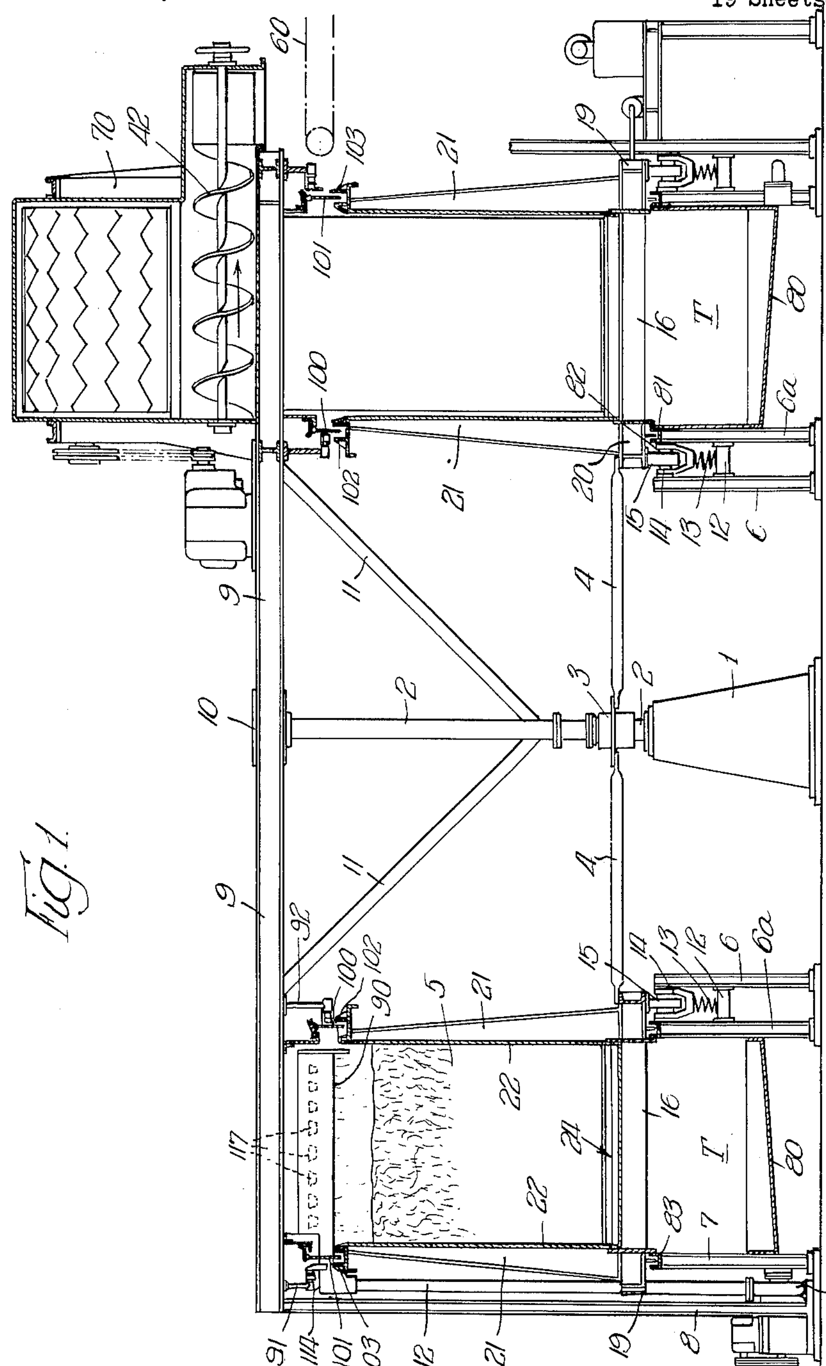
April 26, 1966 H. F. SILVER ETAL 3,248,263

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 1

Fig. 1



INVENTORS
Harold F. Silver,
Clarence R. Steele,
BY Frank B. Price,
Byron, Hume, Groen & Clement
Attys.

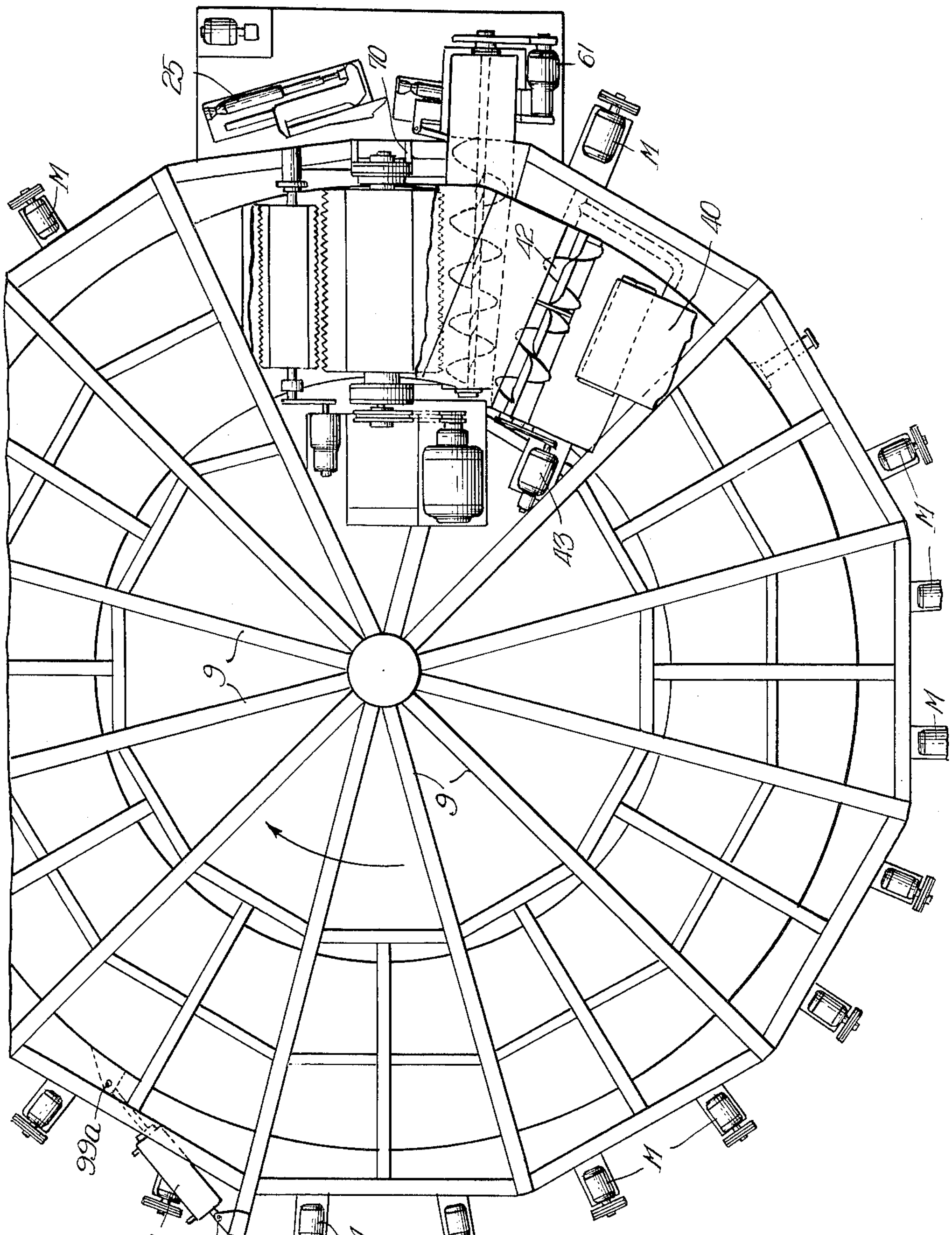


Fig. 2.

INVENTORS.
Harold F. Silver,
Clarence R. Steele,
BY Frank B. Price,
Byron, Hume, Groen & Clement
attys

April 26, 1966 H. F. SILVER ETAL 3,248,263

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 3

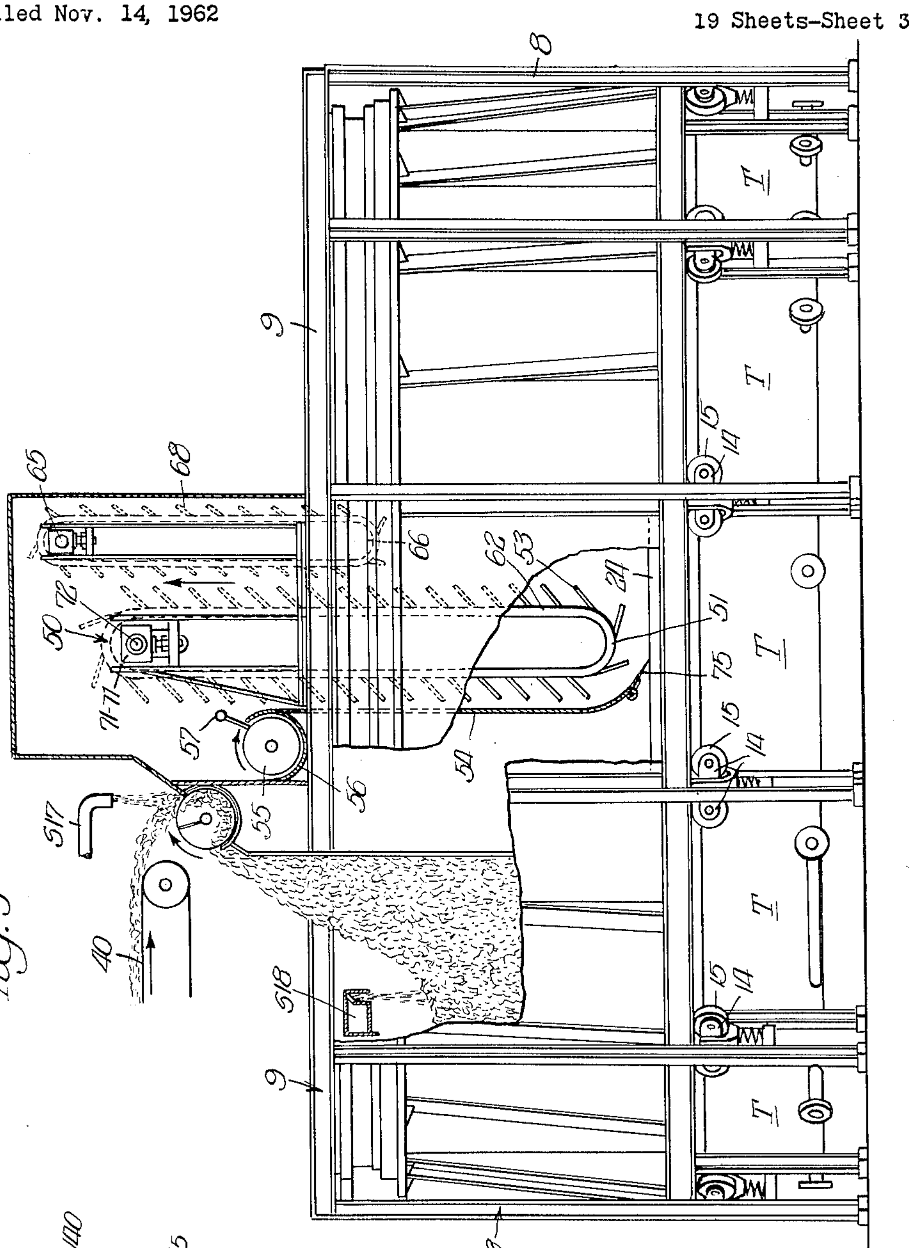


Fig. 3

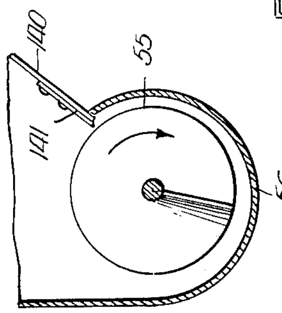


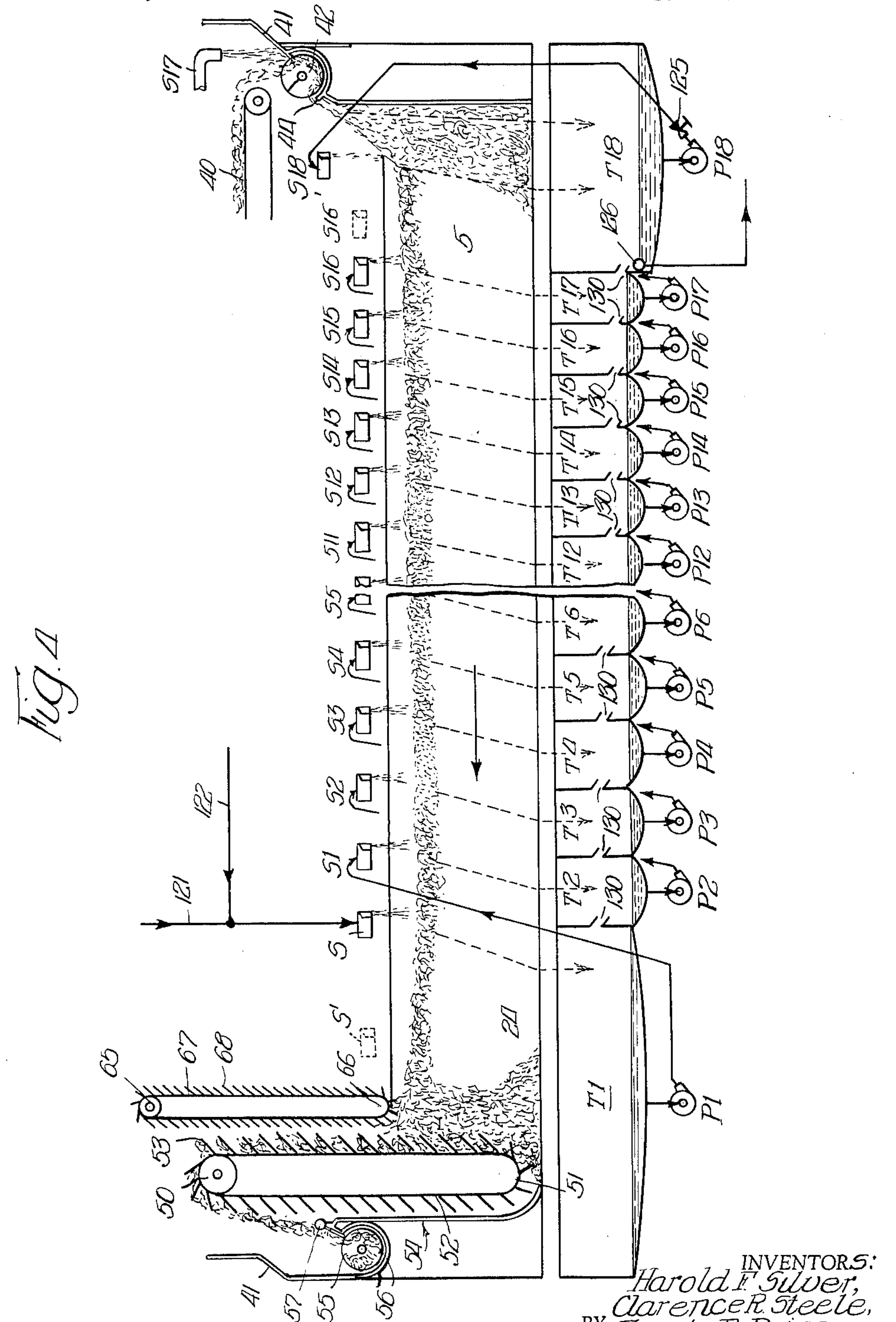
Fig. 3A

INVENTORS:
Harold F. Silver,
Clarence R. Steele,
Frank B. Price,
BY
Byron, Hume, Groen + Clement
attys.

