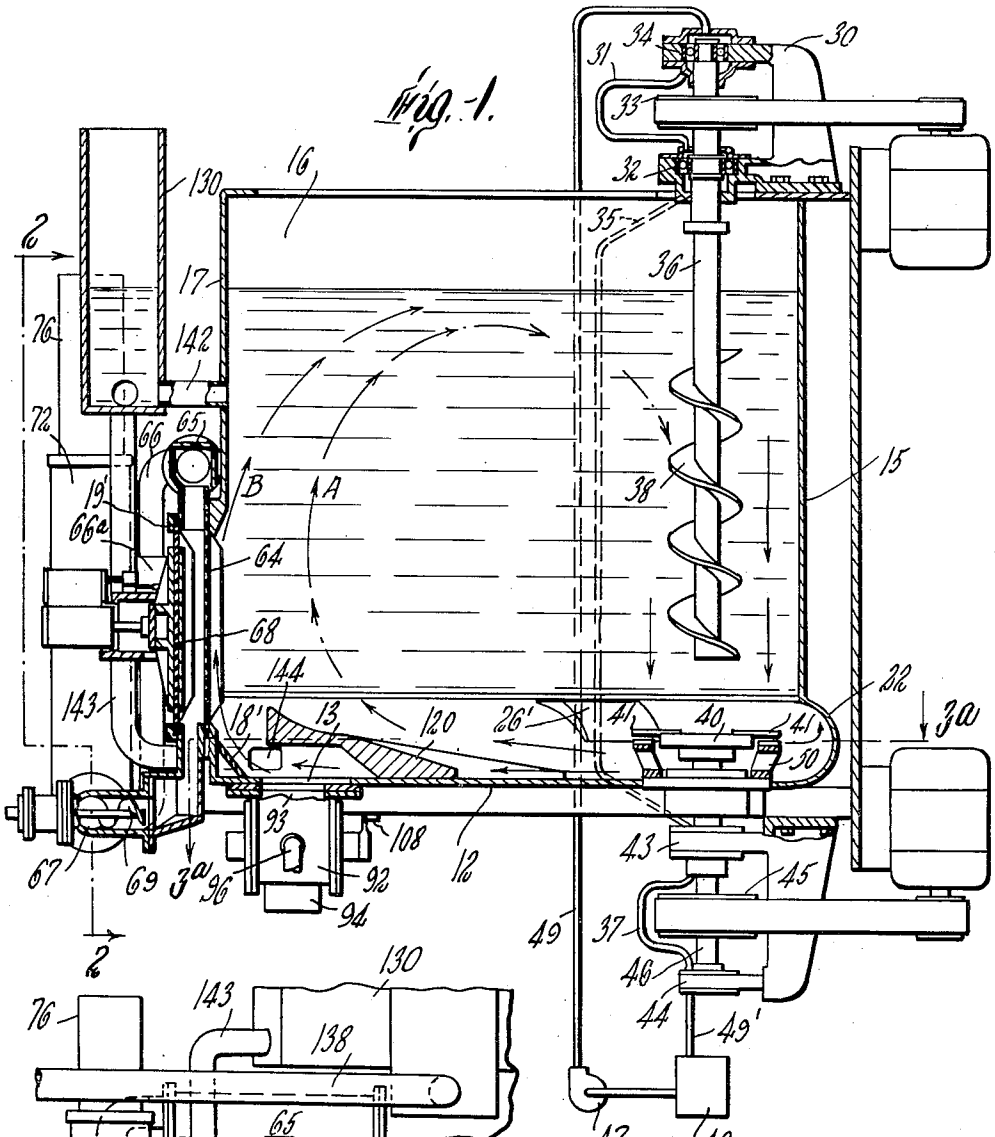
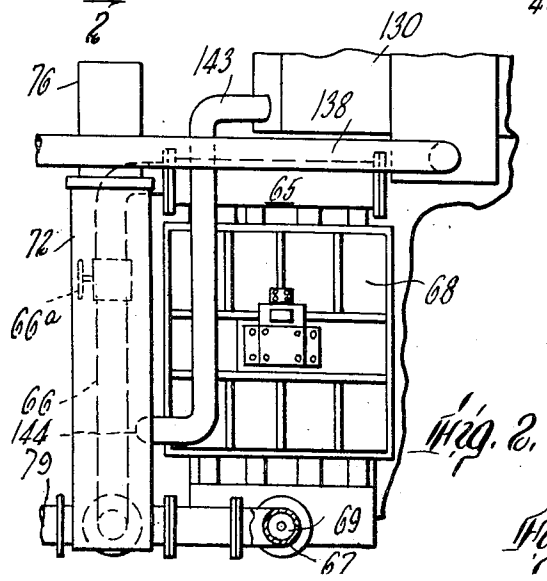
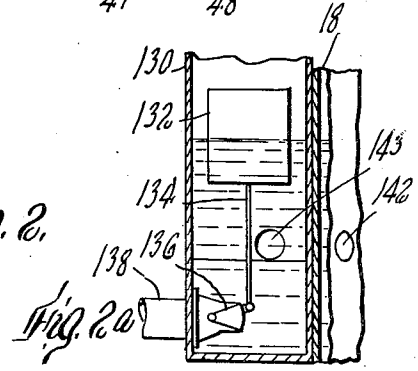
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PULPER

