

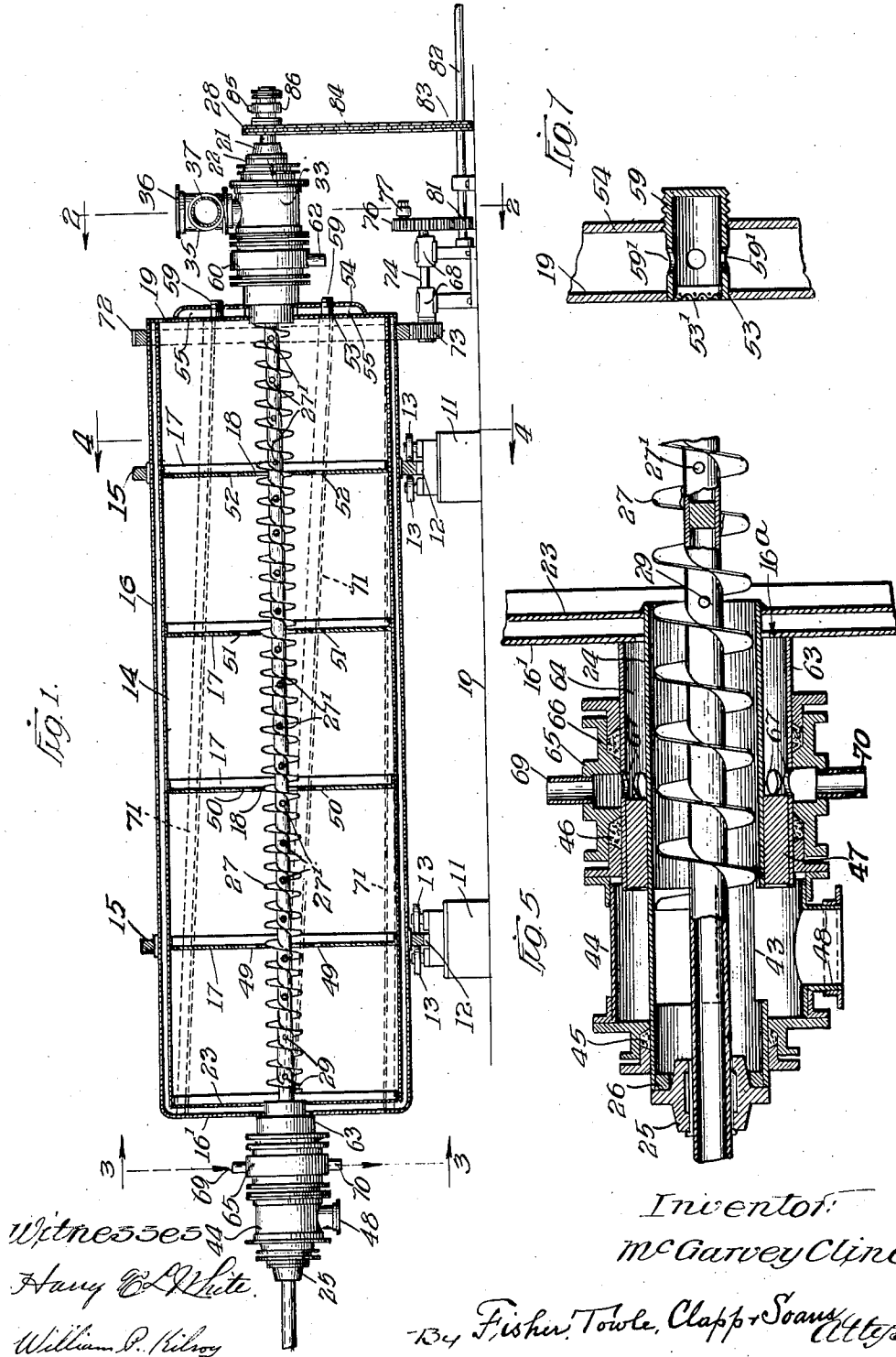
Dec. 1, 1931.