April 26, 1966 H. F. SILVER ETAL 3,248,263

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 4

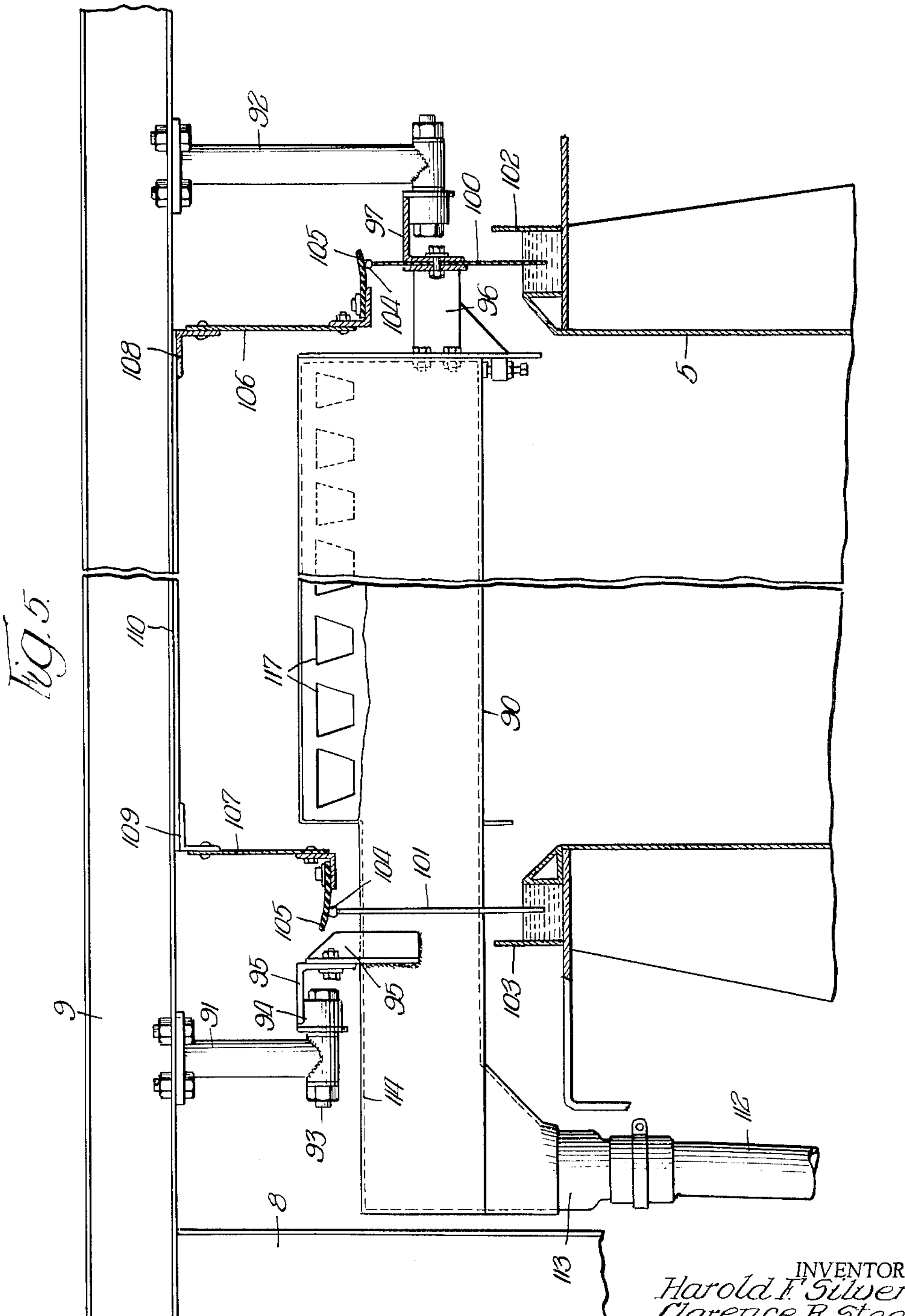


INVENTORS:
Harold F. Silver,
Clarence R. Steele,
BY Frank B. Price,
Byron, Hume, Groen + Clement.
attys.

April 26, 1966 H. F. SILVER ETAL 3,248,263

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 5



INVENTORS.
Harold F. Silver,
Clarence R. Steele,
BY Frank B. Price,
Byron, Hume, Groen & Clement
attys

April 26, 1966 H. F. SILVER ETAL 3,248,263

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 6

Fig. 5A

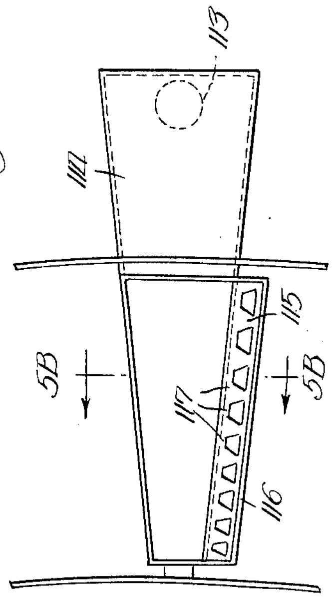
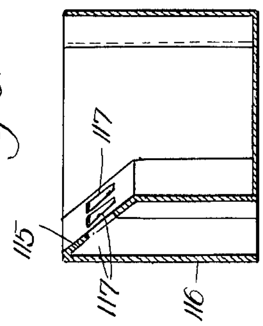


Fig. 5B



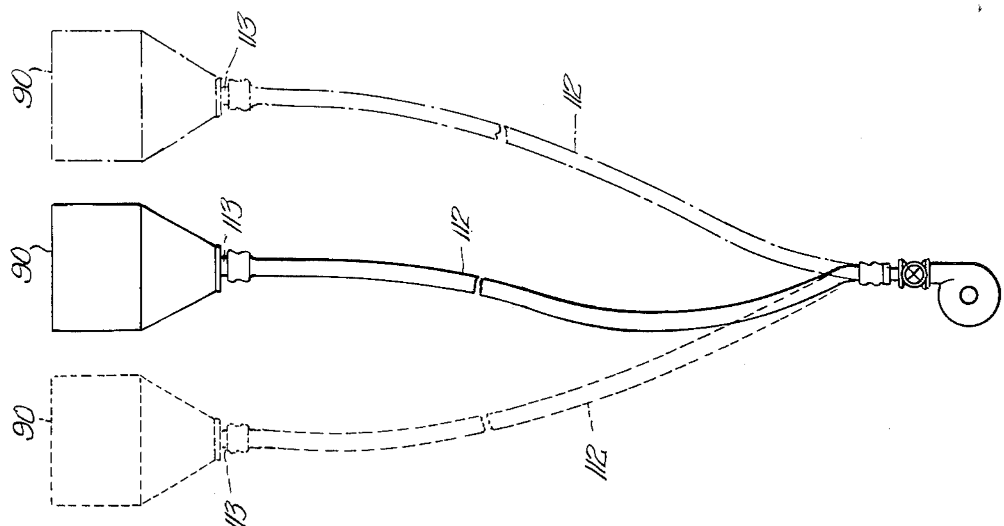
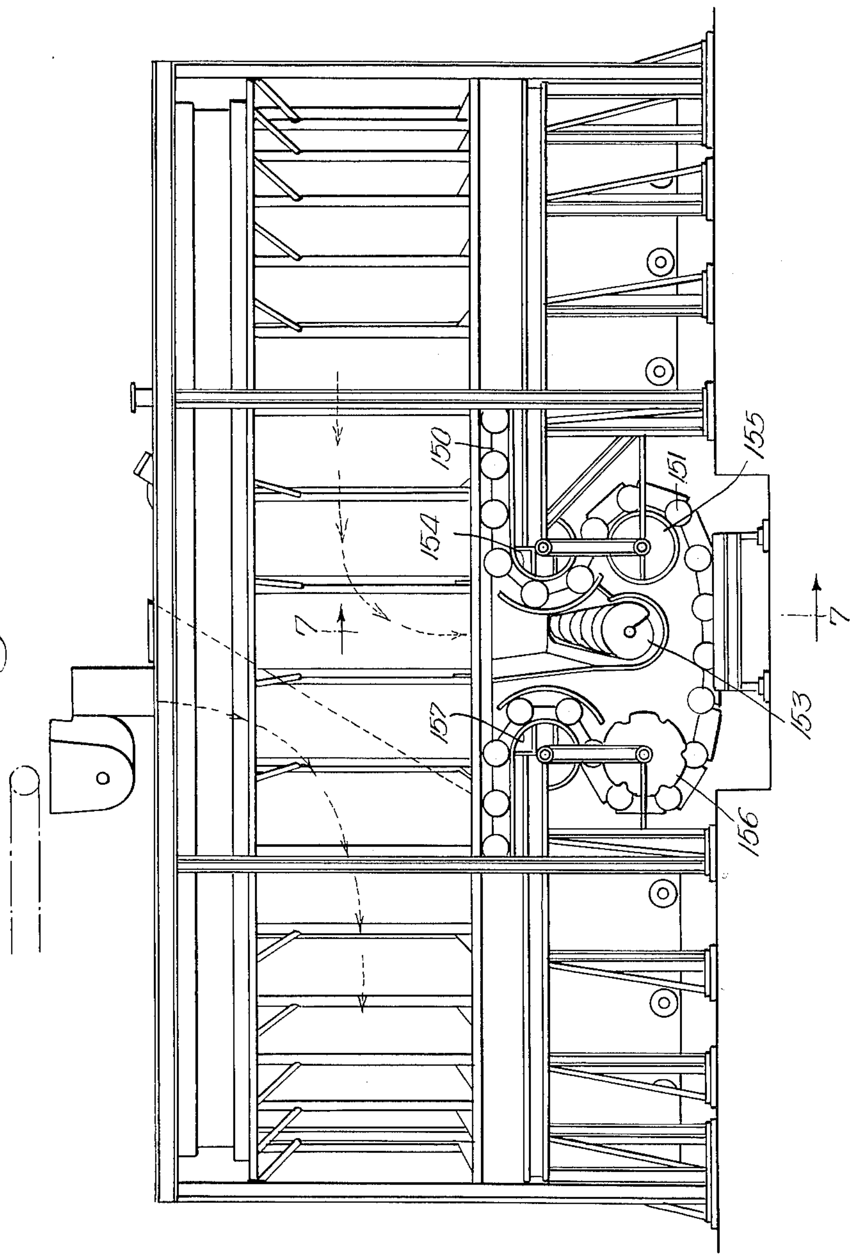


Fig. 5C

INVENTORS
Harold F. Silver,
Clarence R. Steele,
Frank B. Price,
BY
Byron, Hume, Groen + Clement
Attys

Fig. 6



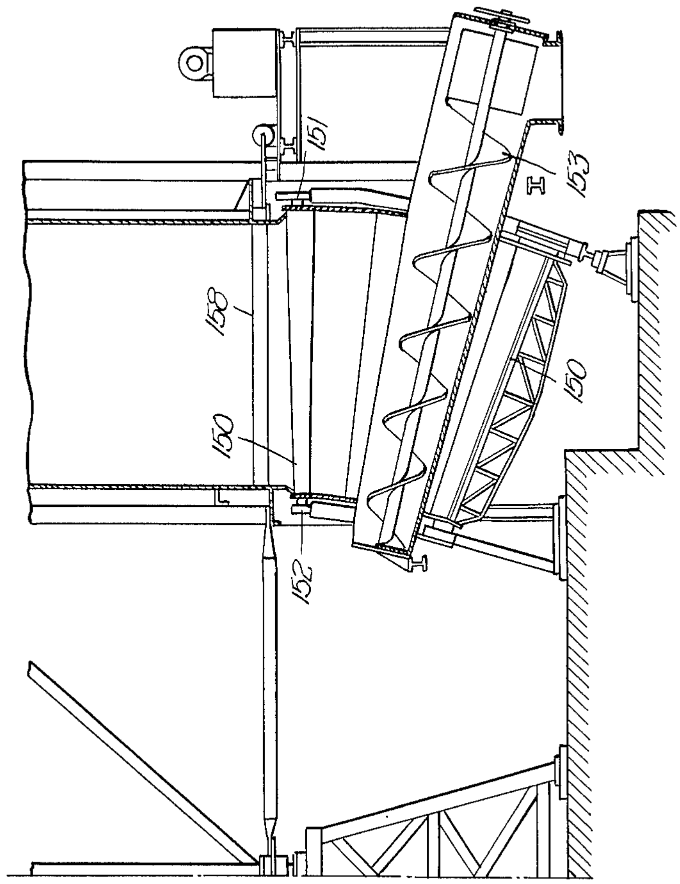
INVENTORS.
Harold F. Silver,
BY Clarence R. Steele,
Frank B. Price,
Byron, Hume, Groen & Clement
Attys.

April 26, 1966 H. F. SILVER ETAL 3,248,263

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 8

Fig. 7



INVENTORS:
Harold F. Silver,
BY Clarence R. Steele,
Frank B. Price,
Byron, Hume, Groen & Clement.
attys

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 9

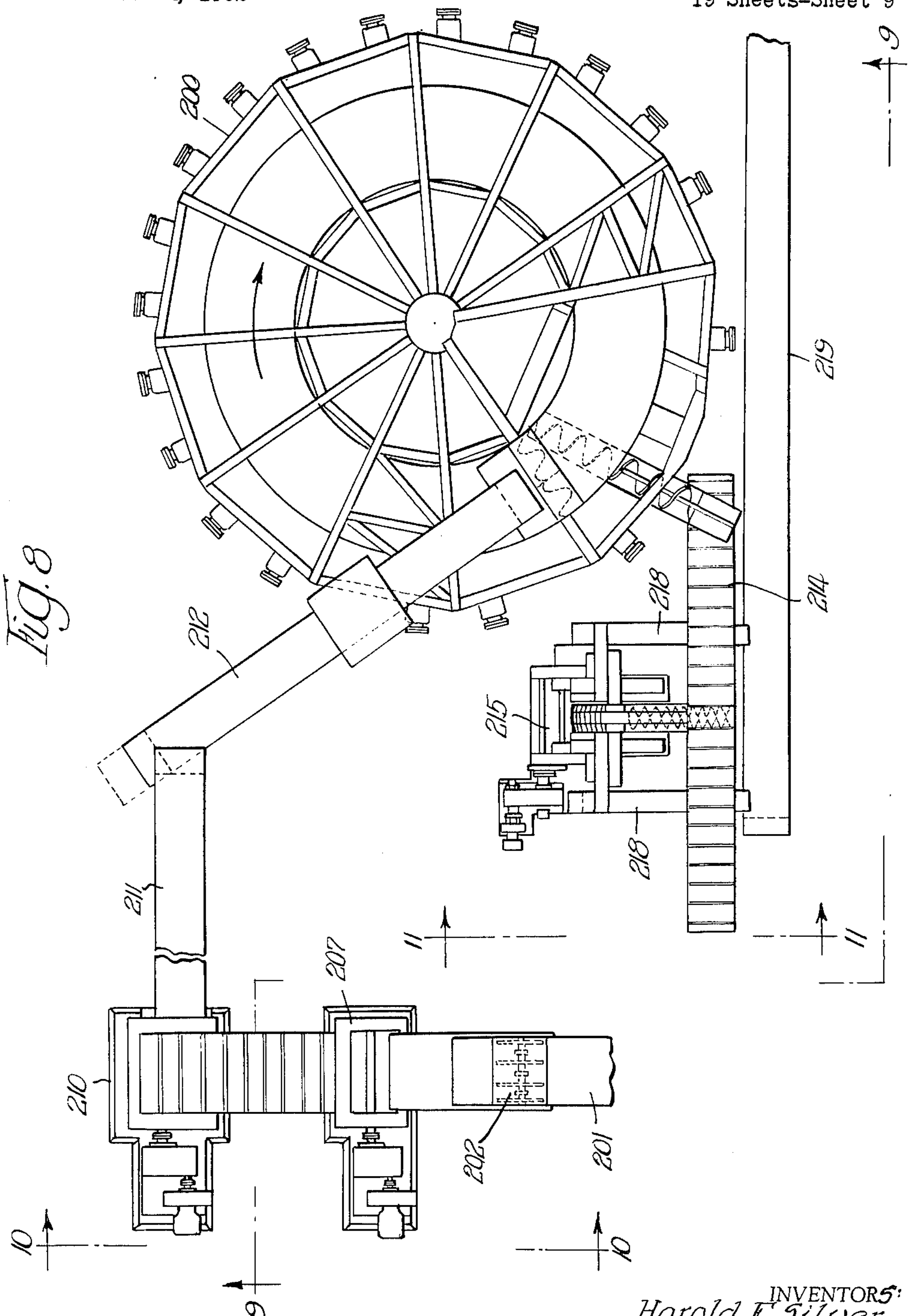


Fig. 8

INVENTORS:
Harold F. Silver,
Clarence R. Steele,
Frank B. Price,
BY
Byron, Hume, Groen + Clement.
Attys

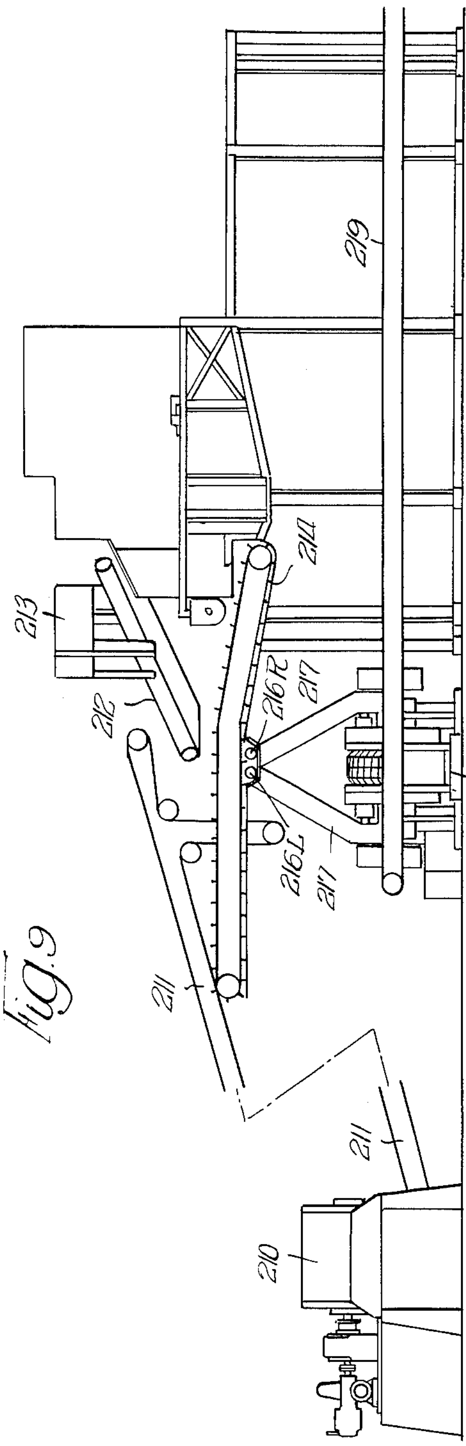


Fig. 9

INVENTORS.
Harold F. Silver,
Clarence R. Steele,
BY Frank B. Price,
Byron, Hume, Groen + Clement.
attys.