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PULPER

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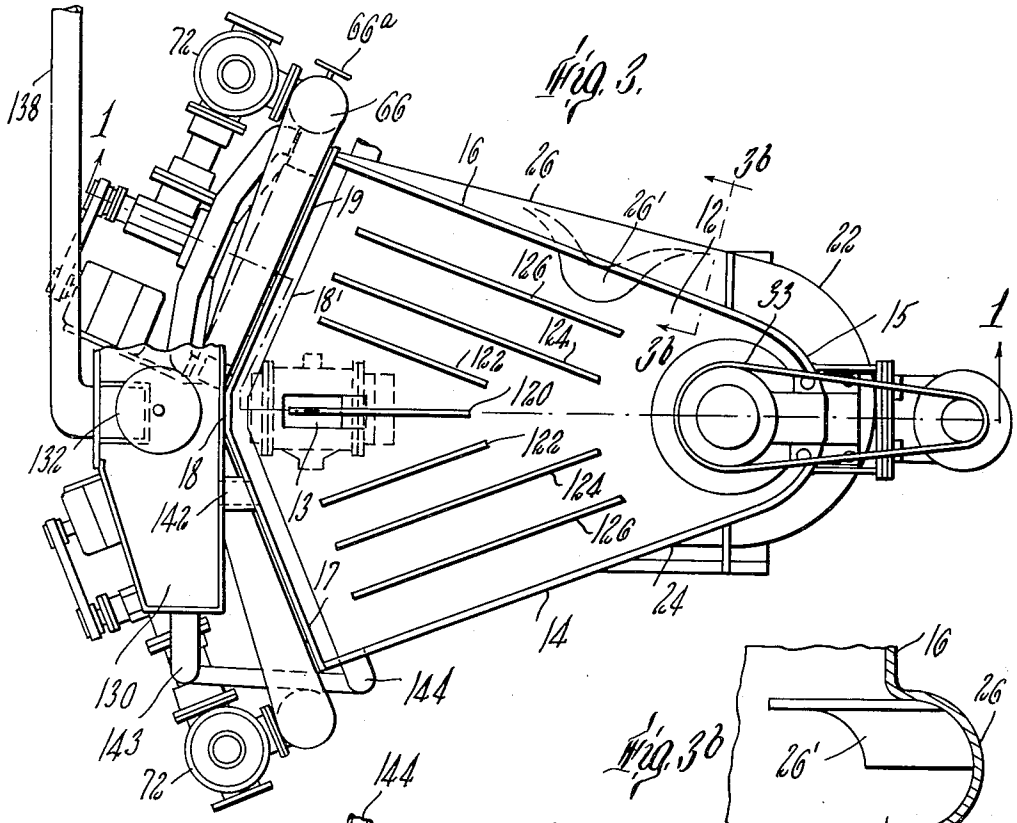


Fig. 3.

Fig. 3b

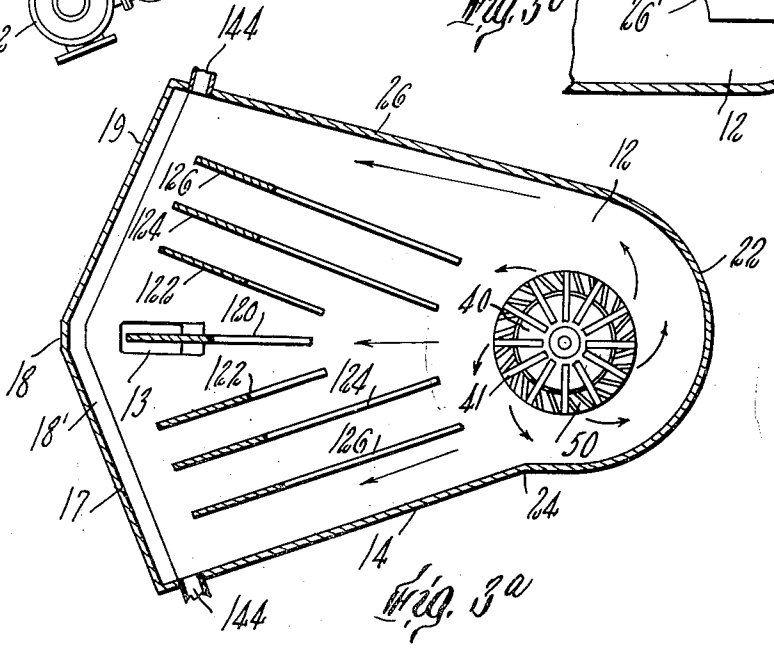


Fig. 3a

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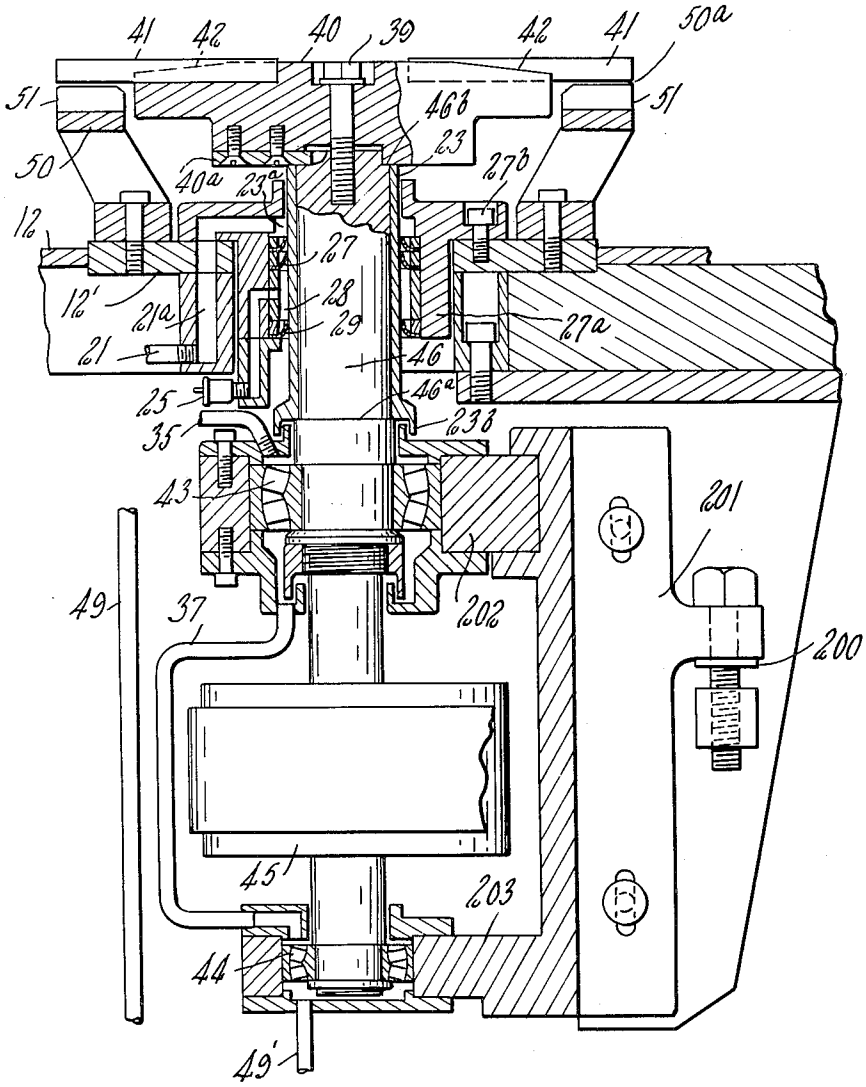


Fig. 4.