McGARVEY CLINE

1,834,577

DIFFUSION APPARATUS

Original Filed June 17, 1926 3 Sheets-Sheet 1



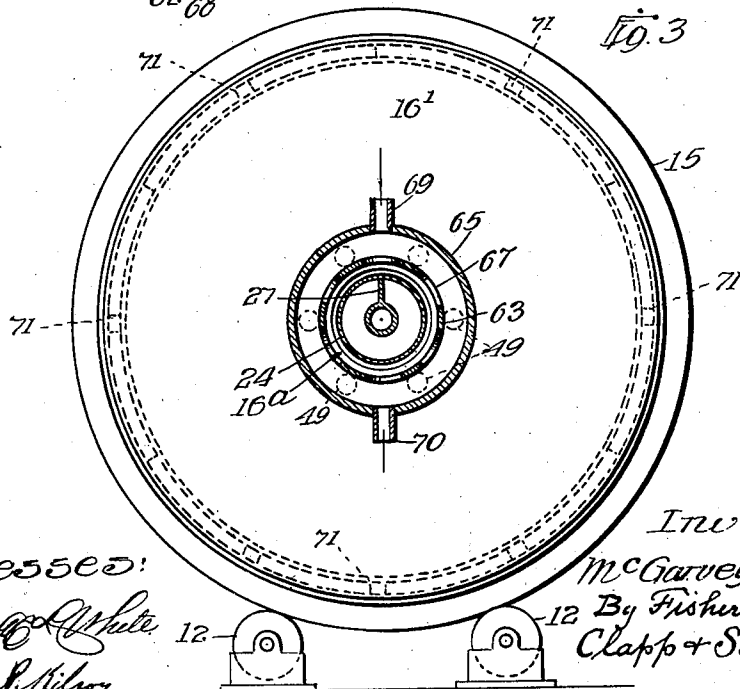
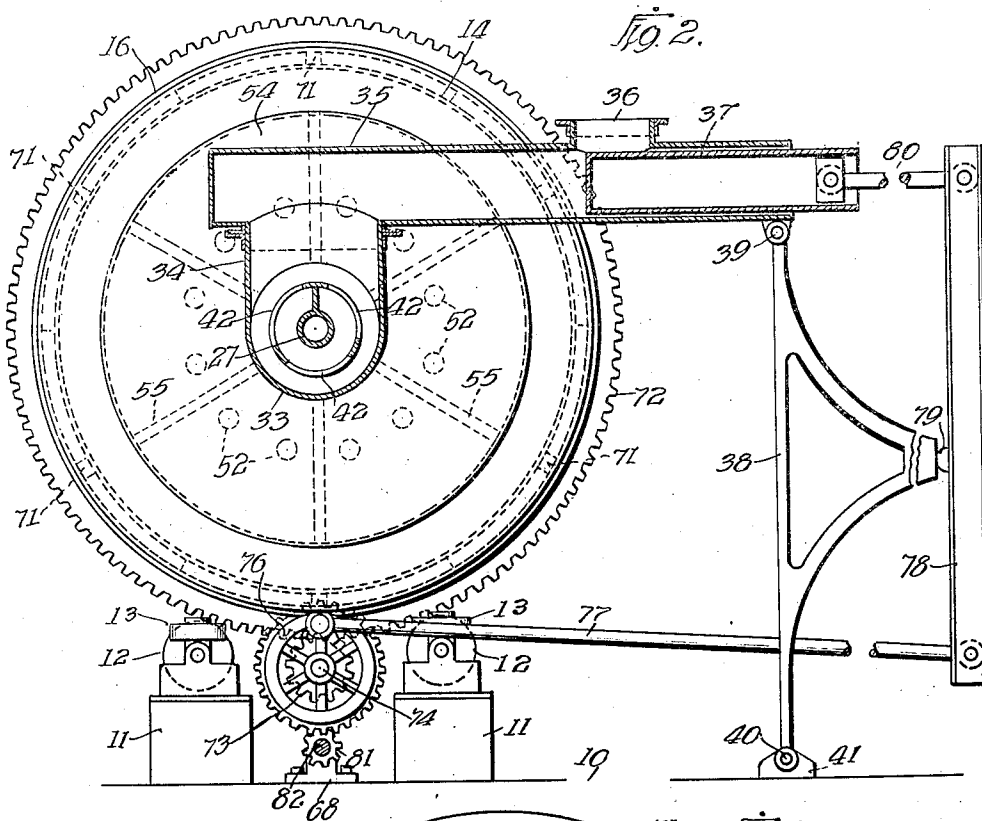
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MCGARVEY CLINE

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DIFFUSION APPARATUS

Original Filed June 17, 1926 3 Sheets-Sheet 2



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Dec. 1, 1931.