April 26, 1966 | H. F. SILVER ETAL | 3,248,263

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 | 19 Sheets-Sheet 11

Fig. 10.

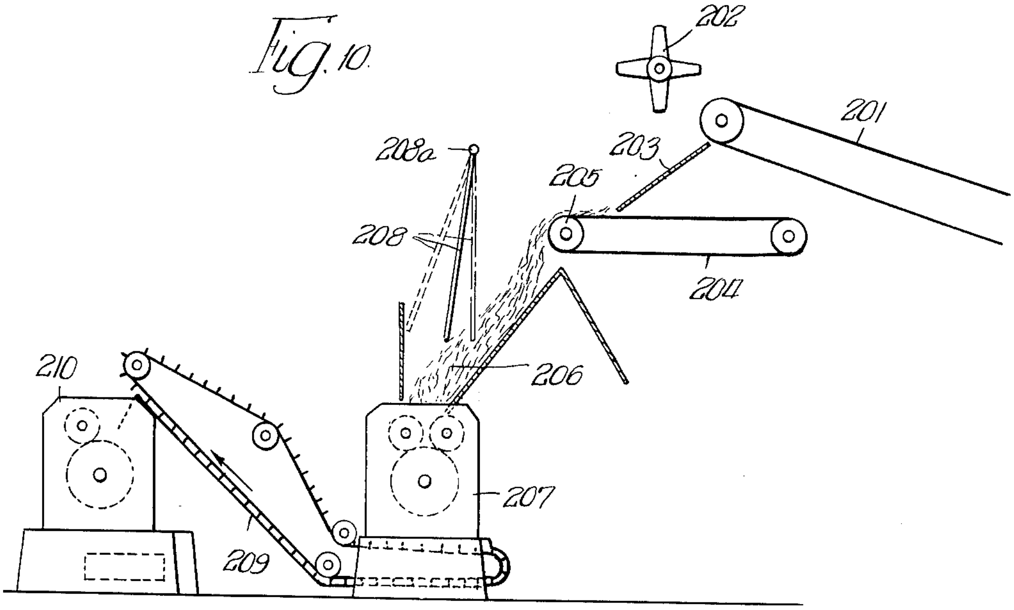
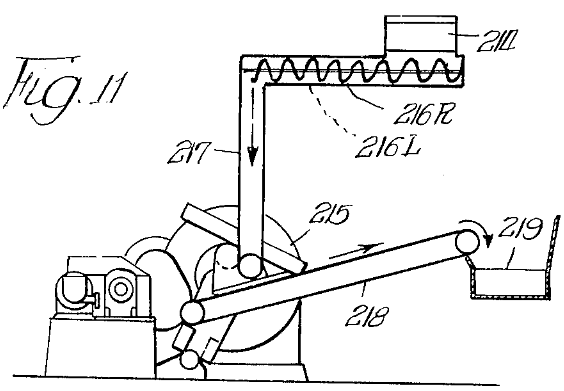


Fig. 11



INVENTORS.
Harold F. Silver,
Clarence R. Steele,
Frank B. Price,
BY
Byron, Hume, Groen + Clement
attys.

April 26, 1966 H. F. SILVER ETAL 3,248,263

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 12

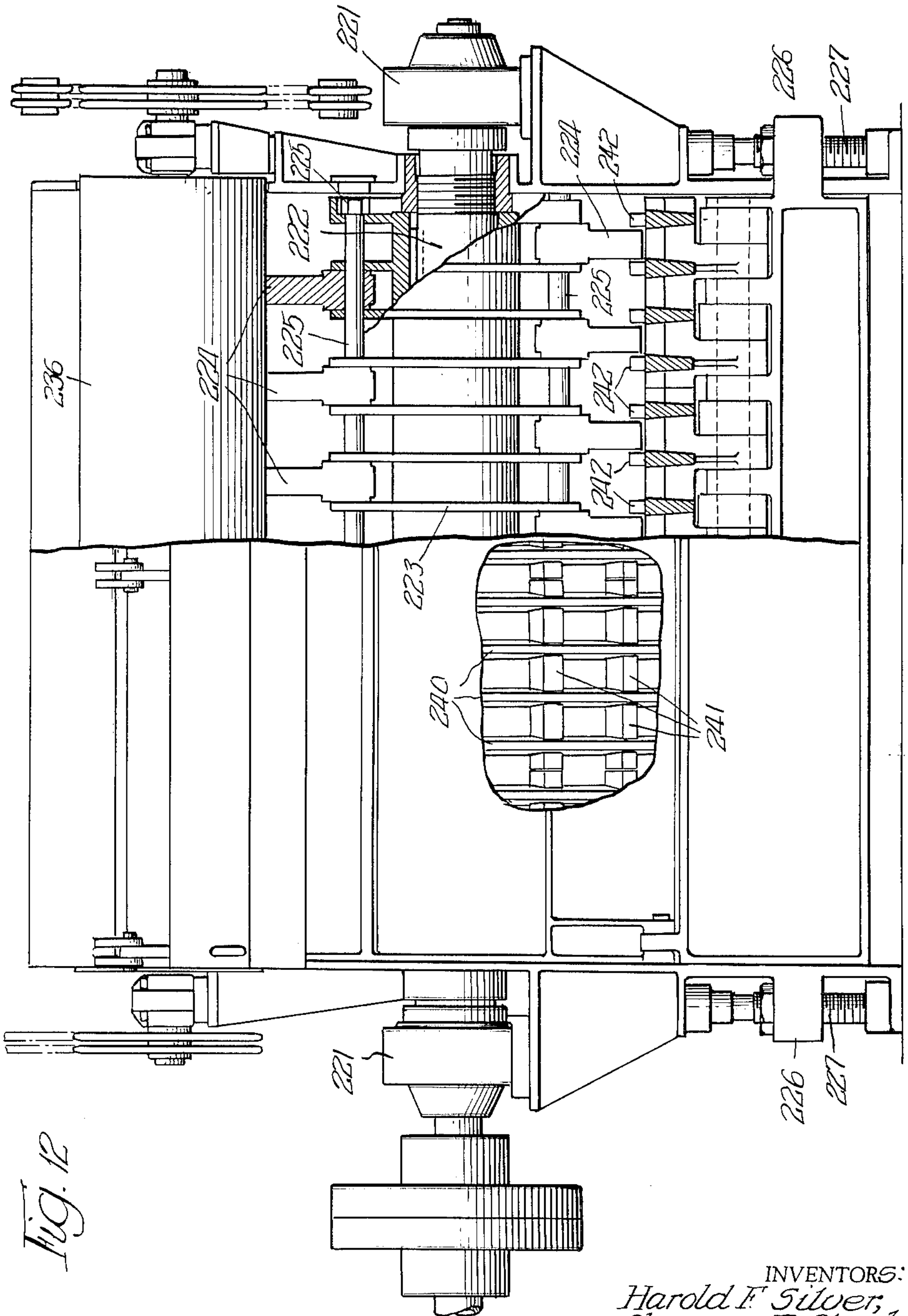


Fig. 12

INVENTORS:
Harold F. Silver,
BY Clarence R. Steele,
Frank B. Price,
Byron Hume, Groen + Clement.
attys.

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 13

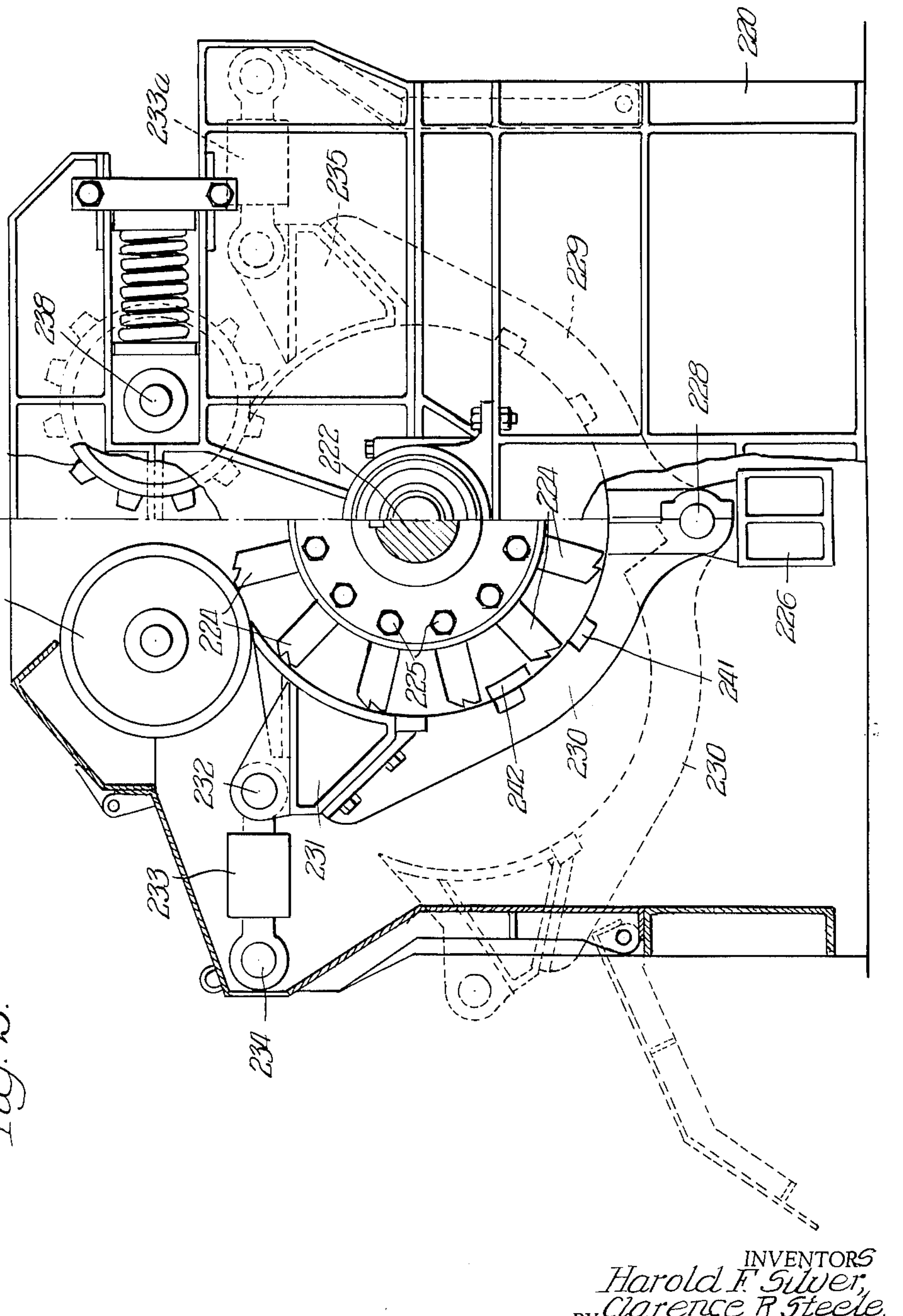


Fig. 13.

INVENTORS
Harold F. Silver,
Clarence R. Steele,
BY Frank B. Price,
Byron, Hume, Groen + Clement.
Attys

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 14

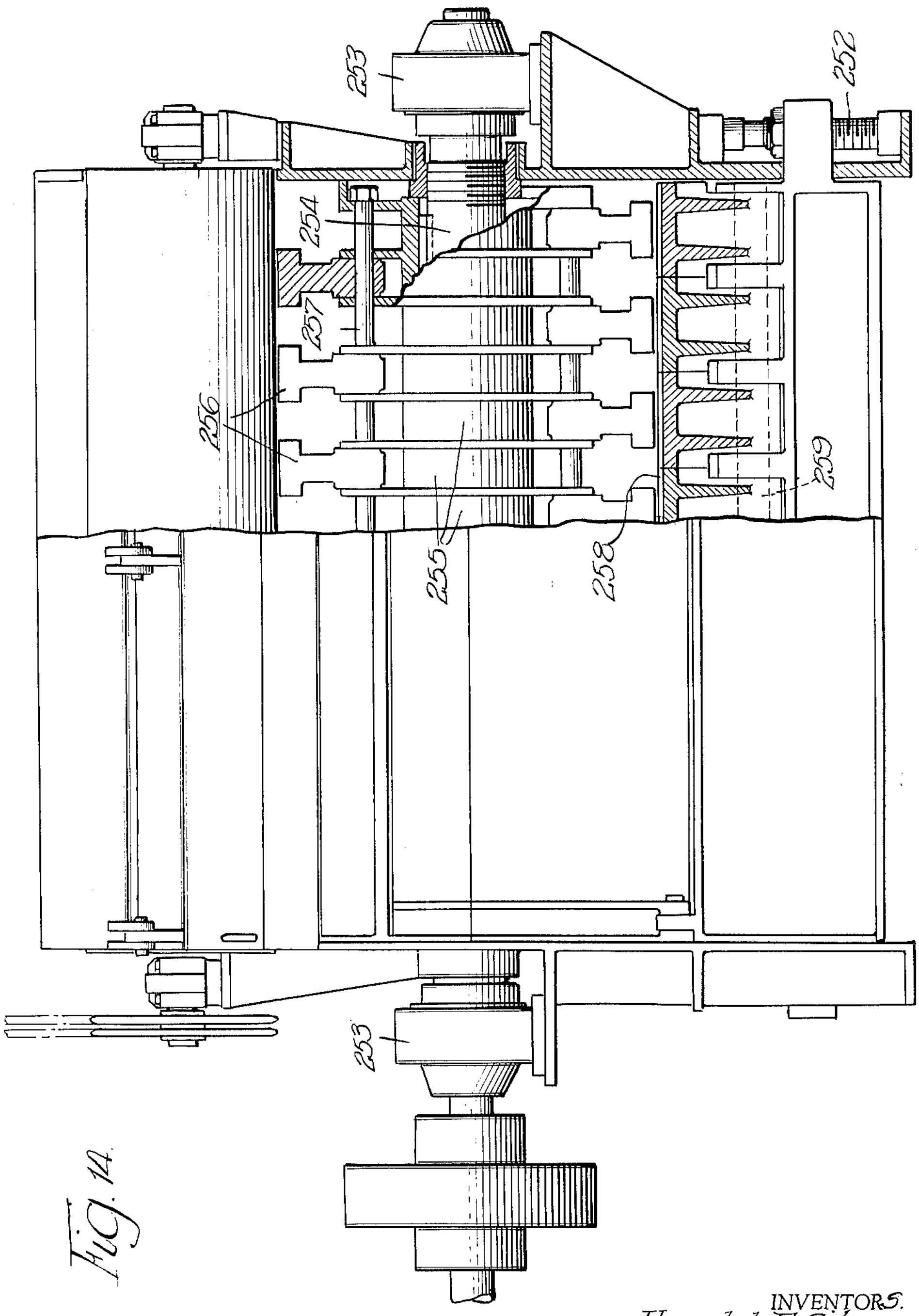


Fig. 14

INVENTORS.
Harold F. Silver,
Clarence R. Steele,
Frank B. Price,
BY
Byron, Hume, Groen & Clement
attys.