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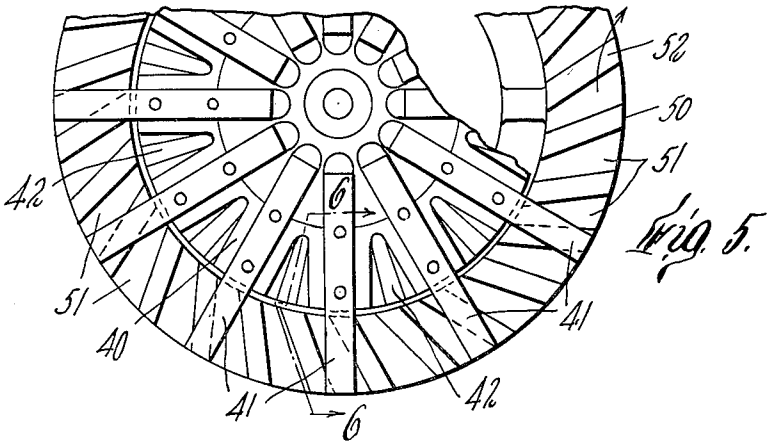


Fig. 5.

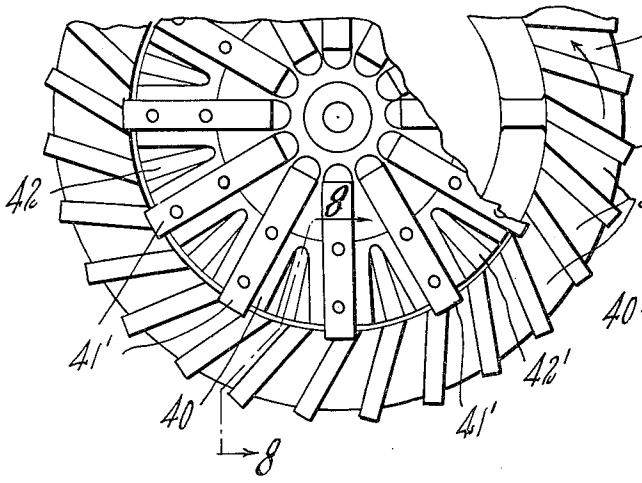


Fig. 7.

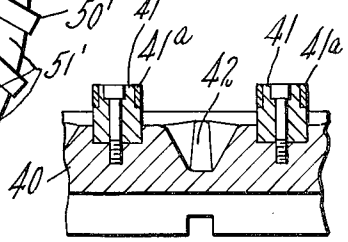


Fig. 9.

Fig. 6.

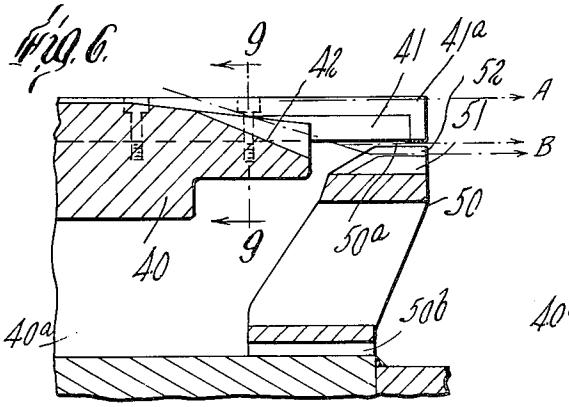
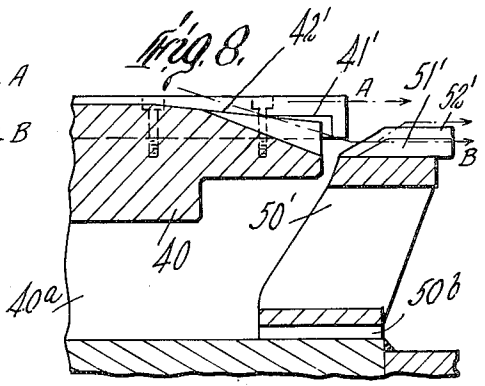


Fig. 8.



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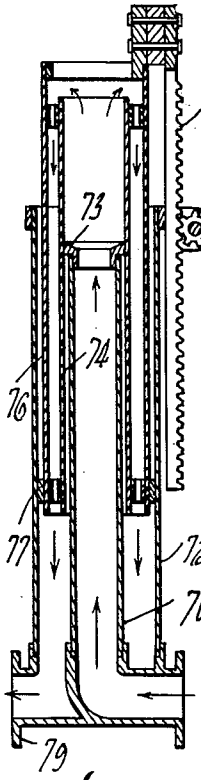


Fig. 10.

