said input end to said output end of said sleeve, said screw being disposed within said sleeve and comprising a helical rib of which the crest slidably engages along said perforate portion and further comprising a shank defining with said rib and perforate portion a screw channel having a cross section decreasing in said direction along said sleeve portion, said screw comprising flipper means disposed between adjacent turns of said rib adjacent said output end, said flipper means including an outer face portion comprising an extension of the shank surface which engages the material being fed and further including resilient means yieldingly urging said face portion against the material in a direction to restrict the screw channel.

4. The combination in accord with claim 3 wherein the shank of the screw increases in diameter abruptly to decrease the area of said channel within one turn of the screw located within said perforate portion by at least substantially one half.

5. The combination in accord with claim 3 wherein the perforate portion of said sleeve is lined with a fine mesh screen having openings smaller than the perforations of the sleeve.

6. The combination in accord with claim 3 wherein the shank of the screw increases in diameter gradually through a plurality of turns of the screw rib within said perforate portion of said sleeve to decrease the area of said channel.

7. In a screw press comprising a screw, a flipper having a leading edge and a trailing edge, means mounting the flipper on said screw between two adjacent turns of the rib thereof for swinging of its trailing edge portion generally radially inwardly and outwardly between said adjacent turns of the screw rib, said flipper comprising spring means urging said trailing edge portion to swing outwardly.

8. A screw press comprising an elongated cylindrical perforate sleeve, a screw comprising a plurality of rib turns fittingly disposed in said sleeve, said screw comprising a root surface portion of which a part is movable radially inwardly and outwardly thereby to control the cross sectional area of the screw channel at said part, spring means yieldably urging said part radially outwardly from the axis of the screw toward said sleeve, and means to adjust the force of said spring means.

9. The combination in accord with claim 8 wherein said sleeve comprises an imperforate open ended outlet end portion and wherein the radially movable part of said root surface portion is disposed within said imperforate end portion.

10. A screw press comprising an elongated casing, an elongated perforate, open ended sleeve of circular cross section spaced within the walls of said casing and defining a collecting space for liquids in said casing outwardly of said sleeve, a screw having an outlet end portion and a body portion in said liner, said casing comprising an inlet chamber into which the inlet end of said sleeve opens, said chamber being divided by means resisting the passage of solids from said collecting space, means for

introducing mixtures of solids and liquids into said chamber, a vane having a body portion and a leading edge and hingedly mounted at its leading edge to said screw and disposed in the screw passage adjacent the outlet end portion thereof and swingable on its said hinged edge in directions to restrict and open said passage, and spring means engaged between said vane and screw urging said vane to swing in the direction to restrict said passage.

11. A screw press comprising a closed container, an elongated upright cylindrical sleeve, said sleeve comprising a first imperforate elongated portion sealed externally of the sleeve to a wall of said container and terminating upwardly in an end opening outside of said container, said sleeve further comprising a second elongated portion disposed inside said container and having a plurality of perforations therethrough, said container being larger than said sleeve whereby to provide enclosed liquid collection space outwardly of said second portion of said sleeve, a screw disposed in said sleeve having a lower end portion in said container below said lower end of said sleeve and having an upper end portion comprising a full turn of the screw in said first portion of said sleeve, means extending generally radially outwardly from said lower end of said sleeve and engaging the walls of said container for restricting the passage of solids and defining therebelow in said container a lower chamber portion communicating with the interior of said sleeve through said lower end thereof and further defining above said means a second chamber portion outwardly around said second portion of said sleeve, means for introducing a mixture of solids and liquid into said lower chamber portion, means for rotating said screw, means for removing liquid from said second chamber portion, and means for forming a pressure retaining plug of solids ahead of said one turn of the screw which is located in said imperforate sleeve portion, said last means comprising a flipper carried by said screw between adjacent rib portions at said turn and a spring engaging said flipper and urging it yieldably in a direction to oppose the passage of solids through said one turn.

12. In a screw press comprising a screw, a flipper having a leading edge and a trailing edge portion, means mounting the flipper on said screw between two adjacent turns of the rib thereof for swinging of its trailing edge portion generally radially inwardly and outwardly between said adjacent turns of the screw rib, said flipper comprising resilient means urging said trailing edge portion to swing outwardly.

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