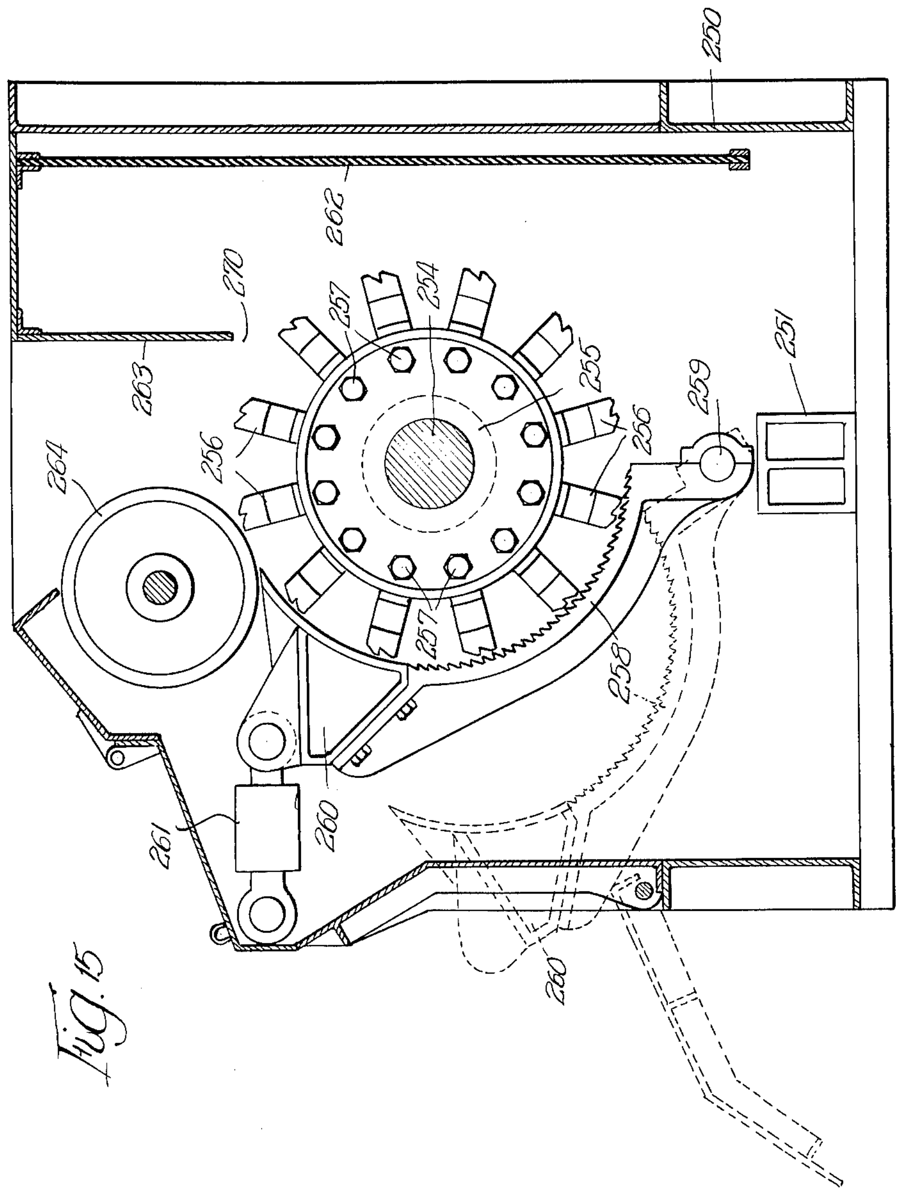
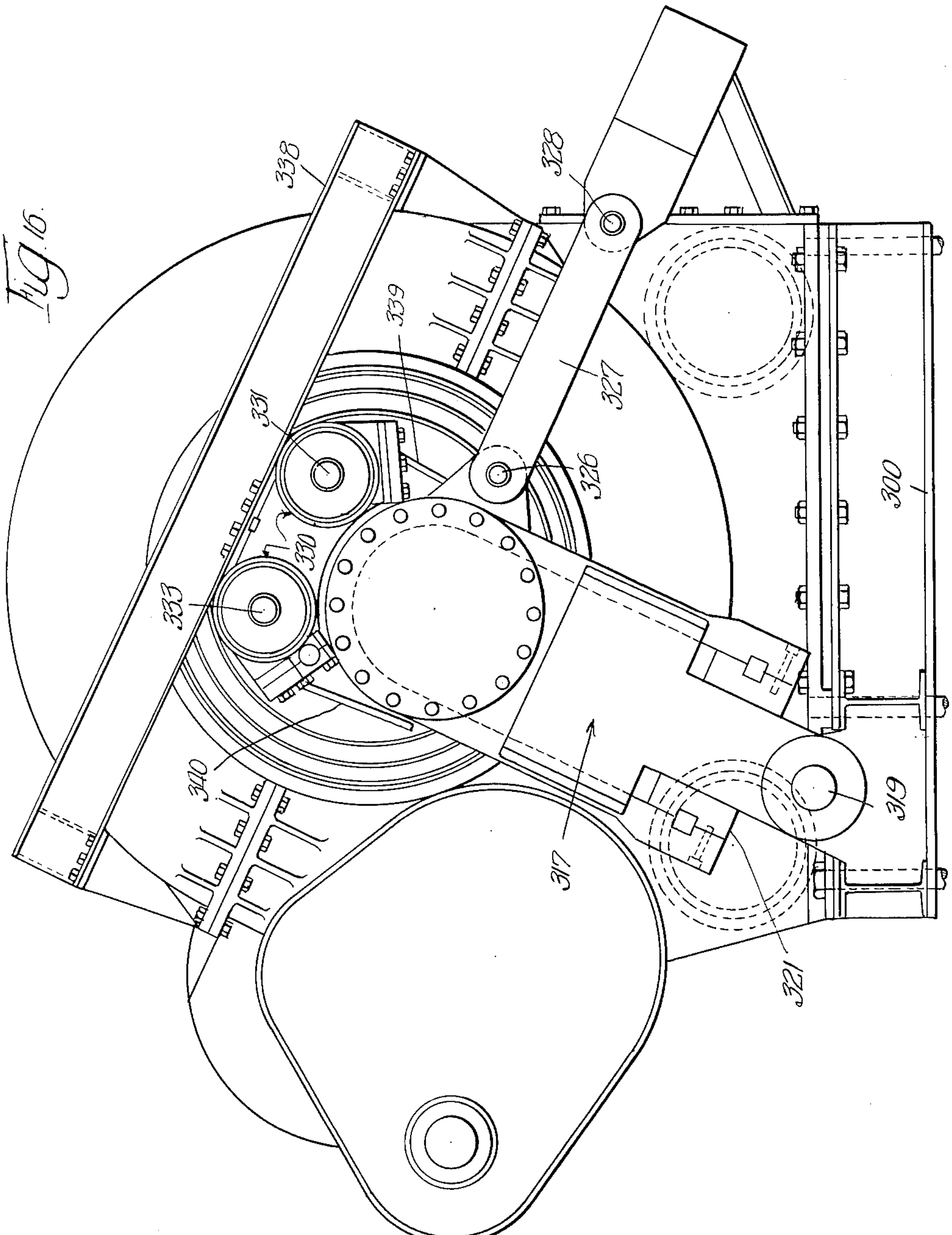


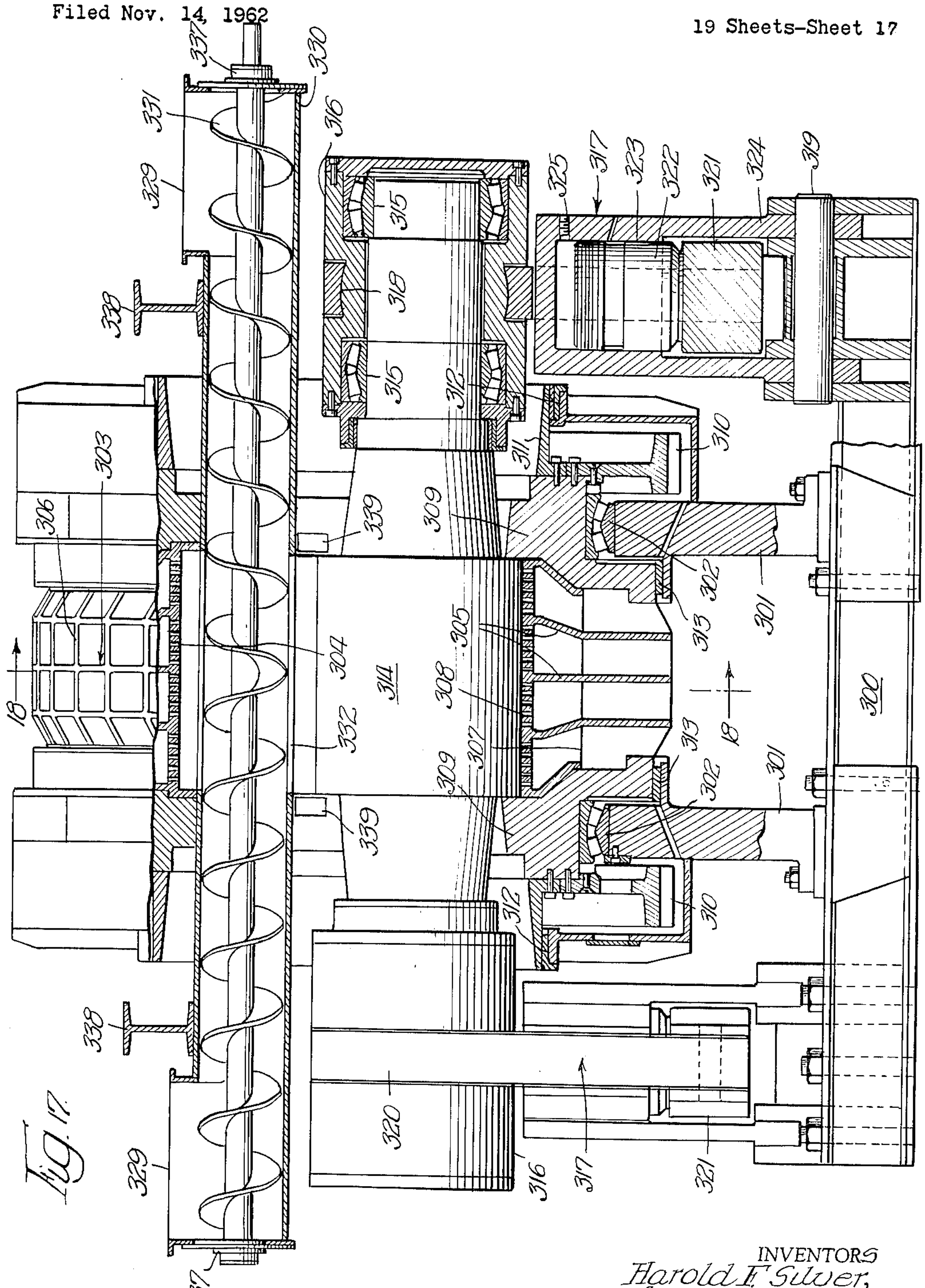
Fig. 15

INVENTORS
Harold F. Silver,
BY Clarence R. Steele,
Frank B. Price,
Byron, Hume, Groen & Clement
attys

Fig. 16.



INVENTORS:
Harold F. Silver,
Clarence R. Steele,
BY Frank B. Price,
Byron, Hume, Groen & Clement
attys



INVENTORS
Harold F. Silver,
Clarence R. Steele,
BY Frank B. Price,
Byron, Hume, Groen & Clement
attys.

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 18

Fig. 18

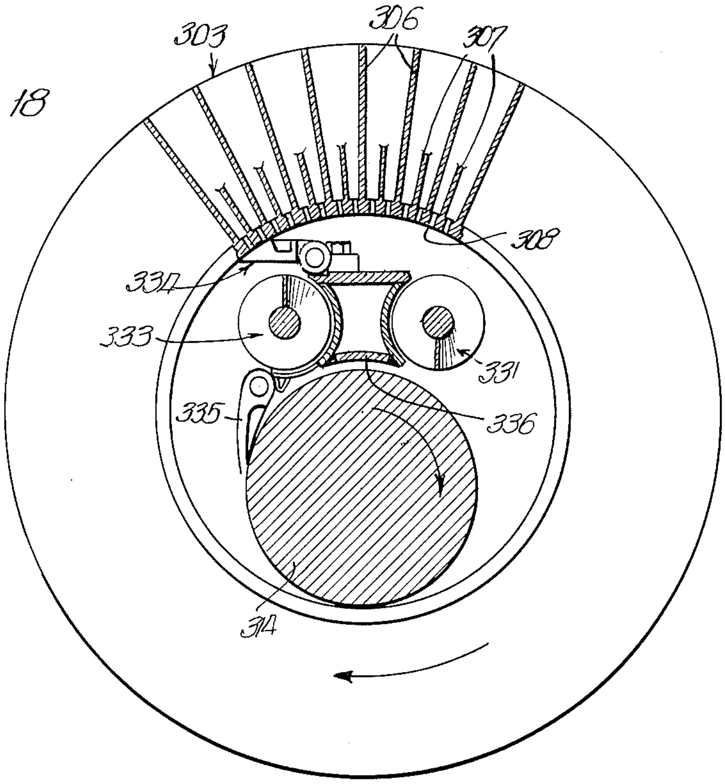
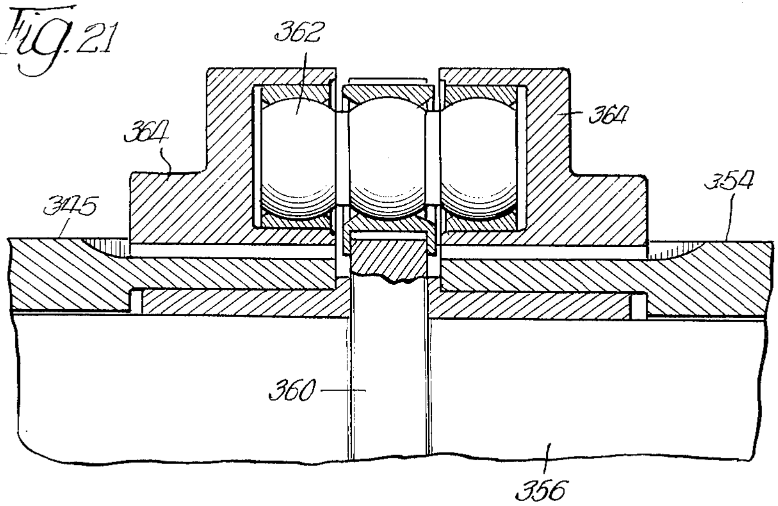


Fig. 21



INVENTORS
Harold F. Silver,
Clarence R. Steele,
BY Frank B Price,
Byron, Hume, Groen + Clement.
attys.