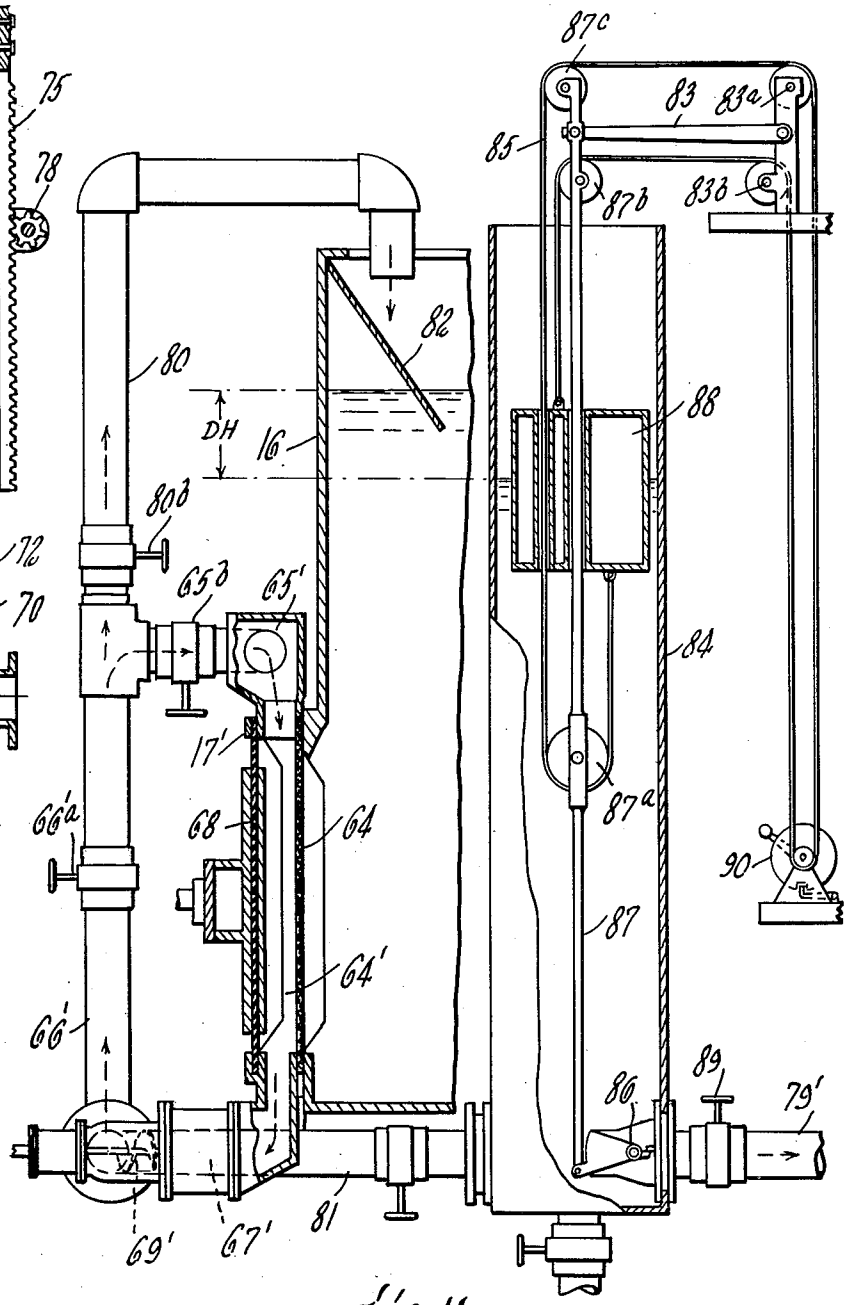


Fig. 11.

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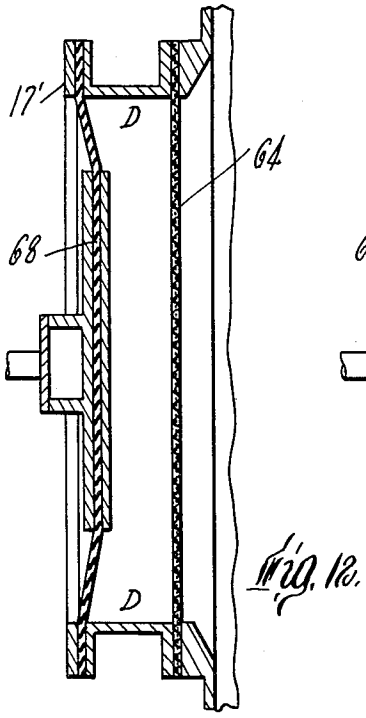


Fig. 12.

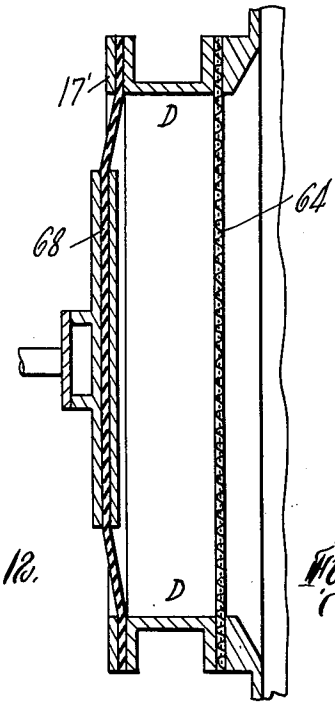


Fig. 13.

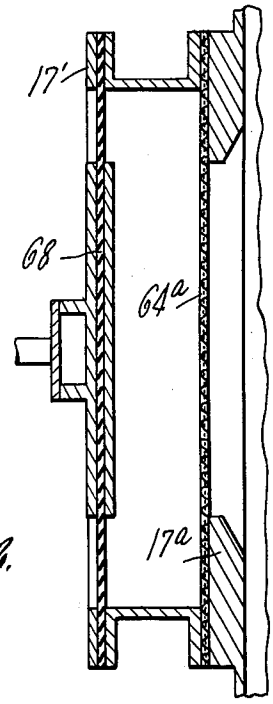


Fig. 14.

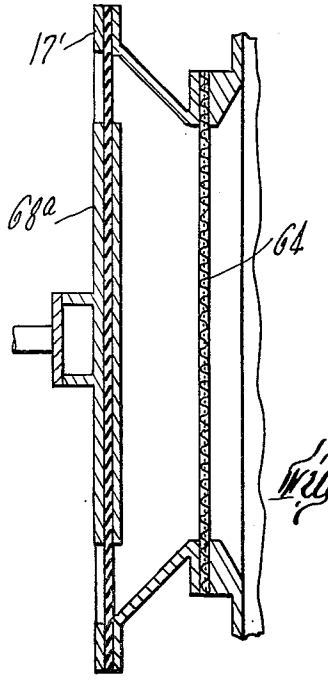


Fig. 15.