MCGARVEY CLINE
DIFFUSION APPARATUS

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Original Filed June 17, 1926 3 Sheets-Sheet 3

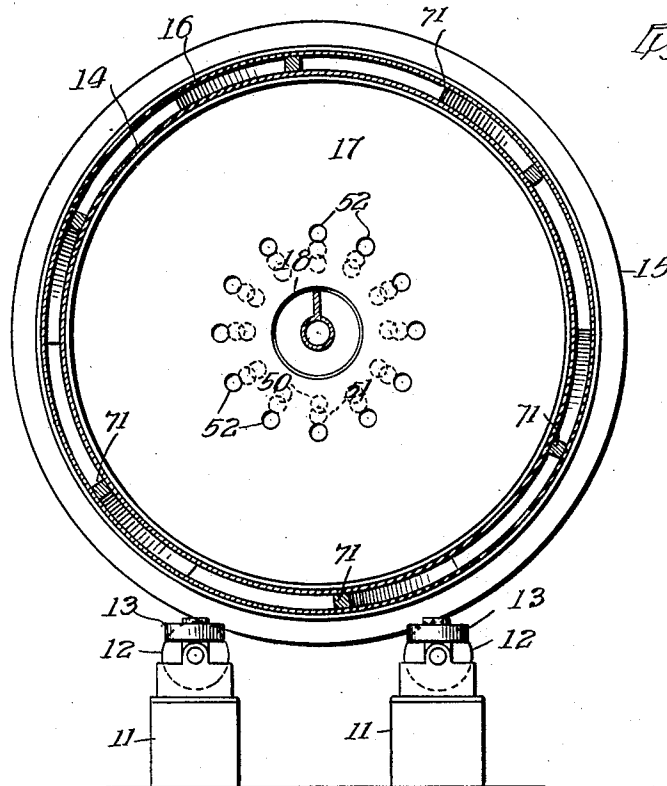


Fig. 4.

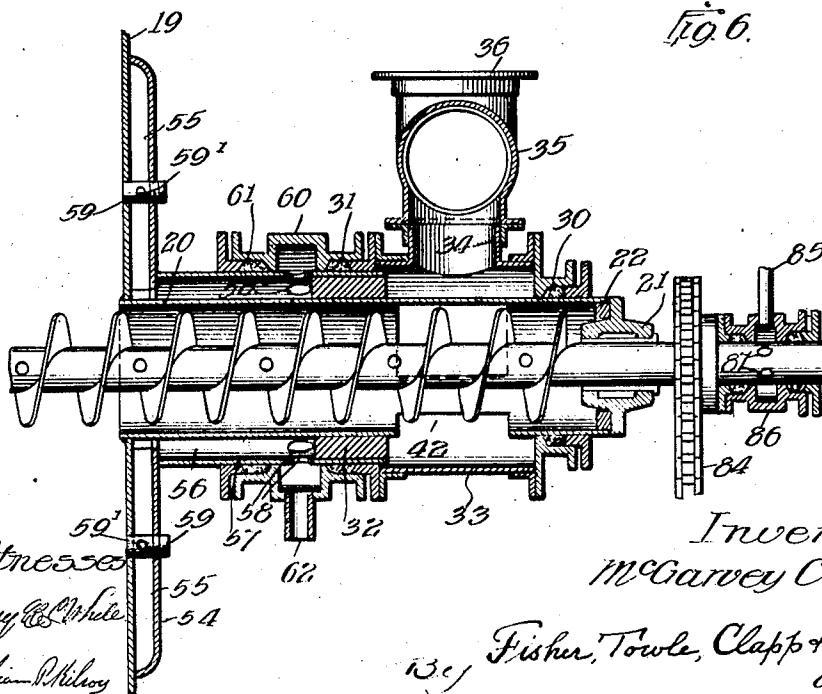


Fig. 6.

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UNITED STATES PATENT OFFICE

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DIFFUSION APPARATUS

Application filed June 17, 1926, Serial No. 116,519. Renewed December 21, 1928.