April 26, 1966 H. F. SILVER ETAL 3,248,263

SOLVENT EXTRACTION PROCESS

Filed Nov. 14, 1962 19 Sheets-Sheet 19

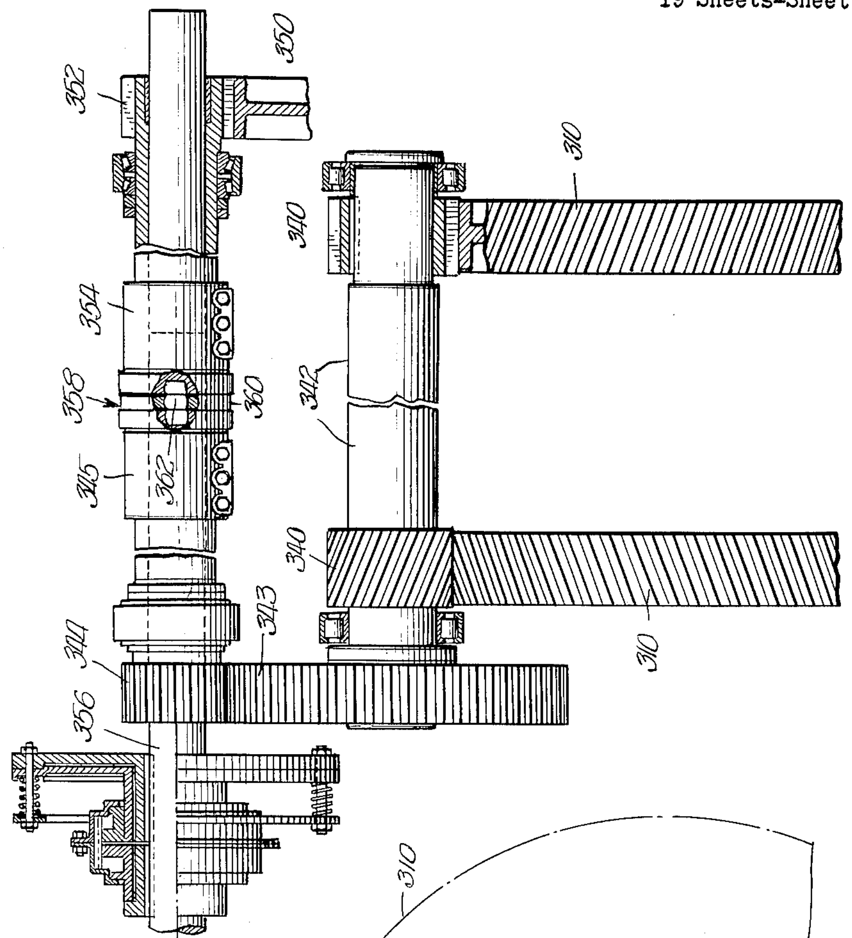


Fig. 19

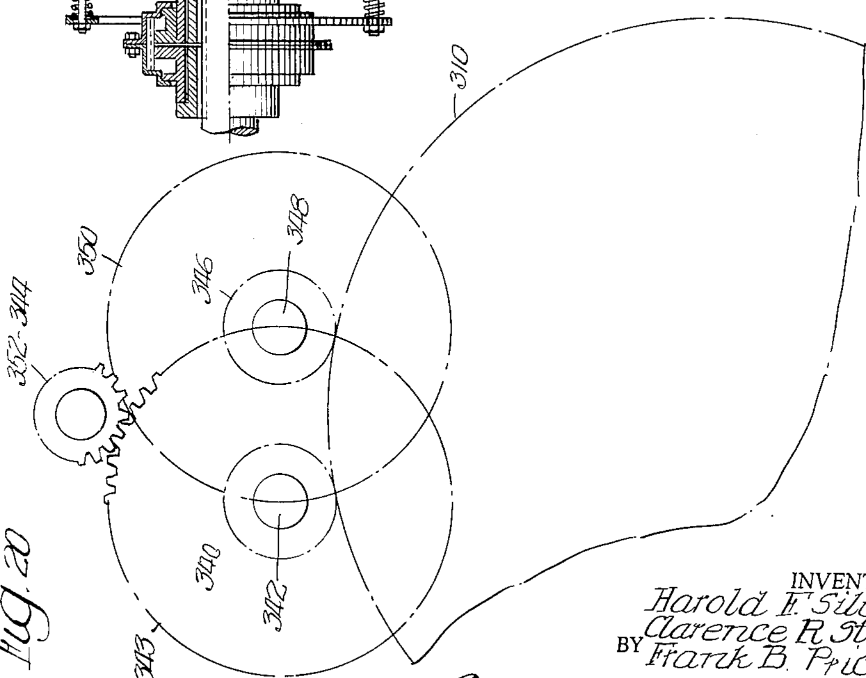


Fig. 20

INVENTORS
Harold F. Silver,
Clarence R. Steele,
BY Frank B. Price,
Byron, Hume, Groen & Clement
attys

United States Patent Office 3,248,263
Patented Apr. 26, 1966

1

3,248,263
SOLVENT EXTRACTION PROCESS
Harold F. Silver, Clarence R. Steele, and Frank B. Price, Denver, Colo., assignors, by direct and mesne assignments, to American Factors Associates, Limited, Honolulu, Hawaii, a corporation of Delaware
Filed Nov. 14, 1962, Ser. No. 237,575
13 Claims. (Cl. 127—45)

This invention relates to a new and improved process for removing or extracting, by the use of a suitable solvent or solvents, soluble substances from subdivided solids by diffusion, leaching, or lixiviation.

This invention also relates to new and improved apparatus which is especially adapted for use in carrying out the process of this invention.

More specifically, the process and apparatus of this invention are designed to carry out the removing and extracting procedure of the type referred to by a continuous operation, as distinguished from a bath operation, and to effect such removal or extraction by employing an essentially counter-current flow or movement between the mass of subdivided solid material undergoing treatment and the extracting solvent or solvents employed.

In processes of this type which employ solvent as the liquid extracting medium it necessarily follows that recovery of the soluble substance free from the solvent requires subsequent separation of the two, which is a costly procedure. Accordingly, an objective for an improvement in this art is that of securing the removal and recovery of the maximum quantity of soluble substance while employing for that purpose the smallest possible amount of solvent.

Theoretically the counter-current relative movement of the solid material and the solvent is well suited to diffusion, leaching, and lixiviation procedures, and good practical usage has been made of such practice in the past. However, as far as these applicants know all prior art procedures of this general type which have employed counter-current relative movement between the solids and solvent to effect such extraction have left a great deal to be desired from the standpoint of providing a procedure which employs a solids and solvent relationship which adequately approaches the ideal for the most efficient extraction. Theoretically, the greatest efficiency would be achieved, other circumstances permitting, if each drop of the liquid solvent were brought successively into diffusing, leaching, or lixiviating contact with each particle of the solid material, in that sequence or order establishing a true counter-current flow therebetween.

Whereas such an ideal operation is desirable in principle it poses an impossible problem from the practical standpoint, but, at the same time, it is to be understood that in this art improvement does lie in the direction of approaching as closely as possible the theoretically ideal flow contact relationship between the solids and the solvents.

Another objective in this art is that of maintaining at all times, best possible solids and solvent conditions with respect to the relative quantities of each throughout the entire mass of material undergoing treatment.

Based on these considerations the present invention proceeds upon the principle of providing an process and apparatus which establishes and maintains an elongated continuous uninterrupted mass of subdivided solid material to be treated of substantially rectangular cross-section, having substantially uniform bulk density and permeability throughout, said mass having its length extending horizontally, preferably on the circumference of a circle, but on a straight or other line if desired, its width defined by vertical side faces and its depth maintained at all times at a substantially constant dimension with the upper face thereof constituting a substantially horizontal even surface disposed at a level which gives to said mass a depth dimension of substantial magnitude. It is to be understood, however, that the solid material will become slightly compacted as it travels through the treatment zones, and to this extent the bulk density and permeability thereof will be slightly altered.

2

The process of this invention provides for the close lateral confinement of the side faces of said mass without frictional or other disturbance. The apparatus of this invention provides for closely contacting confining side walls immediately adjacent the side faces of said mass to contain the solvent placed thereon without relative movement between the side walls and said mass, for confining the solvent to the desired downward travel throughout said mass without channeling or otherwise undergoing non-uniform flow action. The downward flow of the solvent is therefore characterized as being carried out without disturbance or movement of the material of said mass such as would result from a relative sliding movement between the containing side walls and the mass itself. Such relative movement not only would continuously agitate and disturb the uniform character and disposition of the mass itself, thus producing channeling or other unwanted actions, but would also disturb the relatively quiescent downward movement of the solvent in a manner detrimental to the high efficiency resulting from this invention and, in addition, would prevent the successful practice of clarification procedures, hereinafter more fully explained, contemplated for this invention.

The process and apparatus of this invention accordingly provide for the continuous application of fresh subdivided solid material at one end of said mass and the continuous removal, at a corresponding rate, of spent solid material from the other end of said mass, while at all times maintaining conditions which will cause the material of said mass to be deposited in a condition of substantially uniform bulk density and permeability with a substantially level and even top surface and in close non-channeling and supported contact with the side walls.

In addition, the process and apparatus of this invention provide for the desired gravitational passage of the solvent liquid through a limited and particular zone or portion of the mass so that fresh liquid first encounters the most spent material and also in such manner that the continuous stream of liquid fed to the top of said zone or portion of said mass comes in contact for diffusing, leaching, or lixiviating activity with a vertical column of said mass of substantial depth but of relatively small cross-sectional area. In addition, the zones of treatment are determined solely by the control of the supply of liquid solvent employed and not by partitions intersecting the mass. In other words, this invention provides that the mass from end to end shall be continuous, uninterrupted, and uniform and thus free of dividing walls or partitions or any other similar structures such as would create pockets or corners or other spaces that will not uniformly fill as required. Thus the continuous character of the mass renders it free from channeling or any tendencies which would interfere with the uniform flow, association, and contact between the solids and liquids as required for this invention.

After the first downward pass of the solvent liquid is accomplished, as above set forth, the liquid is continuously collected at a point below the treated zone or mass column and returned to the top of the mass and deposited on the next adjacent zone or column and thereafter again collected at the bottom and again returned to the top, repeatedly on and on progressively to the end that the liquid undergoes successive passes through the respective columns or zones in the direction moving from the end of the spent material toward the end where the fresh material is added to the mass.

In addition to the foregoing, the process and apparatus of this invention contemplate selectively locating the solvent distributors positioned above the mass longitudinally thereof so as to alter, within limits, the location of the solvent outlets, respectively, with respect to the collecting zones or tanks positioned below the mass.

It should be understood that any particular material undergoing treatment will have its own peculiar permeability characteristics, depending upon its nature and its preparation and, accordingly, the time interval for the passage of solvent therethrough will depend on the particular material being processed. The control of the ultimate destination of the solvent in the underlying solvent receiving zones or tanks must take into account this permeability factor and the rate of speed at which the material is moved relative to said zones or tanks. This involves a longitudinal adjustment of the solvent outlets with respect to the underlying solvent receiving zones or tanks.

The ideal operation of the process requires that the solid material be so prepared that its permeability rate will permit just 100% of the overall solvent throughput to pass successively through each solvent outlet, each treatment zone of the said mass, and each bottom collecing zone, thus creating the longest possible effective path of solvent travel through the said mass without recirculation through any individual treatment zone; and this, while maintaining the maximum amount of solvent in contact with the said mass.

With the solid material thus prepared, there will be a certain position of the solvent outlets that will permit such operation without flooding of solvent at the top of the said mass.

If the preparation of the solid material is such that its permeability rate will not permit the passage of the said 100% of solvent throughput through each treatment zone, then the solvent outlets must be adjusted in the direction of solvent advance, and flooding at the top of the said mass will be avoided because part of the solvent will be advanced greater than one treatment zone.

If the permeability rate of the solid material is such that only 50% of the overall solvent throughput will pass through each treatment zone, there will in effect be created two separate paths of solvent travel, each skipping intermediate treatment zones, and this will result in an effective length of solvent travel one-half that at the said 100% operation.

Intermediate permeability rates will call for intermediate adjustments of the solvent outlets, and will result in intermediate lengths of effective solvent travel.

If the preparation of the solid material is such that its permeability rate is so great that the maximum amount of solvent cannot be maintained in contact with the said mass at the said optimum 100% operation then the solvent outlets will be adjusted in a direction opposite that of the solvent advance, and there will be partial recirculation of solvent through each solvent outlet and treatment zone. In general, recirculation of solvent in a treatment zone of substantial depth results in reduced extraction that partially offsets the advantage of maintaining maximum contact of solvent and solids. Therefore, any preparation of the solid material that permits a solvent flow substantially in excess of the said 100% operation, with consequent recirculation, will usually be found to be undesirable. However, in some instances recirculation may prove to be desirable, and the process and apparatus are capable of operation in such manner.

The flow of solvent should be such that the solvent quickly penetrates the top of the mass and passes downwardly with some lateral spreading to contact the material constituting the particular column or zone of the mass selected for treatment by a particular solvent outlet. The slight pooling that occurs immediately beneath the outlets should be confined to this limited area and the solvent should quickly disappear as a result of its downward passage into the mass so that there will be no overall pooling on top, such that the solvent from the individual successive outlets can run and mix together.

A further feature of the invention is to provide a process and apparatus which permits the solvent at the point of highest concentration where it is removed from the system to be filtered and thus cleansed by passage through the mass of material undergoing treatment which itself has previously been cleansed by washing with the same juice on a prior pass in the circulation.

As another feature of this invention a process and apparatus are provided which include the steps and mechanisms above referred to for diffusing, leaching, or lixiviating, which are especially adapted for use in extracting sugar from sugar cane. In this form of the invention a system is provided which employs diffusion, leaching, and lixiviation of the above described type, together with mechanism for processing the cane prior to its introduction into the diffuser, and an additional mechanism for receiving the spent cane and subjecting it to a pressing action for the recovery of a substantial portion of the residual juice. In a system of this type for processing sugar cane, it is highly important that such residual juice be recovered and returned to the diffusing process.

With respect to this aspect of the invention it is important to reduce the cane to a fiberized mass made up of individual fibers with associated pith. The cane is so prepared by subjecting it, in the manner hereinafter described, to the action of two novel pieces of equipment herein defined as a cane buster and a cane fiberizer. In addition the preferred action with respect to the pressing of the spent cane, commonly called "bagasse," may be carried out in apparatus of the type hereinafter defined and claimed as a bagasse press. The spent cane before pressing will hereinafter be called "wet bagasse" and after pressing "pressed bagasse."

In the light of the foregoing it may be understood that it is an object of this invention to provide a process and apparatus which is capable of carrying out an extraction for removal of soluble substances by the use of a suitable solvent or solvents from subdivided solid material by diffusion, leaching, or lixiviation, which is characterized as having a higher efficiency productive of a greater yield with the minimum amount of solvent. By way of illustration and as applied to the diffusion of sugar from sugar cane, this invention is capable of extracting high percentages of sugar when operated at a draft as low as approximately 100. As used here, "draft" should be understood to mean the weight of diffusion juice leaving the diffuser expressed as a percentage of the weight of the "prepared cane" entering the diffuser. "Prepared cane" is the total cane entering the diffuser, including trash, dirt, leaves, and any other foreign material.

A further object of this invention is to provide a process for extracting sugar from sugar cane which produces juice of greater clarity.

It is a further object of this invention to provide a process and apparatus through the use of which juice may be extracted from sugar cane which is purer than such extracts of the prior art or, in other words, is productive of sugar juice having less impurities dissolved therein.

It is a further object of this invention to provide a system of the type referred to which employs apparatus for fiberizing the cane to a particular form and consistency which is productive of an appropriate permeability and is conducive to a good diffusion, leaching, and lixiviating action.

A further object of the invention is to provide new and improved constructions for such fiberizing devices.

It is a further object of the invention to provide a new and improved bagasse press of the type adapted for use in a cane sugar extracting system herein referred to.

It is a further object of the invention to provide a system for extracting sugar from sugar cane in which a bagasse press is employed to recover residual juice from the wet bagasse and in which such recovered juice is returned to the diffusion system.

Other objects and advantages of this invention will be apparent to one skilled in this art as the following description proceeds. As illustrative of the invention reference will now be made to the particular forms thereof illustrated in the accompanying drawings in which:

FIGURE 1 is a side elevational view partly in cross-section of a continuous diffusing, leaching, or lixiviating mechanism constructed in accordance with this invention and capable of carrying out the process herein described and claimed;

FIGURE 2 is a plan view of the mechanism illustrated in FIGURE 1;

FIGURE 3 is a side elevational view of the device shown in FIGURE 1 taken from a position at 90° from that of FIGURE 1 as viewed from the right. This figure is partly in cross-section to illustrate the feeding mechanism;

FIGURE 3A is an elevational view in cross-section showing the construction of the scroll housing and its relationship to the scroll as employed in this illustrated embodiment of this invention.