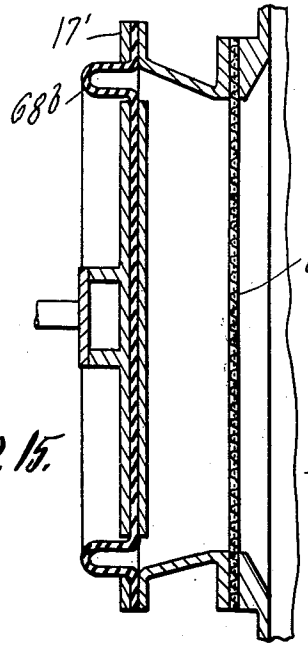


Fig. 16.

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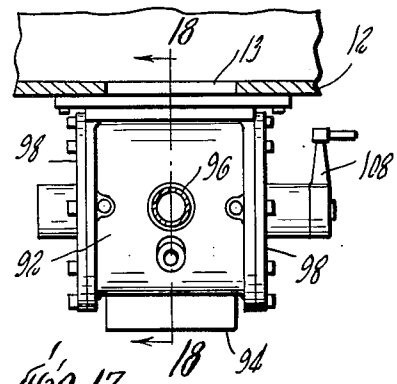


Fig. 17.

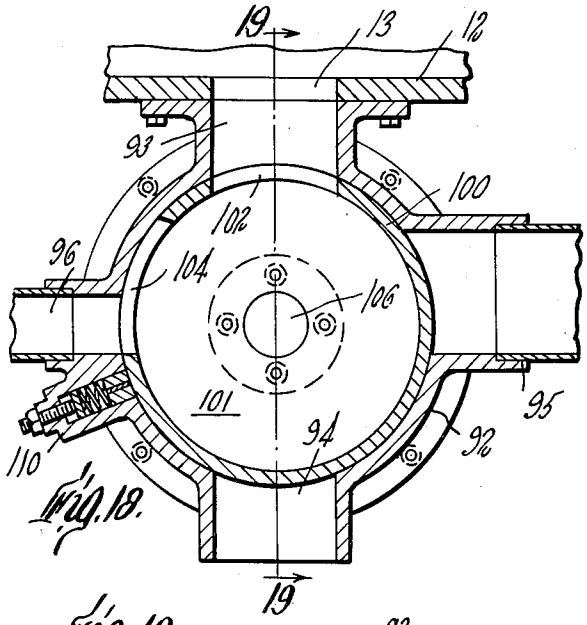


Fig. 18.

Fig. 19.

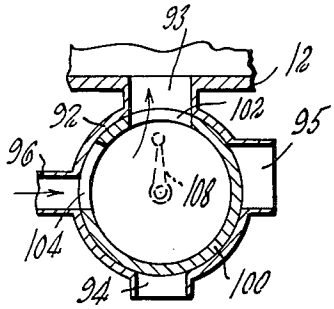
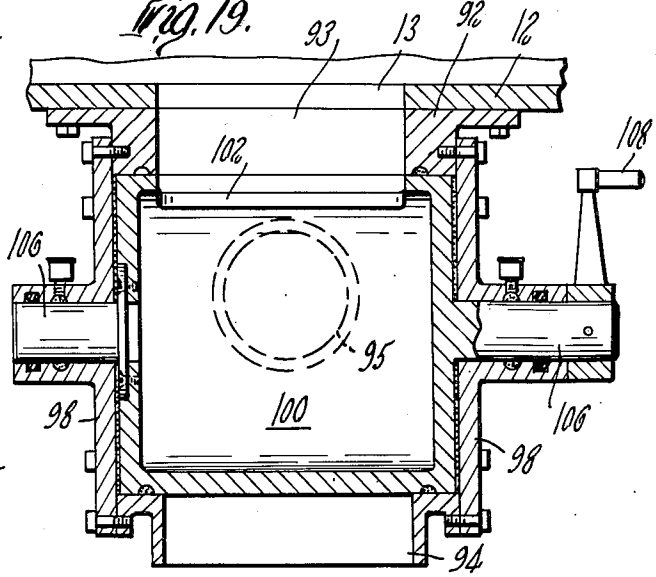


Fig. 20.



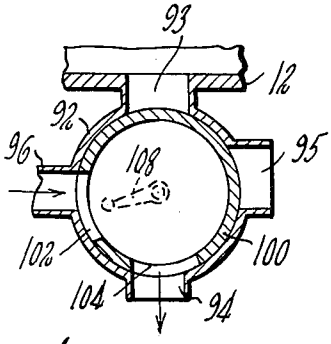


Fig. 21.

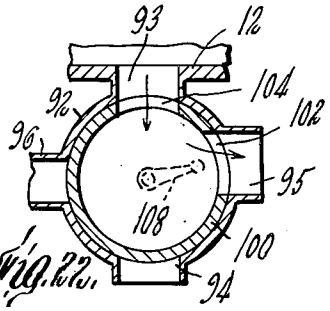


Fig. 22.

United States Patent Office 3,021,080 Patented Feb. 13, 1962

3,021,080

PULPER

Merle P. Chaplin, South Portland, Maine, assignor, by mesne assignments, to Diamond National Corporation, New York, N.Y., a corporation of Delaware

Filed Mar. 17, 1959, Ser. No. 799,964
1 Claim. (Cl. 241—69)

This invention relates to apparatus for disintegrating dry, fibrous materials such as wastepaper, in combination wtih apparatus for immediately removing the disintegrated or separated fibres from the disintegrating portion of the equipment or apparatus. The disintegrated fibrous materials are removed in liquid form with the individual fibres in substantially the same condition as they were when the original dry, fibrous sheet or other material was produced. In other words, the fibres, having been separated from each other, are delivered from the apparatus without material injury or degradation, enabling their reuse with little or no impaired strength and durability.

Reference is made to my two prior patents for defibering equipment, these being Patents 2,648,261 and 2,796,006. Fibre disintegrators and separators constructed in accordance with the teachings of the above-mentioned patents have proved extremely useful.

This invention is concerned with certain improvements and additional novel features which have been developed as a result of the operation of the equipment built in accordance with the teachings of the above patents.