This invention relates to diffusion apparatus, such as is employed in a variety of arts for extracting a soluble material from solid material through the agency of a solvent introduced into the presence of the stock treated within a suitable container, with or without the application of heat.

Apparatus of this general character is extensively used in extracting sugar from cane and beets, in extracting tannin from ground bark, in recovering soda compounds from wood pulp in which it has been employed as a digestive agent, in extracting rosin from resinous wood, and in numerous other industries.

Heretofore so far as I am aware, such apparatus has usually consisted of a number of individual retorts or cells, usually arranged in a group, into which the material treated is introduced at the top and withdrawn from the bottom, with a solvent supply pipe and branches therefrom to the several cells; the latter being successively filled and emptied, and the liquor from the first filled cells of the series being transferred to the last or freshly filled cell. Diffusion apparatus of this type involves considerable time and labor in the successive filling and emptying of the cells, as well as costly equipment such as pumps, piping, and valves; and the primary object of the present invention is to provide a very simple unitary apparatus in the nature of a horizontally disposed rotating drum which may be internally divided into a series of laterally adjacent compartments, with means for charging the stock to be treated into the drum at one end of the drum and discharging it from the other end of the drum, with a continuously operating mechanism for feeding the stock from one cell into the next cell of the series as soon as each cell is charged with stock to a predetermined height, and means for causing a counterflow of the solvent through the several cells of the series; the material being agitated or tumbled in the several cells by the rotation of the drum. Another object is to provide, in association with an apparatus of the character indicated, means for supplying heat, which may take the form of a steam

jacket surrounding the drum, or a perforated pipe for a supply of steam through the feeding mechanism, or both. Still another object is to provide, in an apparatus equipped with a steam jacket, a simple construction whereby the condensed steam may be readily drained off.

My invention has been more particularly designed for the recovery of rosin from rosin-bearing wood, wherein petroleum naphtha or other suitable rosin solvent is employed; but it is to be understood that the invention is by no means limited in its character and scope to the recovery of rosin, but is capable of use in any and all arts where diffusion apparatus is employed.

Other objects and attendant advantages of the invention will be apparent to persons skilled in the art as the same becomes better understood by reference to the following detailed description taken in connection with the accompanying drawings in which I have illustrated one practical form in which the invention may be embodied, and wherein—

Fig. 1 is a side elevation of the apparatus, in vertical axial section through the drum; Fig. 2 is an end elevation, in vertical section through the charging device on the line 2—2 of Fig. 1;

Fig. 3 is an end elevation from the opposite end of the apparatus, in vertical section through the steam supply and drain pipes and ports;

Fig. 4 is a vertical transverse section through the drum and conveyor screw, on the line 4—4 of Fig. 1;

Fig. 5 is an enlarged vertical axial section through the parts at the left hand end of the drum, viewing Fig. 1;

Fig. 6 is an enlarged vertical section through the parts at the right hand end of the drum, viewing Fig. 1; and

Fig. 7 is an enlarged sectional detail through one of the solvent overflow openings at the right hand end of the drum, showing a removable screen and screen carrier.

Referring to the drawings, 10 designates the foundation or floor surface on which are mounted two pairs of blocks 11 carrying the usual vertical supporting rollers 12 and hori-

zontal end thrust rollers 13. 14 designates the drum equipped a short distance inwardly from its ends with rings 15 resting and rolling on the supporting rollers 12 and confined laterally by the thrust rollers 13. This drum is provided with a circumferential jacket 16 to which the rings 15 are applied, said jacket being spaced from the drum sufficiently to provide an annular flow passage for steam when used for heating purposes. The drum is divided into a series of compartments by a group of internal partitions 17, each formed with a central aperture 18. To one end of the drum is secured a cover-plate 19 which also forms a closure for that end of the steam jacket, and secured to and extending centrally from the cover 19 is a tubular stem or trunnion 20, Fig. 6, closed at its outer end by a bearing 21 and fastening ring 22 to which the bearing 21 is attached. The opposite end of the drum is closed by a cover-plate 23 secured to and extending centrally from which is a hollow stem or trunnion 24, Fig. 5, closed at its outer end by a bearing 25 attached to a fastening ring 26.