FIGURE 4 is a diagrammatic showing of the operation conducted in the device illustrated in FIGURES 1 to 3, inclusive, illustrating the disposition of the solvent outlets with respect to the respective collecting receptacles below the mass being treated, all as disposed when a typical 100% circulation of the liquid is being effected;

FIGURE 5 is an enlarged elevational view partly in cross-section of the solvent outlet mechanism illustrated in the upper left hand corner of FIGURE 1;

FIGURE 5A is a plan view showing the solvent outlet trough illustrated in FIGURE 5;

FIGURE 5B is an elevational view in cross-section taken on the line 5B—5B of FIGURE 5A and looking in the direction of the arrows;

FIGURE 5C is an end view of the solvent outlet trough illustrated in FIGURES 5 and 5A and including the associated pump and connecting hose. The dotted and dot and dash line representations show the adjustable nature of the solvent outlet troughs and the flexibility of the hose connection with the pump;

FIGURE 6 is a side elevational view of a modified form of diffusing device of the general type illustrated in FIGURE 1 characterized as having a bottom section permitting the passage of the spent material from the bottom of the diffuser instead of at the top as illustrated in FIGURES 1 to 3, inclusive;

FIGURE 7 is a fragmentary cross-sectional view in elevation taken on the line 7—7 on FIGURE 6 and looking in the direction of the arrows;

FIGURE 8 is a plan view of a system incorporating a diffusing, leaching, or lixiviating mechanism of the type illustrated in FIGURES 1 to 3, inclusive, especially adapted for processing sugar cane and which incorporates in addition to the extracting mechanism a cane buster and a cane fiberizer for preparing the cane from the field, preparatory to its introduction into the extractor, and also a bagasse press for removing from the spent cane a substantial portion of the residual juice that is carried out with it;

FIGURE 9 is a side elevational view taken on the line **9—9** of FIGURE 8 and looking in the direction of the arrows;

FIGURE 10 is an elevational view taken on the line **10—10** of FIGURE 8 and looking in the direction of the arrows;

FIGURE 11 is a side elevational view of the bagasse press as viewed along the line **11—11** of FIGURE 8 and looking in the direction of the arrows;

FIGURE 12 is a side elevational view of the cane processing mechanism herein referred to as a cane buster, partly in cross-section to show the disposition of the busting hammers and with the covering wall removed from another portion of the figure to disclose the anvil construction of the buster;

FIGURE 13 is an end elevational view of the cane buster illustrated in FIGURE 12, partly in cross-section and with a portion of the end frame removed;

FIGURE 14 is a side elevational view similar to that of FIGURE 12, illustrating the construction of the cane fiberizer;

FIGURE 15 is an end elevational view of the fiberizer illustrated in FIGURE 14, partly in cross-section and with its end frame removed to show the internal construction;

FIGURE 16 is a side elevational view of the bagasse press;

FIGURE 17 is an elevational view of the bagasse press as illustrated in FIGURE 16, partly in cross-section along the axis thereof;

FIGURE 18 is a view of the bagasse press illustrated in FIGURES 16 and 17, taken on the line **18—18** of FIGURE 17 and looking in the direction of the arrow;

FIGURE 19 is a view of the gearing mechanism employed for driving the bagasse press illustrated in FIGURES 16 to 18, inclusive;

FIGURE 20 is a diagrammatic view in elevation showing the arrangement of the driving gears shown in FIGURE 19;

FIGURE 21 is an enlarged cross-sectional view showing one of the pins of the equalizing coupling of the gearing illustrated in FIGURE 19.

Referring now to FIGURES 1 to 3, inclusive, it will be noted that the device here illustrated comprises a pedestal **1** which has an upstanding post **2** extending vertically therefrom and on which may be mounted a rotary bearing member **3** to which is suitably attached a series of radially extending struts **4—4**. These struts may be of any suitable number and they extend outwardly for attachment to the rotary annular shaped material-holding chamber designated **5**.

Surrounding the pedestal **1** and disposed on the arc of a circle are a plurality of pairs of supports **6** and **6*a*** disposed about the axis of the upstanding post **2** as its center. Outward therefrom are a plurality of pairs of supports **7** and **8**, respectively, also arranged on the arc of a circle and disposed concentrically with respect to the sets of supports **6** and **6*a***. The outer post **8** of each of the outer pairs extends upwardly as shown in FIGURES 1 and 3 and is connected with a cross beam **9** which extends radially inwardly to the center attachment **10** on the post **2**. As shown in FIGURE 2 a plurality of beams **9** of any suitable number may be employed, depending upon the size of the machine, and may be disposed in the manner illustrated in the drawing. Diagonal braces **11—11** may be provided as desired.

Between supports **6** and **6*a*** there is preferably mounted a cross support **12** mounting a suitable spring **13** which supports a guided yoke **14** carrying the supporting rollers **15—15**. Similar rollers are mounted between each set of supports **6** and **6*a*** and also between each set of supports **7** and **8**. Above the rollers are a series of radially disposed beams **16—16** which are attached at their inner ends to the radial struts **4—4** and which are equipped with two track-like surfaces adjacent their ends, respectively, as shown at **19** and **20**, in FIGURE 1. It will be noted that these tracks are located so as to contact the rollers 15—15 and are circular so as to extend entirely around the machine for supporting the multiplicity of radial beams 16—16. Extending from each of the beams is a pair of upright supports 21—21 to which are mounted side walls 22—22, respectively. Located between the side walls adjacent the bottom thereof and supported by the series of radial beams 16—16 is an anular shaped perforated floor 24 which forms with the side walls 22—22 an unobstructed annular chamber, supported on the rollers 15—15 and adapted to rotate around the axis of the center post 2. Such rotation may be effected by suitable hydraulic means 25—25 which engage with a suitable rack not shown, disposed on the outer surface of the rotating chamber 5 whereby the chamber and its contents may be suitably rotated at any desired speed in the direction illustrated by the arrow in FIGURE 2.

Located below the rotating chamber are a plurality of solvent collecting tanks T1 to T18, inclusive, as illustrated in FIGURES 1 and 3 and as diagrammatically represented in FIGURE 4. Each tank is equipped with a pump referred to, respectively, as P1 to P18, inclusive, which draws liquid from its associated tank and pumps it to a corresponding solvent outlet identified, respectively, as S1 to S18, inclusive. Tank T1 is a relatively large one, as is tank T18. The intervening tanks, namely, tanks T2 to T17, inclusive, are, it will be noted, progressively smaller for the purpose of decreasing the area of the draining activity as the solvent advances progressively toward the end of the apparatus where the fresh material is added. It is found that in normal practice the fresh material is less compacted at the point of introduction and, therefore, is more permeable, and admits of a throughput of more solvent per unit area. In order, therefore, to maintain substantially the same quantity of solvent collected in each particular tank in a given unit of time, it is necessary to reduce progressively the area of the tanks, respectively, in the direction toward the end where the fresh material is added.

As shown in FIGURE 4, fresh cane or other material may be fed to the apparatus from a suitable belt or other conveyor 40 and is preferably fed on to an inclined wall 41 which feeds the same to scroll 42 in the manner illustrated. As best shown in FIGURE 2 the scroll 42 has oppositely wound spiral flights thereon extending from a point on the scroll located approximately on the center line of gravity of the underlying mass of material in the chamber 5. The rotation of the scroll may be effected by a suitable motor 43 in a direction which feeds the material, passing from the conveyor 40, outward from said center line and so as to cause the material to be discharged over the lip 44 of the housing which partially surrounds the scroll. This lip 44 may be inclined from said center line downwardly in opposite directions towards the ends thereof so as to co-act with the scroll in the production of a uniform feed of the material supplied to the apparatus throughout the width of the material-holding chamber 5.

The feeding of the material with substantially uniform density across the width of the mass and with a substantially even horizontal top surface is assisted by the application of solvent through the solvent inlets S17 and S18, as illustrated in FIGURES 3 and 4. It will be noted that the application of the solvent as well as the disposition of the material fed by the scroll 42 in a circular apparatus must be such as to allow for the fact that less material and solvent are required toward the inside face of the mass than toward the larger diameter outside face. This is effected by having the scroll flights of opposite pitch meet at a point located somewhat outwardly of the center line between the two side walls of the material holding chamber.

As shown in FIGURES 1 to 4, inclusive, the spent material or wet bagasse, as the case may be, is removed

from the apparatus by means of an elevating device consisting of an upper pair of sprockets 50—50 and lower shoes 51—51, around which are trained suitable chains 52—52, one at each side of the elevator, which carry a plurality of elevating members 53, disposed in the general manner illustrated in the drawings. This elevator has its downward moving flights located adjacent an end wall 54 which is associated with a scroll 55 and a scroll casing 56 which extends upwardly, as shown in the drawing, to provide an opening at the top for receiving the spent material or bagasse from the elevator. The removal of bagasse from the elevator and the feeding thereof to the bagasse form the elevator and the feeding thereof to the scroll 55 is assisted by a driven roller 57. The scroll is rotated in a direction which causes the material to move outwardly, as shown in FIGURE 1, and to be deposited upon the conveyor 60 for disposal or further treatment. As shown in FIGURE 2 this scroll is driven by suitable gearing from a motor 61.

In addition to the elevator, a hugger mechanism is preferably employed in conjunction therewith which is similarly constructed, i.e., it has a pair of sprockets 65—65 at the top and a pair of shoes 66—66 at the bottom and has mounted thereon a pair of chains 67—67, also carrying a plurality of flight members 68, disposed at an angle as shown. The hugger mechanism is preferably spaced somewhat from the elevator in the manner shown and moves at a greater speed so as to assist the elevator in picking up the material. As illustrated in FIGURE 3, the elevator derives its support from a frame member 70 mounted on the main frame structure at the proper location in the circumference of the apparatus, and is equipped with adjustable bearings 71—71 at opposite sides for supporting the shaft 72 which carries the sprockets 50—50. In addition to the portion of the frame 70 extending upwardly, a further portion extends downwardly into the material receiving chamber, but without contacting the side walls thereof. To the lower portion of frame 70 are attached shoes 51—51 so as to hold flights 53 in close relationship with the perforated floor 24 of the material holding chamber 5. Adjacent the bottom of wall 54 is a scraper 75 pivotally mounted and constructed so that its scraping edge will engage the bottom of the floor and scrape it clean and direct all of the material up toward the elevator flights 53.

Referring now to FIGURE 1, it will be noted that each of the tanks T has a bottom 80 which slopes slightly outwardly so as to feed the solvent to its pump P. Each pump will be operated by a suitable motor M as shown, particularly in FIGURE 2.

Mounted on the top of the series of supports *6a*, is an annular trough 81 in which is carried a sealing liquid which cooperates with a depending annular flange 82 which is carried on the base of the radial beams 16—16, respectively. A similar trough 83 is mounted on top of the series of supports 7 which trough also carries a sealing liquid and which cooperates with an annular sealing flange 84 depending from the beams 16—16, respectively. As the side wall of the tanks T are continuous and their upper ends connect, respectively, with the troughs 82 and 83, it will be seen that the space within the tanks, respectively, and the space within the material carrying chamber 5 are in free communication through the screen bottom 24 of the chamber 5, and, whereas the chamber is freely rotatable on the supporting rollers 15 with respect to the underlying tanks, these spaces are effectively sealed from the exterior atmosphere.

The form of the solvent outlet trough mechanism employed for the device here disclosed is shown in the upper left hand corner of FIGURE 1 and in greater detail in FIGURES 5, 5A, 5B and 5C. When referring to these figures it will be noted that the solvent outlet troughs 90 are shown in the form of a radially disposed container which is supported from an adjacent beam 9 by means of depending supports 91 and 92, through a circular track mechanism hereinafter described. These supports may be of any suitable construction, but as here shown support 91 is provided with a stub shaft 93 on the end thereof rotatably carrying a roller 94. Similarly, support 92 carries a stub shaft 93 and a supporting roller 94. It is to be understood that a series of such supports 92, with their associated rollers, are provided on a plurality of beams 9 with the rollers, respectively, disposed on the arc of a circle around the shaft 2 as a center and also that a plurality of support 91 will likewise be provided with their rollers 94 disposed on the arc of a circle concentric to the inner rollers 94. The troughs are provided with a track member 95 which is welded or otherwise secured to the troughs and which is formed as a complete circle around the mechanism and is disposed so as to have rolling and supporting engagement with the outer set of rollers 94. At the inner end of the trough a support 96 is provided which carries a circular track member 97 which has supporting and rolling engagement on the inner set of rollers 94. Suitably carried by the troughs is cylindrical member 100 adjacent the inner end thereof, and a larger but similar cylindrical member 101. These cylindrical members are securely attached to the troughs, respectively, and provide the structural members which maintain the troughs in proper angular disposition. When mounted in the manner described; i.e., with the inner track member 97 supported on the inner rollers 94 and the outer track member 95 supported on the outer rollers 94, it will be seen that the series of solvent outlet troughs is mounted for angular displacement so that the position of the solvent outlets, as a unit, may be adjusted as desired. As shown particularly in FIGURE 5 the inner cylindrical member 100 is so disposed that the bottom portion thereof depends and cooperates with a trough 102 which is carried by the mechanism constituting the material holding chamber 5 so that it moves therewith. Also the bottom edge of the cylindrical member 101 depends in similar fashion and cooperates with a liquid holding trough 103 which is likewise carried by the structure constituting the material holding chamber 5. The upper edges of each of the cylindrical members 100 and 101 is equipped with a sliding surface 104 adapted to have frictional contact with a flexible sealing ring 105—105 suitably secured, respectively, to depending cylindrical skirts 106 and 107, respectively. Whereas these skirts are cylindrical throughout the portion of the device serving to hold the material undergoing treatment they are interrupted in that portion thereof where the elevator and feeding mechanisms are positioned. As shown in FIGURE 5 these skirts, respectively, may be attached to the supporting beams 9 by means of suitable curved angle rings 108 and 109, respectively. The space between the angle rings 108 and 109 is closed by a suitable roof 110 attached to the underside of the beams 9, which roof may be equipped with inspection and access doors at suitable locations.

Referring now, particularly, to FIGURE 1, it will be noted that the solvent supplied to each trough is taken from the corresponding tank T located beneath the material holding chamber 5 by the associated pump P which is attached to an upwardly extending flexible hose 112 which is connected at its upper end to an inlet member 113 in connection with the end of the solvent trough 90. As illustrated in FIGURE 5C the flexible hose 112 will be of such character and of sufficient length to permit the connection between the pump and the trough to be maintained throughout all positions of adjustment of the trough. It will also be noted from the foregoing that when the troughs are moved as a unit, as above indicated, an effective seal is maintained at all times in the space occupied by the trough above the material holding chamber 5. It should be noted, however, that, at the location on the diffuser where the fresh material is introduced and the spent material is removed, the space corresponding to that occupied by the solvent troughs is merely suitably closed, but is not completely sealed from the atmosphere.

Referring now to FIGURES 5A and 5B, it will be noted that in this particular illustrative embodiment the solvent trough preferably has a general shape of a truncated wedge, and adjacent the inlet end is provided with a top cover 114 which creates a chamber in communication at its inner end with that portion of the trough which is disposed in solvent feeding relationship to the material contained in the material holding chamber 5. This latter portion of the trough is open at the top and is preferably shaped in the manner shown in FIGURES 5A and 5B. One side, it will be noted, is provided with an inclined wall 115, from which there is a downwardly extending baffle plate 116 which is designed to restrain the solvent which passes from the trough and directs the same downwardly. The solvent flows from the trough through a plurality of openings 117 which may be of any suitable shape, but preferably trapezoidal, and disposed, as shown, with the shortest side downwardly. In addition the width of these trapezoidal openings is progressively diminished for each successive opening from the outside inwardly so that the amount of solvent passing therethrough by a gravitational flow is controlled approximately to correspond with the quantity of material underlying each of the openings of the trough. The space defined by the baffle plate and the side wall of the trough is preferably closed at its ends so as to avoid unwanted lateral splashing of the solvent. In operation it will be noted that the liquid pumped in through hose 112 enters the inlet end of the trough at 113 and then flows radially inwardly until it reaches the portion thereof which is open at the top. Here the liquid level will be free to rise until the gravitational flow through the outlet openings will equal the amount of liquid supplied from pump P.

The value of the trapezoidal shape of the openings is to maintain the proper relationship between the flow through the openings, respectively, for all quantities of solvent supplied therethrough.

An understanding of the overall operation may be gained by inspecting FIGURE 4 where there is shown a schematic developed view representing the 360° of a circular diffuser of the type previously described. As already pointed out, the fresh material is fed by the scroll 42 in such manner as to create a mass in the material holding chamber 5 which has a substantially rectangular cross-section. This mass, being supported on the perforated bottom 24 of the material holding chamber 5, and being held by the sides 22 thereof, is caused to move at a predetermined rate from a position on the right hand side of FIGURE 4 to the left hand side thereof, where the spent material is discharged as represented by the arrow 120. In addition, the introduction of fresh material has been effected in such manner as to establish continuously a mass which has substantially uniform bulk density throughout and, therefore, substantially uniform permeability for the percolation of solvent. The single qualification to be made in this respect, however, is the circumstance that fresh material is generally less compacted than that which has undergone treatment in the diffuser and, therefore, there is a slight diminution of the permeability progressively from the inlet to the outlet end of the material holding chamber 5. In addition the feeding has been carried out in a manner so as to assure a substantially even top surface of the mass.