Accordingly, it is an object of the present invention to provide a greatly improved pulper by the use of a novel tank and element arrangement to provide highly efficient circulation of the liquid-fibre mixture, not only for most efficient, speedy and complete pulping, but also for selective removal of finished fibres as well as for removal of accumulated unwanted materials, such as staples and other metallic fastening elements, commonly found in waste materials to be pulped. In general, this object of the invention has been accomplished by utilizing a tank of generally acute angled V shape in horizontal cross-section with an outwardly extending involute shaped portion adjacent the bottom, the circulating means, especially the impactor portion being located adjacent the involute portion and being rotated in the direction of increasing involute radius for most efficient circulation of the liquid-fibre mixture past a screen located in one of the tank walls. Also, the impactor structure itself is of improved design for more efficient operation. Further aids to circulation within the tank may also be provided, such as upstanding vanes in the tank bottom and an end wall having a pair of flat portions at an obtuse angle to one another carrying the screens.

It is another object of the invention to provide a pulper of much improved mechanical construction, especially from the standpoint of simplicity of construction and ease of maintenance. Thus, the pulper of the present invention is especially easily maintained, both when running and otherwise.

Another object of the invention is the provision of a novel dump valve for removal of unwanted materials, it being a feature of such valve that it be capable of cutting metallic materials tending to jam it in its operation.

It is another object of the invention that novel impactor disk means as well as mounting and lubricating means therefor are provided for most efficient operation with minimum pulp dilution.

It is yet another object of the invention that improved level control and recirculation means are provided for increased efficiency with minimum air entrapment.

The novel features, then, of the present invention may be tabulated as follows:

(1) A novel shape of disintegrator tank structure in which the disintegrating action is concentrated in one portion of the tank, and the screening or fibre-separating action in another portion of the tank.

(2) Provision for the disintegrated material escaping from the disintegrating zone and passing through the screening or fibre-separating zone.

(3) The provision of a rotating impactor member and a stationary cooperating impactor member.

(4) An impactor structure having a broad fibre impact area for both rotating and stationary members, with such members being readily replaceable and renewable.

(5) A new, highly efficient means for attaching the rotating impactor assembly to the shaft.

(6) An improved mounting for the shaft on which the rotating impactor assembly is mounted.

(7) Novel means for sealing the rotating impactor shaft against leakage of pulp materials from the disintegrating tank, including both grease and water seals.

(8) A readily replaceable and renewable sealing assembly, including the seals themselves and the sleeve on the shaft which the seals contact.

(9) The provision of circulating oil lubrication for the shaft bearings for both the impactor member and spiral feeding member.

(10) An improved means for removing the disintegrated or screened stock from the tank.

(11) An improved means for removing screened stock from the fibre-separating mechanism.

(12) An improved means for introducing water or other liquid to the disintegrator tank.

(13) Improved screened stock circulation.

(14) An improved design of dump valve and junk remover.

(15) A pre-separating action within the disintegrator tank circulation allowing the more completely disintegrated material to contact the screening or separating surface or surfaces, but largely preventing the undisintegrated material from reaching these surfaces and interfering with the screening or separating action.

(16) A pre-separating action within the disintegrating mechanism whereby the more completely disintegrated materials are subjected to additional impactor action.

Various other novel features will appear in the following specification and drawings showing and describing preferred embodiments thereof.

In the drawings:

FIG. 1 is a side elevation of the apparatus of the invention, partly in section, showing the disintegrator tank; spiral feeding member; the impactor members; the involute tank section permitting stock acted on by the disintegrator to escape horizontally from the disintegrator zone; the deflector members which deflect the larger undisintegrated materials from the screening zone; the dump valve or junk remover location; the screening or separating section; the screened stock circulating and control means, and the water infeed means.

FIG. 2 is a side exterior view of the screening of fibre-separating and screened fibre delivery portions of the apparatus of FIG. 1.

FIG. 2*a* is a cross-section of a portion of the apparatus of FIG. 1 showing the water infeed system thereof.

FIG. 3 is a top view of the apparatus of FIG. 1 showing the pulper tank, the deflector members in involute wall and in the bottom of the tank, the spiral feeding mechanism and the two screening or fibre-separating mechanisms. The location of the dump valve is shown in dotted lines with the tank opening directly above.

FIG. 3*a* is a cross-sectional plan view showing the lower portion of the apparatus of FIG. 1, particularly the shape of the bottom of the tank under the involute portion.

FIG. 3*b* is an enlarged partial sectional elevation showing the involute wall deflector member.

FIG. 4 is an enlarged side cross-section through the rotating and stationary impactor assemblies of FIG. 1, the shaft mounting and bearings, and the water and grease-sealing arrangement.

FIG. 5 is a plan view of the rotating and stationary impactor members in one form, as shown in FIG. 1, with the rotating impactor members projecting over the stationary impactor members.

FIG. 6 is a cross-section of the rotating and stationary members of FIG. 5.

FIG. 7 is a plan view of a modified form of the rotating and stationary impactor members wherein the rotating impactor members do not project over the stationary impactor members, and are located somewhat below.

FIG. 8 is a cross-section of the rotating and stationary members of FIG. 7 showing the bottom surface of the rotating members below the top surfaces of the stationary impactor members.

FIG. 9 is a cross-section, common to FIGS. 6 and 8, and taken on the lines **9—9** thereof, which shows the recessed areas in between each of the rotating impactor members on the rotating impactor.

FIG. 10 is a cross-section which shows the screened fibre stock delivery structure also shown in FIGS. 1 and 2. In this case, the screened fiber stock overflows a vertically adjustable tube, the height of this tube determining the difference in level between the stock inside the pulper and the stock flowing from the screened fibre section.

FIG. 11 is a cross-section which shows a modified form of screened stock delivery in which the screened fibres do not overflow an adjustable level device, but rather are removed under pressure by a float controlled valve, the location of the float determining the differential level between the stock inside the pulper tank and the stock being removed from the screened section. This view also shows means for recirculating the screened stock by the screen itself, and also for returning a portion of the screened stock back to the pulper tank.