Journalled in the bearings 21 and 25 and extending entirely through the drum and the tubular trunnions 20 and 24 of the latter is a long conveyor screw 27; the central apertures 18 of the several partitions 17 accommodating the passage of this screw through the several compartments of the drum. One end of the screw shaft, for instance that projecting beyond the bearing 21, may be equipped with a sprocket 28 for driving the shaft, while the opposite end of the shaft, up to a point where the latter enters the adjacent end of the drum, is made tubular for connection to a source of solvent. At a point where the shaft enters the left hand compartment of the drum one or more lateral holes or ports 29 are provided to permit the solvent to flow freely into the compartment at that end.

Mounted on the tubular trunnion 20 is the mechanism for charging the drum with the stock to be treated. As shown in Figs. 2 and 6, this comprises a pair of spaced stuffing boxes 30 and 31, the former mounted directly on the trunnion 20 and the latter mounted on a filler ring 32, a U-shaped member 33 surrounding and spaced from the trunnion 20 and suitably attached to and supported on the gaskets of the stuffing boxes and formed with a neck 34 of reduced width, a horizontal feed chute or cylinder 35 overlying and communicating with the neck 34 and formed with a receiving mouth 36, and a plunger 37 reciprocable in the chute 35. The free end of the chute 35 may be supported by a link 38 articulated thereto at 39 and similarly articulated at 40 to a lug 41 on the foundation or floor; this manner of supporting the feed chute and plunger permitting the latter to adjust themselves automatically to any

slight variations from true center of the axis of the drum due to wear on the supporting rollers 12 or otherwise. By reference to Fig. 2 it will be seen that the portion of the trunnion 20 which underlies the neck of the feed pipe 33 is provided with openings 42 through which the stock readily enters the trunnion 20 into the field of action of the feed screw.

The hollow trunnion 24 at the discharge end of the drum, Fig. 5, is provided on its lower side with a discharge opening 43, this portion of the trunnion being enclosed by an inverted U-shaped member 44 supported, like the member 33, on the adjacent glands of a pair of stuffing boxes 45 and 46, the former mounted directly on the trunnion 24 and the other on a filler ring 47 that corresponds to the filler ring 32. The lower end of the U-shaped pipe section 44 is formed with a narrowed neck 48 through which the spent material is discharged by gravity or otherwise directly, or through a conduit, to any suitable receptacle or place of deposit.

The several partitions 17 are formed with overflow openings 49, 50, 51 and 52 located at successively more remote points from the axis of the feed screw 27; as a consequence of which, the solvent flows first into the left hand compartment, rises therein until it reaches the opening 49, through which it overflows into the next compartment up to the height of the slightly lower opening 50, thence flows into the central compartment, and so on through the series. From the right hand compartment the solvent flows, through openings 53 covered with screens 53' in the right hand cover-plate 19, into a shallow cup-shaped receiver 54 that is attached externally to the cover-plate 19 and, as shown in Fig. 2, is divided by radial partitions 55 into a plurality of sector-shaped chambers each having an opening 53, the inner ends of which chambers are open and communicate with an annular flow conduit 56 formed by the tubular stem 20 of the drum and a tubular neck 57 fast on the receiver 54 and encircling the trunnion 20. The tubular neck 57 is extended to a fit on the filler ring 32, and is formed with a plurality of ports 58, which latter are encircled and covered by a chambered ring 60, the side walls of which are formed as parts of the stuffing box 31 and an inner stuffing box 61 on the neck 57. As shown in Fig. 7, the screens 53' guarding the overflow openings 53 are preferably mounted on the inner ends of hollow plugs 59 that are screwed through the wall of the receiver 54 into the openings 53 and are provided with lateral ports 59'; this arrangement providing for easy removal and cleaning of the screens when required. The liquid solvent, loaded with the soluble material picked up from the stock in the several chambers of the drum, flows successively into the

sector-shaped compartments of the receiver 54 as said compartments pass through the region underlying the axis of the screw, and, as said compartments pass through the region overlying the axis of the screw and are inverted, the loaded solvent flows down through the conduit 56 into the hollow ring 60, whence it is discharged through a depending nozzle 62 to any suitable point of storage. The ring 60 and its packings are held non-rotatable by the discharge pipe 62, or any other convenient means:

Describing next the heating means, the jacket 16 of the drum is continued to cover one end of the latter, as shown at 16', and is formed with a tubular neck 63 encircling the trunnion 24, forming with the latter an annular conduit 64 for steam and water of condensation that communicates with the chamber of a hollow ring 65, structurally substantially identical with the hollow ring 60 at the other end, its sides forming parts of the stuffing box 46 and a companion stuffing box 66 mounted on the neck 63. The neck 63 extends to a fit on the filler ring 47, and in the transverse plane of the hollow ring 65 is formed with a plurality of ports 67, communicating freely with the chamber of the hollow ring 65. A steam supply pipe 69 enters the top of the ring 65, and a condensate drain pipe 70 leading to a suitable trap, or normally closed by a suitable valve (not shown), taps the lower side of the ring 65, the latter being held against rotation by the drain pipe 70 or otherwise. Extending lengthwise of the cylinder jacket is a group of inclined or oblique bars 71 extending from end to end of the jacket, which serve to catch the portion of the steam that condenses, and return the condensate into the end portion of the jacket formed between the cover-plate 23 and the jacket plate 16', whence the condensate flows through the annular conduit 64 and through the ports 67 into the lower portion of the ring chamber 65 and out through the condensate drain 70. It will be observed that the end wall 16' of the steam jacket extends inwardly past the inner end of the neck 63, forming an annular lip 16'', which forms a dam to prevent backflow of condensed steam discharged from the steam jacket into the conduit 64 leading to the drain 70.

Any suitable means may be employed for rotating the drum and for actuating the discharging mechanism; that shown in Figs. 1 and 2 comprising the following parts. Fast on one end of the drum is a ring gear 72 driven by a pinion 73 on one end of a shaft 74 journaled in bearings 68 at the receiving end of the machine. On the other end of shaft 74 is a crank disc 76, formed as a spur gear, having a pitman connection 77 to the lower end of a rocking beam 78 fulcrumed at 79 on any suitable support with its upper end connected by a link 80 with the feed plunger 37, the feed and the rotation of the drum being thus synchronized. The gear 76 is shown as driven by a pinion 81 fast on a drive shaft 82, which latter also carries a sprocket 83 connected to and driving the sprocket 28 through a chain 84.

In the treatment of some substances it may be desirable to introduce a heating medium into direct contact with the material undergoing treatment, either in addition to or in lieu of the indirect heating afforded by the heating jacket above described. The described apparatus may be equipped for such direct heating very simply by making the shaft of the worm 27 hollow from the charging end of the apparatus to a point within the final or left hand compartment, radially porting it, as shown at 27', and placing one end of the shaft in communication with a steam supply pipe 85 through a suitably packed hollow ring 86 encircling the shaft and communicating with holes 87 in the latter.

In the operation of the apparatus, the stock is continuously fed by the charging mechanism into the hollow trunnion 20 of the drum through which it is advanced by the screw 27 into the first or right hand chamber; the drum meanwhile being slowly rotated. As soon as the stock in the first chamber reaches approximately midheight of the latter, the excess material is caught and advanced by the screw into the second compartment, and so on until all of the compartments are substantially half filled with material which, under the rotation of the drum, is constantly agitated and tumbled. Simultaneously with the introduction of the stock to be treated, the solvent is turned on at the opposite end and successively fills the compartments from left to right to the levels determined by their respective overflow openings 49, 50, 51, 52 and 53. The solvent, flowing through the drum in the opposite direction to the travel of the material, of course meets the latter, with the heaviest charged solvent meeting the freshest stock in the right hand compartment, and the fresh solvent meeting the longest treated stock in the extreme left hand compartment. When the last compartment is charged with spent stock up to the point where it is caught by the feed screw, it is worked out of the latter to the final discharge.

The apparatus cannot be emptied by the normal operation of the machine, because, in the first place the axial conveyor element does not advance the material until the drum has been filled with the solid material to such a degree that the conveying element comes in contact with the solid material. When the feeding of the solid material is stopped, the machine retains all of the solid material contained between the shell of the drum and the conveying element at the axis. In the second place, the drum is not inclined toward the

discharge end and the axial conveyor element is the only means of advancing the solid material through the drum and out of the central discharge opening. Thus, a segment of the revolving drum remains full of material.