As shown in FIGURE 4 it will be noted that the solvent collecting tanks T1 to T18, inclusive, are stationarily attached and maintained in a fixed disposition with respect to the inlet and outlet ends, respectively, of the moving mass of material undergoing treatment. However, as above pointed out, the solvent outlet troughs are adjustable as a unit by limited angular movement so that the said solvent outlet troughs can be given, as a group, a selected and predetermined position overlying the material undergoing treatment, thus creating a particular relationship with the underlying tanks.

The power means for effecting the angular movement of the solvent outlet troughs may be of any suitable type, but as here shown on FIGURE 2 it comprises a conventional double acting hydraulic cylinder **98** connected at one end to a stationary part as at **99** and at its other end to the track ring **95** as at **99***a*.

With these capabilities in mind it will be noted from FIGURE 4 that, when sugar cane is being treated and the mass has been established in the manner above indicated, the diffusion of sugar from the cane may be carried out by first introducing into a trough S solvent which is preferably made up of fresh water supplied through pipe **121** and press juice from the bagasse introduced through pipe **122**. This solvent permeates the mass and, by virtue of its percolation therethrough, is collected in the preferred operation in tank **T1**. From the bottom of this tank the solvent is taken into the inlet of pump **P1** and supplied to the trough **S1**. Correspondingly, the solvent from trough **S1** percolates through the underlying mass and, in accordance with the preferred operation, is collected in tank **T2**. The solvent in tank **T2** is, in turn, pumped by a pump **P2** to the trough **S2** and progressively on and on in a similar manner throughout the entire system until the solvent supplied to trough **S16** finds its way into tank **T17**. At this point the solvent from tank **T17** is pumped by pump **P17** up to the outlet **S17** which, it will be noted, feeds the solvent directly on to the fresh can being supplied from the belt **40** to the scroll **42**. This solvent finds its way into the tank **T18**, which is equipped with a pump **P18**, and from there it is pumped upwardly to the trough **S18**. As a result, the solvent from trough **S18** also finds its way into tank **T18** in a recirculating relationship. By this arrangement, although the solvent in the tank **T18** is a single body of liquid, that which is found at the right hand portion thereof is primarily supplied from solvent outlet **S17**, whereas that occupying the left hand portion of the tank is predominantly derived from solvent outlet **S18**. It is important in this operation to have the liquid from both solvent outlets **S17** and **S18** collected in the single tank **T18** held in a single chamber as shown. This insures that, at all times, an adequate amount of solvent will be available to pump **P18** for recirculation through solvent outlet **S18** to maintain the desired quantity of solvent in contact with the material mass thereunder. Control valve **125**, located in the line between pump **P18** and trough **S18**, permits the adjustment of the amount of solvent taken from the tank **T18** and supplied to outlet **S18** so as to prevent flooding at the top in this area and, at the same time, to maintain a maximum quantity of solvent in contact with the material mass. The finished diffusion juice is taken from the system through an overflow outlet **126** by means of a withdrawal pipe **127**. It will be noted that the location of the overflow outlet **126** at the left hand side of tank **T18** is such that the solvent supplied to it will be generally be that from solvent outlet **S18**. It will be noted that the walls separating the tanks **T1** to **T18**, inclusive, have overflow openings **130** therethrough at successively lower levels, to provide an appropriate path for the solvent during emergency operation in the event of the failure of any one pump. The openings **130** are restricted to lessen undesirable mixing of the solvent of different concentrations, in the event of a complete shutdown, when all of the solvent will drain from the material into the underlying receiving tanks. The dotted line representation of trough marked **S16′** on FIGURE 4, indicates the position of trough **S16** when the solvent outlet troughs collectively are adjusted as a unit to an advanced position effecting that type of operation characterized above as being less than 100% solvent throughput through each zone. In this connection it is to be noted that solvent outlets **S17** and **S18**, which are positioned with respect to the inlet scroll **42**, are not movable with the other solvent outlet troughs in connection with such adjustment.

The dotted line representation of trough marked S′ on FIGURE 4 represents the location of the trough S when the solvent outlet troughs, as a unit, are adjusted to their most retarded position. This adjustment is established for the purpose of merely recirculating the solvent within each zone when there is a lack of supply of fresh material to be treated and the movement of the material holding chamber **5** is discontinued.

An important feature of the elevator device is the ability thereof to effect final drainage of solvent from the spent material. Any such solvent passes down the sloping top surfaces of the flight members **53** and runs down to the material carrying chamber **5** between the said flight members and a vertical rubbing plate that is part of the elevator frame **70**.

In the operation of this system for the extraction of sugar from sugar cane, as above described, advantage can be taken of certain novel features of this process and apparatus which allow the operator to carry out a clarification step which clarifies the sugar juice in the diffuser itself, thus reducing or eliminating the need for subsequent clarification.

In order to do this, and assuming an operation on a 100% or over juice circulation basis, the juice from pump **P17** will have added to it an appropriate quantity of milk of lime or other suitable clarifying agent, the mixture of which will then be suitably heated for flocculating activity and delivered to solvent outlet **S17**. At this point the solvent, with its flocculated and suspended impurities, is added to the fresh fiberized cane in the diffuser where the cane mass serves as a filter to catch and retain the flocculated impurities. Hence, as the juice drains through the mass the flocculated and suspended impurities tend to remain in the fibrous mass and thus become separated from the juice. Any suspended solids which pass through the mass with the juice and find their way into tank **T18** will be recirculated through pump **P18**, with the result that a high level of clarification will be imparted to the finished juice to be removed from the system at the left hand side of tank **T18**. If the system is being operated on a juice circulation basis of 50% then all of the juice from pump **P16** may be diverted from the solvent outlet **S16** and added to the juice from pump **P17** for use in the clarification treatment. For operation on any intermediate juice circulation basis a proportionate amount of juice for pump **P16** may be diverted from solvent outlet **S16** and added to the juice from pump **P17** for use in the clarification procedure.

One important feature of the apparatus here disclosed relates to the novel construction of the scrolls employed. This construction is illustrated in FIGURE 3A. It is a well known fact that certain fibrous materials cannot be handled in conventional scroll conveyors because of their tendency to felt and mat and wedge between the periphery of the scroll flight and the housing, with consequent jamming of the apparatus. This is recognized as true in handling sugar cane.

The scroll of this invention has made it entirely feasible to move masses of sugar cane fibers by scrolls without suffering the jamming and clogging characteristics mentioned. This beneficial result flows from the construction illustrated in FIGURE 3A, from which, it is observed, a novel form of housing is provided around the scroll. Whereas this improvement is applicable to all scrolls, including those employed in this invention, it is illustrated in conjunction with scroll **55** which receives material from the discharge elevator. The novelty resides in the construction and disposition of a housing indicated generally as **56** which has an inclined wall **140** which extends downwardly toward the scroll and terminates at a point adjacent the periphery of the scroll edge. Preferably located on the lower end of the inclined wall is a blade **141** which is suitably secured to the inclined wall **140** by adjustable attaching means. This blade, adjusted in close proximity to the peripheral edges of the scroll, prevents the entrance of any sizable mass of matted material from wedging between the housing and the peripheral edges of the scroll, and the greater and continually increasing radial space between the scroll flight and the housing behind the blade in the direction of rotation of the scroll insures that there will be no wedging of material between the scroll and the housing to cause the jamming experienced with such material in conventional scrolls.

An alternative form of diffuser construction is illustrated in FIGURES 6 and 7. In this form, instead of bagasse being removed from the top of the material carrying chamber characteristic of the form above described, this alternative form has an articulated bottom screen separate from the sides of the material carrying chamber, and this articulated bottom revolves on tracks about the axis of the machine and passes around rollers and sprockets for discharging the material into a discharge scroll at the bottom.

On FIGURES 6 and 7 may be seen the articulated sections **150** of the screen bottom, carried by rollers **151** on their outer ends and rollers **152** on their inner ends. The fresh cane enters at the top following the direction of the arrows and is discharged as bagasse into the removal scroll **153**. This is made possible by the downward passage of the articulated bottom screen sections **150**, which at their outer ends pass over and are guided by curved track **154**, roller **155**, sprocket **156** and curved track **157**, and at their inner ends over similar tracks, rollers, and sprocket of smaller diameters. In this construction the two side plates of the material carrying chamber are joined by struts **158** which hold the side plates in concentric relation with each other.

Except for the foregoing the other essential features of this form of the invention may be carried out in substantially the manner characteristic of the previously described form.

The extracting apparatus described above is particularly constructed and adapted for use in connection with sugar cane employing what may be regarded as a diffusing operation. However, it is to be understood that this invention is equally applicable to other solvent extraction operations such as, for instance, the treatment of sugar beets, alfalfa, wood pulp, and any other materials which lend themselves to procedures of diffusion, leaching, and lixiviation. Such uses will include those employing either aqueous solvents or non-aqueous solvents.

In realizing the advantages of this invention in the extraction of sugar from sugar cane it is highly important to have the cane so prepared that the treaded mass possesses the proper characteristics as to bulk density and permeability. It has been found that the preferred character of the cane fibers is that which gives to the product a permeability which will permit a satisfactory extraction at a draft of approximately 100. It has now been discovered that through the use of suitable instrumentalities sugar cane can be so prepared as to reduce it to a fibrous condition having associated with the fibers thereof the natural pitch, and that when the cane is so fiberized it presents a mass for treatment to the diffusing system which permits the carrying out of a diffusing operation employing a minimum amount of extracting solvent. Accordingly, one form of this invention comprises a system utilizing, in addition to the diffusing step or apparatus above described, additional instrumentalities for reducing the cane to the desired fiberized state previous to its introduction into the diffuser.

In addition, an important savings is realized in a system of this type by returning to the diffuser a substantial amount of the juice that is removed therefrom with the discharged wet bagasse. Accordingly, the system here referred to includes, as an additional instrumentality, a bagasse press which receives the wet bagassee from the diffuser and returns the recovered juice to the diffuser.

A system so constituted is illustrated in FIGURES 8 to 11, inclusive, wherein it will be seen that, in addition to the diffuser **200** a device hereinafter more fully described and identified as a cane buster **207**, is employed initially to process the cane.

In operation the cane from the field, with or without previous cleaning, is initially introduced to the system on a moving cane carrier conveyor **201**, which presents the cane to rotary cane knives **202**, which cut the cane into sizes producing a handleable mass. The cane so cut moves across the plate **203** and is advanced by the belt **204** over a magnetic pulley **205** which serves to remove any tramp iron. The cane is then fed into a hopper **206** above the cane buster **207**. Preferably a sensing plate **208** is employed, mounted on a pivot **208**_a_ so that it may be displaced in a manner representative of the quantity of cane being held at any one time in the hopper. The apparatus is so constructed that the angular position of the sensing plate is connected to control the speed of the cane carrier conveyor, with the result that the desired amount of cane is at all times available to the cane buster. The cane buster further reduces the size of the pieces of knifed cane and produces therefrom a mass of cane in the proper form to be presented to the cane fiberizer. The construction and operation of the cane buster is described in greater detail hereinafter. The cane so reduced in the buster is carried by a conveyor **209** outwardly from the bottom of the buster and thence upwardly and deposited in the top of the cane fiberizer **210**. The construction and operation of the fiberizer is described in greater detail hereinafter. The fiberized cane passes from the fiberizer upwardly on a belt **211** and is deposited on a scale conveyor **212** which serves to convey the fiberized cane to the diffuser **200** and, by suitable mechanism, not shown, contained in the housing **213**, to weigh and record continuously the amount of fiber to be processed. The fiberized cane is fed by the scale conveyor **212** to the material feeding scroll of the diffuser. In other words, the scale conveyor **212**, as illustrated in FIGURES 8 and 9 of the drawings, corresponds to the feeding belt **40** illustrated in FIGURES 2 and 3. After the fiberized cane is deposited in the diffuser and formed into an elongated mass, as above described, it is subjected to a diffusing operation the same as that already referred to. After being so processed the spent cane or wet bagasse is removed from the diffuser by the scroll **55** and delivered to a conveyor **214** which conveys it to one or more bagasse presses. The conveyor **214**, illustrated in FIGURES 8, 9 and 11, corresponds to the conveyor **60**, illustrated in FIGURE 1. In the particular embodiment here illustrated only a single bagasse press is shown, but it is to be understood that two or more may be employed, if required, for parallel operation. Accordingly, conveyor **214** is illustrated as extended in order that excess material which cannot be received by the first bagasse press will be moved on to the next press. The bagasse press **215**, the construction and operation of which are described in greater detail hereinafter, receives wet bagasse from the conveyor **214** by passage first through a pair of oppositely revolving scrolls **216R** and **216L**, the function of which is to receive and convey from the conveyor **214** the particular amount of bagasse that can be handled by the particular bagasse press being fed. Hence, wet bagasse that is not accepted by the scrolls **216R** and **216L** will be carried beyond by the conveyor **214**. From the end of the scrolls **216R** and **216L** the wet bagasse passes downwardly through two chutes **217—217**, in order that it may be equally fed to the press to both sides thereof. The pressed bagasse is discharged from the press through both sides thereof onto two conveyors **218—218**, which are driven to discharge the carried pressed bagasse to a main pressed bagasse conveyor **219**, which removes it for disposal. The juice extracted from the wet bagasse is pumped from the press through suitable piping, not shown, to the feeding pipe illustrated on FIGURE 4 and identified by the numeral **122**.

The preferred construction of the cane buster, as illustrated in FIGURES 12 and 13 of the drawing, comprises a main frame **220**, which serves as a mounting for bearings **221**—**221** at the opposite ends of the machine for accommodating the main rotor shaft **222** mounted therein. This shaft rotatably mounts the rotor designated generally as **223** which has a plurality of hingedly mounted hammers **224** carried on suitable pins **225**. Any suitable number of hammers can be employed and the respective locations thereof can be selected in the manner shown in the drawing. Located below the rotor and carried by the frame **220** is a beam support **226** which is mounted for vertical adjustment by means of rotating screws **227**—**227** or other similar means. The beam support **226** serves as a mounting for hinge pins **228** which hingedly support the two complementary sections **229** and **230** of the anvil members which substantially surround the rotor.

The upper part of anvil member **230** is attached to a beam **231** which has a pivotal connection at **232** with an adjustable turnbuckle **233**, which is pivotally mounted at **234** to the housing. The turnbuckle shown is located at one end of the beam **231** and a similar turnbuckle connection is provided at the opposite end of beam **231**. Similarly, a pair of turnbuckles **233***a* of the same construction will be provided on the opposite side of the device connecting the beam **235** to the housing.

It will be noted from this construction that the supporting beam **226** may be adjusted vertically and that the four turnbuckles may be adjusted laterally so as to provide a proper spacial relationship between the anvils, respectively, and the hammers of the rotor. Adjacent the top a feed roller **236** is disposed in spaced relation to a second feed roller **237**, one or both of which may have feeding teeth thereon as indicated on roller **237**. One of the rollers is preferably mounted in a movable spring backed bearing such as illustrated at **238** so as to avoid breakage or damage to the machine in the event of improper feeding.

Each anvil member consists of a plurality of separate sections tied together at their upper ends by the beams **231**–**235**, and held in fixed position at their lower ends on hinge pins **228**. Each of these sections has openings therethrough constructed and formed in the manner illustrated in FIGURE 12 as viewed through the area where the wall is removed. It will be noted that each of these anvils consists of a plurality of circumferentially extending ribs **240** connected by integral tie bars **241**, having a shape generally as shown in FIGURE 13. It will be noted that the ribs are of greater depth than the tie bars and that the assembly as such provides a plurality of rows of openings through the anvil member which taper outwardly and provide passages through which the busted cane may pass. Mounted on each anvil member projecting inside the inner circumference thereof are a plurality of breaker lugs **242** shown in FIGURES 12 and 13. It will be noted that these are so positioned that the ends of the hammers may pass between them in a slightly overlapped relation whereby a breaking action is established between the lugs and the ends of the hammers. Each of the hammers is preferably provided on its outer face with two teeth which produce a better breaking action when the mechanism is utilized for busting cane. In addition the ends of the hammers will exert a shearing action in conjunction with the integral tie bars **241**. The overall sizes of the pieces of the cane emerging from the buster will be determined generally by the size of the openings in the anvil members.