FIGS. 12 and 13 are diagrammatic side sections showing the operation of the screen and diaphragm of FIG. 11.

FIGS. 14, 15 and 16 are diagrammatic side sections showing modifications of the diaphragm and screen of FIGS. 11, 12 and 13 to increase the efficiency thereof.

FIG. 17 is a side elevation of the junk removing device.

FIGS. 18 and 19, respectively, are enlarged cross-sections and side elevations of the junk removing device shown in FIGS. 1 and 12.

FIG. 20 shows the rotating member of the device in position to receive heavy, metallic, and other materials from the pulper tank.

FIG. 21 shows the device rotated in an anti-clockwise direction, closing the opening into the tank and permitting all materials accumulated in the chamber to be ejected therefrom.

FIG. 22 shows the rotating member of the device rotated to permit the stock to be removed from the pulper tank itself.

In my Patent No. 2,648,261, the feeding and impactor members are located near the corner of a relatively square tank. With such structure, as the material is acted upon by the impactor disk, it is thrown outwardly in a horizontal direction by centrifugal force, and the material which is thrown outwardly and towards the corner section of the tank (FIG. 2), moves upwardly instead of towards the screening area, interfering with the downwardly feeding action of the spiral member.

In my Patent No. 2,796,006, the feeding and impactor members are located in the center of a relatively round tank, the screening mechanisms being located circumferentially in the walls of the tank. As a practical matter, it has been found that only one or two screen sections are commonly in use at any one time. Hence, the circulation imparted to the pulp mass by the disk and impactor members, passes the disintegrated stock over a large area in the tank walls in which there is no screening action present, hence, the efficiency of the screening mechanism itself is thereby reduced by not having exposed to the screen surface all of the material immediately after it leaves the disintegrating area.

Both of these objections are obviated by the design of the tank structure shown in this application, wherein the feeding and impactor members are located in one area of the tank, and the tank opposite the disintegrator member is enlarged in an involute or centrifugal pump shape so that the defibred materials, as they are thrown outwardly, will not be projected upwardly, but will be projected directly towards the screens located in the opposite section of the tank.

As has already been mentioned, the fibre disintegrator and separator of the present invention in general has a pulp tank generally angular or of a V-shape with the feeding and impacting mechanism located adjacent to the V section, and the fibre-separating or screening mechanism located in the wall or walls opposite or away from the V or disintegrating section.

In order to provide means for the disintegrated materials after they have been acted on by the rotating and/or stationary impactors to escape from the disintegrating zone without interfering with the downward motion of the undefibred stock, an enlarged section of the tank, as is best shown in FIG. 3*a*, shows an involute portion adjacent the bottom thereof, essentially the same as would be utilized in a centrifugal pump, which provides that the outwardly thrown material can be projected across the relatively flat bottom of the tank and directly towards the areas in which the fibre-separating and screening mechanism is located.

To assist in the directional flow of the wholly or partially defibred materials projecting across the bottom of the tank by the centrifugal action of the disintegrator disk itself, there is provided a plurality of deflecting vanes or members including a deflector in the volute wall which have two purposes. First, they tend to direct the flow across the bottom of the tank directly towards the screening surfaces, and second, they permit the more finely divided or disintegrated materials to pass between these deflecting members, whereas the larger undefibred pieces of material are deflected upwardly, as shown by the arrows in FIG. 1, thereby effecting, within the circulating medium itself, a preliminary classification of the size or kind of materials within the tank itself.

More specifically, the tank utilized in the apparatus of the invention is made up of a bottom wall **12**, a side wall providing a horizontal V cross-section throughout the major portion of its length, and an end wall. The side wall is in the form of an acute V having an included angle of from about 20 to 60 degrees, preferably about 40 degrees, with a circularly rounded apex **15** and generally straight sides **14** and **16**. The free ends of sides **14** and **16** are connected by an end wall **18** extending therebetween, said wall providing a pair of flat screen portions **17** and **19** in the form of a shallow V with apex outward. Bottom wall **12** is provided with a dump valve inlet **13** adjacent the apex of end wall **18** (FIG. 1).

In order to provide the improved circulation which is a feature of the present invention, the portion of the side wall adjacent the bottom wall **12** is displaced outwardly in the general form of an involute **22**, such involute beginning along one side wall at a point **24** adjacent to and somewhat outwardly along side **14** from the junction of said side and the circular apex **15** of the side wall. From point **24**, the wall of the involute is spaced outwardly at an increasing distance from the circular apex **15** until it reaches a maximum in the region of the junction of apex **15** and the other side **16**. Thereafter, the involute **22** has a straight wall portion **26** with a deflector

member 26' curved in plan view and extending inwardly at a maximum distance at the top of wall portion 26 approximately on a radius of the impeller 40. The wall portion 26 itself is spaced outwardly from side 16 at a progressively decreasing distance until it merges with said side at the free end thereof. The involute 22 and its connecting wall 26 should be of substantial vertical extent, and of a hand in the proper direction of rotation in view of the circulating means which operates as an impeller for circulation within the involute, as hereinafter more fully explained.

As a further aid to circulation in accordance with the principles of the invention, a plurality of upstanding vanes are mounted on bottom wall of the tank, such vanes include a central vane 120 positioned along its axis of symmetry and three additional vanes, 122, 124 and 126, on each side thereof generally parallel to the side 14 or 16 on that side of said axis. Central vane 120 is cut away at its lower portion over opening 13, and the other vanes may also be so cut if desired. In general, the vanes increase in height as they approach end wall 18 but terminate short thereof so as not to interfere with flow therealong, and further, to aid in turning the direction of flow upwardly along screens 64, the lower edge 18' of wall 18 may be curved inwardly toward the bottom wall 12 (FIG. 1).

In the preferred pulper according to the present invention, with the sides at an angle of 40 degrees to one another and the end wall having an angle of about 140 degrees, the length of the straight sides 14 and 16 is about three times the radius of the circular apex 15, with the maximum involute radius being about one and one-half the radius of the circular apex. With this arrangement, the flat screen portions of the end wall may be about twice the radius of the circular apex, the effective diameter of the disintegrator disk at the outside of bars 41 being about half the radius of the circular apex. The overall height of the pulper may conveniently be three to five times the radius of the apex 15, with the screens 64 being located in about the lower half of the vertical height of wall 18. Typically, the base length along the axis of symmetry of bottom wall 12 and the height of the side wall may be about equal and range from about 5 to 10 feet.