The rotation of the drum serves only to mix and agitate the contents and not to advance the material. As fresh material is fed into the charging end of the revolving drum, it is mixed with the retained material at the charging end, and, as this end of the drum accumulates material, the axial conveying element advances such material as momentarily comes in contact with it. It has been observed, in operating these machines, that the mass of material retained in the drum between the axial conveyor element and the shell of the drum is progressively displaced by the fresh material being introduced into the charging end, and as displacement occurs it is advanced through the machine and is finally discharged by the axial conveying element.

The time of retention in this machine, therefore, is a function of the volume of the cylindrical segment of material which cannot be emptied from the machine, and the rate of feed. For example, if the volume of this cylindrical segment of material is two hundred cubic feet, and the fresh material is being introduced at the rate of ten cubic feet per minute, it will take approximately twenty minutes for any particular piece of material to pass through the apparatus. If the rate of feeding is reduced to five cubic feet per minute, the average period of retention would be forty minutes. Thus the apparatus would permit the continuous agitation and treatment of approximately two hundred cubic feet of solid material for a period of time dependent solely upon the rate at which the fresh material is introduced into the machine.

The retention characteristic of the apparatus, as above described, is not dependent upon a multiple compartment drum, although, when it is desirable to carry out the diffusion operation in successive stages, a plurality of compartments may be more economical construction than to have two or more drums operating in series with each other. In certain uses of the apparatus good results are obtained with a single compartment drum.

From the foregoing it will be seen that the described apparatus enables the treatment of the material to be continuously carried on, dispenses with the employment of a plurality of distinct and separate cells, and the transfer of the liquor from one cell to another by a system of pumps, piping and valves; and effects a very thorough mechanical agitation of the stock in all of the cells simultaneously by tumbling, at the same time that the stock is undergoing treatment and transfer from one cell to another. This saves

much time and labor. At the same time it retains the established and approved practice of passing the solvent through the material in a counter direction to the movement of the latter through the successive cells. Both the spent material and the soluble material extracted by the solvent are continuously and automatically discharged so long as the apparatus is running; and the described heating features permit the application of a heating medium either indirectly or directly (or both) to the material at any desired or necessary temperature, readily controlled by the amount of heating medium introduced.

Heretofore the desired specific gravity of the product has been secured by varying the time of treatment in the cells. In the present apparatus this may be secured by either varying the speed of inflow of the solvent or by varying the rate of feed of stock; the drum always retaining a full charge of the latter even after the feed has been stopped.

I have herein illustrated and described one simple practical physical embodiment of the principle of the invention, but it is manifest that the structural details may be widely varied to suit the particular conditions and materials treated without involving any departure from the essential principle of the apparatus or sacrificing any of the benefits and advantages inhering therein. Hence, I do not limit the invention to the particular embodiment herein presented, but reserve all such variations, modifications and mechanical equivalents as fall within the spirit and purview of the appended claims.

I claim:—

1. In a diffusion apparatus, the combination with a rotary horizontal drum, of partitioning means in said drum dividing the latter into a plurality of compartments, and a conveyor screw in said drum extending through said partitioning means.

2. In a diffusion apparatus, the combination with a rotary horizontal drum, of centrally apertured transverse partitions in said drum dividing the latter into a series of compartments, and a conveyor screw in and coaxial with said drum extending through the apertures of said partitions.

3. In a diffusion apparatus, the combination with a rotary horizontal drum, of centrally apertured transverse partitions in said drum dividing the latter into a series of compartments, a conveyor screw in and coaxial with said drum extending through the apertures of said partitions, and charging mechanism for delivering material to the field of action of said screw.

4. In a diffusion apparatus, the combination with a rotary horizontal drum divided crosswise into a plurality of compartments, of means for charging stock to be treated into one end of said drum, means for advancing

ing the stock successively through said compartments, means for discharging the spent stock from the last compartment, and means for introducing a solvent into the presence of the stock in said compartments.

5 5. In a diffusion apparatus, the combination with a rotary horizontal drum, of centrally apertured partitions dividing said drum crosswise into a plurality of compartments, means for charging stock to be treated into one end of said drum, a conveyor screw journaled coaxially with said drum and extending through the apertures of said partitions, means for discharging the spent stock from the last compartment, and means for introducing a solvent into the presence of the stock in said compartments.