One of the important features of the invention is the ready accessibility of the working parts. In the event of damage or the necessity for cleaning, the anvil members can be tilted outwardly to the dotted line position shown in FIGURE 13 so as to give quick and ready access to the rotor for replacement of hammers. As shown, the tilting of the anvil members is effected merely by removing the pins with which each, respectively, is connected to the frame through its associated turnbuckle. In the form here shown, a portion of the side wall, housing the mechanism, is made pivotal to provide space foı the anvil members when in dotted line position.

The rotor may be driven from any suitable source of power and is rotated at whatever speed desired. In the case of sugar cane it is preferably operated in the neighborhood of 800 to 1200 r.p.m. It is important, in the operation of this device, to drive the feed rolls **236** and **237** at a controlled rate in order to assure the feeding of the proper amount of cane to the buster.

In operation all of the material fed to the buster passes through the space defined by the two anvil members where it is acted upon by the hammers, respectively, with the result that it is broken and forced radially outwardly through the openings in the anvil members. In view of the fact that the rotor chamber is closed at both ends and the rotor is completely surrounded by the anvil members, except at the upper inlet portion, all of the material fed to the buster passes through the anvil members under the action of centrifugal force generated by the hammers. The location of the feed roller **236**, with its periphery in close proximity to the ends of the hammers, serves to enhance the inward feeding of cane to the buster and to offset, in large measure, the tendency of the rotor to reject cane due to its centrifugal force. The material is then collected in the bottom space underlying the anvil members and conveyed to the fiberizer.

The fiberizer is illustrated in FIGURES 14 and 15 and in this form of the invention comprises a frame **250** having a supporting beam **251** which is vertically adjustable on a pair of screws **252**—**252** in a manner similar to the construction of the previously described cane buster. At its opposite ends the frame has a pair of bearings **253**—**253** for rotatably mounting a shaft **254** for accommodating the rotor designated generally as **255**, having a plurality of hammers **256** mounted thereon by a series of suitable pins **257**. Associated with the rotor is an anvil constructed as a toothed scrubbing board member **258** carried at its lower end on pins **259** mounted on the supporting beam **251**. The anvil **258** is made up of a plurality of individual sections similarly constructed so as to collectively constitute the anvil and yet allow for sectional replacement when needed. The anvil as a whole is attached to a beam **260** which, in turn, is connected to the frame by a pair of turnbuckles **261**—**261**, like those employed in the buster. It will be seen that this anvil is adjustable through the rotation of the turnbuckle and through the lifting and lowering of the beam **251**. In this case, however, as distinguished from the construction of the buster, the anvil is imperforate and the material fed to the fiberizer must pass over the surface of the anvil under the influence of the hammers and is discharged in a substantially horizontal direction against a flexible curtain **262**.

In the operation of the machine busted cane is fed into the top in the space provided between the flexible curtain **263** and the feed roller **264** which, in this case, is power driven. The cane so fed has been previously broken into chunks of variable size. These chunks, when subjected to the action of the rotor and the associated anvil, are fiberized; that is to say, are divided into individual fibers which carry the associated path of the cane. By adjusting the space between the anvil and the ends of the hammers the character of the fiberized cane can be selected. The flexibility of curtain **262** prevents a build up of the fiberized cane at its point of impact and permtis it to drop freely onto a suitable conveyor below. Associated with the fiberized cane is a substantial volume of air moving at the same high velocity. The air is dissociated from the fiberized cane at the curtain **262** and passes upwardly and through opening **270** for recirculation by the rotor.

Here, again, it will be noticed that the hammers are constructed with two teeth or cutting edges on their outer ends. As particularly shown in FIGURE 14 the outer ends of the hammers are widened so that collectively they sweep substantially the entire surface of the anvil. The anvil employed in this fiberizer is also capable of being removed to the dotted line position shown in FIGURE 15 to provide ready access to the rotor for cleaning and replacement of hammers.

The bagasse press of this invention and the drive gearing therefor are illustrated in FIGURES 16 to 21, inclusive, of the drawings. By referring to FIGURES 16 and 17 it will be noted that the press comprises a bed frame **300** on which are mounted side frames **301—301**, each of which is provided with a bearing **302**. Mounted for rotation within the bearings **302—302** is a cylindrical cage **303** of any suitable construction, but preferably formed as illustrated. The cage comprises a perforated cylinder **304** strengthened by circumferential ribs **305** and cross ribs **306** and **307**. The cylinder has openings **308** extending from the inside working face thereof to the exterior of the cylinder. These openings are round in cross-section and have their outer portions of larger diameter than their inner portions. Mounted on each end of the cylinder **304** is a trunnion ring **309** which carries the inner race of bearing **302** and provides a mounting for the ring gear **310**. Carried by the side frames **301—301** are housings for the ring gears **310—310**, respectively. Attached to the trunnion rings **309—309** are sealing rings **311—311** which cooperate with said housings in sealing relationship, as shown at **312—312**. Additional seals are provided at **313—313**. These two sets of seals serve to close the chambers housing the bearings **302—302** and the ring gears **310—310**.

Mounted inside of the cage **303** is a roll **314** so disposed that its axis is parallel to the axis of the cage, but eccentric thereto. Roll **314** is supported in bearings **315—315** mounted in bearing housings **316—316**. These housings are held in place by two yieldable hydraulic systems **317—317**, each having a self-aligning connection **318** with its associated housing at one end and a pivotal connection, by means of a pin **319**, with the bed frame **300** at its other end.

Each hydraulic system comprises a yoke **320** which passes over housing **316** and extends downwardly and is attached and keyed to a cross member **321**. Resting on cross member **321** is a hydraulic piston **322** in sliding association with cylinder member **323** which has two lugs **324—324** attached to the bed frame by pin **319** previously mentioned. The construction of the yoke **320** and the cylinder **323** is such that they have slidable and guided association with each other. The hydraulic systems allow the axis of the roll **314** to yield, as required, toward the axis of the cage and, yet, provide a predetermined resistance to such yielding movement. For this purpose an opening **325** for the passage of hydraulic fluid is provided in the cylinder **323**.

Each bearing housing **316** is pivotally connected as at **326** to a link **327** which, in turn, is pivotally connected as at **328** to a stationary part of the frame. It will be apparent that as the roll **314** yields upwardly its axis moves approximately on an arc around the pivotal connection **328**, as a center. Consequently, the location of the pivot mounting **328**, which anchors the link **327** to the frame, has been selected so that the axis of the hydraulic system **317** and the axis of the link **327** are disposed at substantially a 90° angle.

Wet bagasse is fed to the press by introduction at opposite ends of the machine through openings **329–329** in the housing **330** surrounding the scroll **331**. This scroll has flights of opposite hand meeting at the middle of its length so as to convey wet bagasse from both ends of the press into the cage thereof. This symmetrical method of feeding provides a more uniform distribution of the wet bagasse to the working area of the press and results in a higher efficiency and capacity than otherwise would be possible. The scroll housing **330** at the feed openings **329–329** is constructed in the manner illustrated in

FIGURE 3A of the drawings. On the other hand, the housing is cylindrical and completely surrounds the remaining portion of the scroll except for the opening **332** therein provided for the feeding of wet bagasse into the press.

A discharge scroll **333** of construction the same as that of scroll **331** is also mounted in the press in such manner that when rotated in the proper direction it will discharge the pressed bagasse from the press in both directions.

A scraper **334** actuated by a spring or weight is mounted in the press substantially in the manner shown in FIGURE 18 for removing the pressed bagasse from the pressing surface of the cylinder **304**. A similar scraper **335**, similarly actuated, is also provided for scraping the pressed bagasse from the surface of the roll **314**.

In the preferred embodiment the two scroll housings will be constructed so as to constitute a single beam member which at its midpoint will appear in cross-section like the showing in FIGURE 18 at **336**. Supporting bearings **337–337** for the scrolls, respectively, are mounted in the ends of their associated housings.

The single beam member formed by the housings extends through the space in the press between the wall and the roll, as illustrated in FIGURES 17 and 18, with its projecting ends attached to and supported by the frame of the press through the instrumentality of beam structures **338–338**. The ends of the press chamber are closed, with allowance for the movement of the roll, by suitably shaped end plates **339** and **340**.

The location of pin **319** anchoring the hydraulic system to the bed frame is selected so as to locate the roll **314** within the press cage somewhat off the vertical center line in the direction of the upmoving side. This results in the juice at the ends of the roll adjacent the bight point between the roll and the cage flowing by gravity in the direction toward the wet side of the press.

In view of the relatively large amount of power required to operate a press of the construction here disclosed and the necessity for having the driving power equalized in its application, a novel gearing arrangement of the type illustrated in FIGURE 19 is preferably employed.

In this gearing arrangement the two ring gears **310–310** which are tied together as a unit through their attachment to the cage cylinder **303**, are provided with oppositely disposed helical teeth. These two ring gears are driven by two pinions **340–340** fixed to a suitably mounted shaft **342**. On the end of shaft **342** is keyed a spur gear **343** therefor which, in turn, meshes with and is driven by a pinion **344** carried on and driven by a quill **345**.

Another set of driving pinions **346–346**, like pinions **340–340**, also are provided and are mounted on a shaft **348** which is displaced somewhat around the periphery of the rings gears from the location of shaft **342**. These pinions **346–346** also have helical teeth and are suitably mounted for meshing with the ring gear **310–310** as shown in FIGURE 20. Shaft **348** is driven by a spur gear **350** which meshes with pinion **352** which is mounted on and is driven by quill **354**. The two quills **345** and **354** are connected to a power shaft **356** through an equalizing connection designated generally as **358**.

By referring to FIGURE 21 it will be seen that the equalizing connection **358** comprises a flange **360** on the power shaft **356** which has a series of slots formed in its periphery for accommodating, one in each slot, a compensating driving pin **362**. Two or more of such pins may be provided around the circumference of the flange as may be desired. The ends of the pins project from the two sides of the flange **360** and extend into cylindrical sockets in the quill collars **364–364** as shown. The respective portions of the compensating driving pins at the locations where they are associated with the flange **360** and the quill collars **364–364** are provided with bearing surfaces conforming to the surface of a sphere in the manner shown in FIGURE 21. Associated bearing parts of proper configuration are located in the flange slots and the cylindrical sockets, respectively, so as to establish a driving connection between the flange and each of the quills. The bearing parts in the slots are mounted in radial movement therein and the bearing parts in the cylindrical sockets are mounted in axial movement therein. These movements provide the necessary accommodation for the dimensional changes incident to the angular movement of the pins during operation.

From the foregoing description it will be apparent that the oppositely disposed helical gearing between the pinions **340–340** and the ring gears **310–310** will cause an axial movement of shaft **342** to establish an equalization of the driving power from spur gear **343** to the two ring gears **310–310**. Similarly, the helical teeth meshing the ring gears **310–310** and pinions **346–346** will equalize the driving action of shaft **348** by spur gear **350**. It will also be apparent that due to the spherical bearing surfaces of the driving pins, that slight angular displacement may be effected between the driving flange **360** and each of the quill collars **364–364** in the manner and of the magnitude which will enable an equalization of the driving power to each of the spur gears **343** and **350**.

The extraction system herein described is capable of being adapted to substances having a wide range of different characteristics so long as the substances are suitable for percolative removal of soluble solids by a solvent.

The arrangement of solvent outlets and collecting tanks thereunder may be constructed with any increment of increase or decrease of distance between the successive stages of treatment to suit any change in the permeability in the material mass as it progresses through its path of travel. The solvent outlets as a group may be made angularly or linearly adjustable over as large a number of treatment zones as desired by increasing the arcs of the first and last collecting tanks with respect to the sum of the arcs of the intermediate tanks and by arranging the solvent outlets to correspond.

In the embodiment shown on the drawings, the solvent outlets are adjustable over a range of four treatment zones. This wide range of adjustment makes it possible to compensate for large variations in permeability of material masses without significant loss of capacity.

For the purpose of increasing the efficiency of extraction or for suppressing bacterial growth in the treatment of certain substances the use of heat may be employed. This can be accomplished by the use of heat exchangers for the solvent at any desired points, or by the direct injection of vapor or steam where aqueous solvents are used.

With the system operated either hot or cold, certain chemicals, such as chlorine, formaldehyde, or sulphur dioxide, may be used for the control of bacterial growth.

The term "subdivided solids" as used in the appended claims is intended to include solid substances existing as particles, such as grain or the like, as well as substances which have undergone subdivision by breaking, cutting or other action.

The forms of this invention herein disclosed are illustrative and are given only by way of example. The scope of the invention is not to be limited thereby as it is intended that the appended claims be construed as broadly as may be permitted by the prior art.

We claim:

1. The process of continuously extracting a soluble substance from subdivided solid material which comprises establishing an elongated substantially horizontal continuous mass of said material in a trough-like unpartitioned receptacle having a draining bottom and upstanding side walls of substantial height, moving said mass and receptable as a unit while providing close lateral support for said mass by said side walls without relative movement between said mass and side walls, maintaining said mass by continuously adding fresh material to one end thereof and continuously removing spent material from the other end thereof, applying solvent to the top of a selected zone of said mass located adjacent the end thereof where the removal of spent material is effected, causing said solvent to pass downwardly by gravity through the material of said zone throughout the volume thereof without substantial channeling either within said mass or at the interfaces between said mass and said side walls and at a rate that maintains the interstitial spaces of said material sufficiently full to effect a substantially uninterrupted extraction activity on the material of said zone, passing said solvent through selected successive portions of said mass, in series, with like results, until the entire mass has been treated, and finally collecting the concentrated solvent from a location below the end of said mass where the fresh material is added.

2. The process defined in claim **1** further characterized in that the solvent is passed only once through each selected successive portion of said mass.

3. The process defined in claim **1** further characterized in that the cross section of said mass is rectangular.

4. The process defined in claim **1** further characterized in that the horizontal cross-sectional area of the treatment zones, respectively, are progressively increased in the direction of the mass movement.

5. The process defined in claim **1** further characterized in that the treatment zones of the mass are progressively decreased in the direction of the solvent advance.

6. The process defined in claim **1** further characterized in that the solvent is applied to the top of said mass at a series of spaced locations selected from a range of possible locations which vary one from the other in their longitudinal displacement with respect to the locations of solvent collection from each of said zones, respectively.

7. The process defined in claim **1** further characterized in that the spent material is removed upwardly in a substantially vertical direction from said mass.

8. The process of extracting sugar from sugar cane comprising the steps of fiberizing sugar cane and subjecting the fiberized sugar cane to the diffusing process defined in claim **1**.

9. The process of extracting sugar from sugar cane comprising the steps of fiberizing sugar cane, subjecting the fiberized sugar cane to the diffusing process defined in claim **1**, and then pressing the spent cane to extract substantial quantities of juice therefrom and returning the extracted juice to the diffusing operation.

10. The process defined in claim **1** further characterized in that the longitudinal axis of the mass is disposed on the circumference of a circle.

11. The process defined in claim **10** further characterized in that the material is added to said mass in quantity throughout the width thereof in proportion to the magnitude of the radii of the respective points of addition.

13. The process defined in claim **10** further characterized in that the solvent is added to said mass in quantity throughout the width thereof in proportion to the magnitude of the radii of the respective points of addition.

13. The proces defined in claim **10** further characterized in that the material and solvent are added to said mass in quantity throughout the width thereof in proportion to the magnitude of the radii of the respective points of addition.

References Cited by the Examiner

UNITED STATES PATENTS

651,883	6/1900	Pfeiffer	127—3
747,520	12/1903	Weinrich	127—4 X
803,945	11/1905	Weinrich	127—4 X
1,265,582	5/1918	Adams	127—4
1,311,070	7/1919	Hinckley et al.	100—43

(Other references on following page)

UNITED STATES PATENTS

1,355,101	10/1920	Winchester et al.	100—43
1,448,421	3/1923	Sorensen	127—55 X
2,260,341	7/1940	Villasuso	127—43
2,325,426	7/1943	Rietz	241—86
2,344,611	3/1944	Harris	241—86
2,650,176	8/1953	Horton et al.	127—43
2,948,385	8/1960	Todd	198—213
2,953,485	9/1960	De Le Calle	127—3
3,077,975	2/1963	Hobbs	198—213

FOREIGN PATENTS

565,928	4/1958	Belgium.
424,978	3/1911	France.
751,534	6/1933	France.
851,176	10/1952	Germany.

MORRIS O. WOLK, *Primary Examiner.*