6. A form of claim 5, wherein the stock charging and discharging means include hollow necks on the ends of the drum and extensions of the conveyor screw operating in said hollow necks.

7. A form of claim 4, wherein the solvent introducing means produces successive overflows of the solvent from one compartment into the next adjacent compartment.

8. A form of claim 4, wherein the solvent introducing means produces successive overflows of the solvent from one compartment into the next adjacent compartment in a direction counter to the direction of movement of stock through the compartments.

9. A form of claim 5, wherein the partitions are formed with solvent overflow openings at successively increasing distances from the axis of the drum from one end of the latter to the other.

10. A form of claim 5, wherein the solvent is received through one end of the drum and discharged through the other, and the partitions are formed with solvent overflow openings at successively increasing distances from the axis of the drum from the solvent-receiving to the solvent-discharge end of the latter.

11. In a diffusion apparatus, the combination with a rotary horizontal drum, of partitions dividing said drum crosswise into a plurality of compartments, said partitions having central openings for the passage of stock from one compartment to the next and overflow openings for the passage of solvent from one compartment to the next, a conveyor screw extending through said central openings, a solvent supply conduit leading through one end of said drum, a solvent discharge conduit mounted on the other end of the drum, and a circular group of chambers on said drum end each communicating with the adjacent end compartment and with said discharge conduit.

12. In a diffusion apparatus, the combination with a rotary horizontal drum, of a conveyor screw in and coaxial with said drum operating to advance material from one end of the drum to the other as the material is

tumbled in said drum, a steam jacket on said drum for heating the material in the latter, an outflow conduit for water of condensation at one end of the jacket, and means in said jacket for directing the flow to said outflow conduit.

13. A specific form of claim 12 wherein said flow directing means comprises a plurality of inclined strips within said jacket, and an extension of said jacket covering one end of the drum and communicating with said outflow conduit.

14. In a diffusion apparatus, the combination of a horizontal drum, rollers on which said drum is supported for rotary movement, hollow trunnions on the ends of said drum, a continuous conveyor screw extending through said drum and trunnions, and a feed mechanism mounted on one of said trunnions.

15. In a diffusion apparatus, the combination of a rotary horizontal drum, hollow trunnions on the ends of said drum, a conveyor screw extending through said drum and trunnions, means for introducing a solvent into one end of said drum, and a solvent discharge conduit encircling the trunnion at the other end of said drum communicating with the interior of the latter.

16. In a diffusion apparatus, the combination of a rotary horizontal drum, hollow trunnions on the ends of said drum, a conveyor screw extending through said drum and trunnions, a discharge opening for spent material in one of said trunnions, means for introducing a solvent into one end of said drum, a solvent discharge conduit encircling the trunnion at the other end of said drum communicating with the interior of the latter, and a feed mechanism mounted on said last-named trunnion.

17. In a diffusion apparatus, the combination of a rotary horizontal drum, a steam jacket covering the circumference and one end of said drum, hollow trunnions on the ends of said drum, a conveyor screw extending through said drum and trunnions, and a conduit encircling one of said trunnions and communicating with the end jacket of said cylinder, a steam admission pipe leading into said conduit, and a water of condensation discharge pipe leading from said conduit.

18. In a diffusion apparatus, the combination with a rotary drum having axial orifices in each end, of a continuous rotary conveyor element in and coaxial with said drum and orifices, said conveyor operating to advance material through the orifices and from one end of the drum to the other; the size of the conveyor element, orifices, and drum being so proportioned that a segment of the drum remains filled with material which may not be expelled by the conveyor element and which materially exceeds in volume the quantity

being advanced through the drum by the conveyor element.

19. In a diffusion apparatus, the combination with a substantially horizontally disposed rotatable, elongated container having axial orifices in each end, of a continuous conveyor element in and coaxial with said container and orifices, said conveyor operating to advance material axially from one end of the container to the other, the size of the conveyor element, orifices and container being so proportioned that a segment of the container remains filled with material which may not be expelled by the conveyor element and which materially exceeds in volume the quantity being advanced through the container by the conveyor element.

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