The circulating means includes, mounted on the upper edge of the side wall adjacent apex 15, a bearing support member 30 having mounted therein a pair of spaced bearings 32 and 34 supporting for rotation therein, preferably coaxially of circular apex 15, a downwardly extending shaft 36 having a cantilever screw section 38 of left-hand pitch. Shaft 36 is driven through a pulley 33 mounted therein between the bearings by any suitable means, not shown, at relatively low speed of about 100 r.p.m. in a direction to move stock downwardly. Bearings 32 and 34 are lubricated by oil passed through inlet pipe 49 to the upper side of upper bearing 34 and thence downwardly through said bearing pipe 31 and lower bearing 32 into discharge pipe 35, as more fully described below.

The impactor disk 40 is mounted for rotation on the end of a shaft 46 extending upwardly through the bottom wall of the tank, said shaft being carried in a pair of spaced bearings 43 and 44 with a drive pulley 45 therebetween. In accordance with the present invention, then each of bearings 43 and 44 are located outside of the tank and hence may be lubricated and cooled by a suitable lubricating fluid continuously passed through all of the bearings 32, 34, 43 and 44 by pump 47 from reservoir 48, along a pipe 49 to the upper bearing 34, thence through pipes 31, 35 and 37 successively, connecting the upper with the next lower of said bearings, and finally from the lower bearing 44 through pipe 49' back to reservoir 48 for reuse.

Considerable difficulty has been experienced in the operation of pulpers of either of the two aforementioned patents, due to leakage of pulp and fibre materials mixed with water downwardly, along the shaft in the bottom of the tank, sometimes finding their way into the bearings which support the impactor shaft. Thus, it has been generally customary in equipment of this kind, to provide a sealing and water lubricating bearing at the top of the impactor shaft, and to inject sufficient water up through this bearing so as to keep it thoroughly lubricated and to prevent pulp or other materials from reaching the wearing or bearing surfaces. However, in use, both bearing and shaft eventually become worn, and the shaft may be scored, and it may not be possible to thoroughly keep the fibrous and other abrasive materials from reaching the bearing surface. Leakage is thereby rapidly aggravated.

Attention is directed to FIG. 4 which shows a greatly improved design of impactor shaft mounting with means of replacing the sealing parts or assemblies with a minimum of time and/or expense. In FIG. 4, the shaft is shown at 46 and the rotating impactor disk 40 is mounted on said shaft centrally thereof. Removably mounted on the disk are a series of replaceable impactor bars 41, also shown in FIGS. 5 and 7, and the entire assembly is mounted directly on the end of the shaft 46 by a single bolt or retaining member 39, the rotary motion being imparted from the shaft to the disk by a key 40*a*.

The shaft 46 is mounted in two anti-friction bearings 43 and 44 with the drive pulley 45 located therebetween. The upper portion of shaft 46 is protected by an outer sleeve 23 supported by a shoulder fit 46*a* on shaft 46, the upper end being flush with the shoulder 46*b* at the upper end of the disintegrator shaft 46 so that the sleeve will be tightly secured in place. The shaft 46 is provided with a pair of spaced seal elements 27 and 29 with an annular grease-containing space 28 therebetween about shaft 46. It will thus be seen that the entire portion of the shaft 46 which may be exposed to water or fibrous materials is protected by the outer sleeve 23 which is made of water-resistant and hard-surfaced materials, providing long life against the action of the pulp and fibrous materials and the bearings of the seals 27 and 29 against its rotating surface.

To provide for seal lubrication, grease or other lubricating materials are introduced through pipe 25 into space 28 between the single lower seal and the two upper seals. The lower seal prevents the grease or other lubricating material from escaping downwardly, and any surplus lubricating material can escape by the upper seals 27 and add to the lubrication of these seals as they bear against the rotating sleeve 23.

To very largely prevent pulp and other abrasive materials from reaching the seals 27, clear water from pipe 21 is introduced through passage 21*a*, passing between the seal retainer 27*a* and the shaft sleeve 23 and diluting the liquid mixture in the space 23*a* directly above the seal retaining member 27*a* and below the rotating impactor disk 40. Only a small amount of clear water is necessary for this purpose, and the space 23*a* is maintained relatively free of fibrous and/or other materials, thereby greatly prolonging the life and serviceability of the upper seals 27.

When and if it is desired to examine the seals, or if there is ever any evidence of grease or water leakage by these seals, which will be thrown outwardly by the projecting flange 23*b* at the bottom of the sleeve 23, the entire sealing assembly including the protective sleeve 23 can be readily removed from the inside of the tank. This is accomplished first, by loosening the retaining member 39, and lifting the disk off the end of the shaft. Retaining bolts 27*b* holding the seal retainer 27*a* are then removed, and the entire sealing assembly, including the sleeve 23 lifted out of the opening in the bottom of the tank, thereby enabling it to be thoroughly examined and any worn parts renewed or replaced. This is an exceedingly important feature where the impactors mounting shaft projects through the bottom of the disintegrating tank. Replacement of water lubricated bushings and/or other means heretofore employed are extremely expensive and occur

altogether too frequently to be satisfactory for efficient operating purposes.

The impactor shaft bearings 43 and 44, as well as the bearings 34 and 32 which support the downwardly feeding member 38, are not only protected against any entrance of water or other foreign material, but also are thoroughly lubricated by a forced oil lubrication system, supplied by pump 47 which furnishes the lubricating oil to the bearings successively, 34, 32, 43 and 44, this oil being returned to a reservoir 48 where it is filtered, reconditioned if necessary, and again returned to the bearings as above described.

The use of anti-friction bearings, in accordance with the design here disclosed and shown in FIG. 4, means that the impactor shaft and its disk are held in accurate alignment and operation, particularly when a stationary impactor member is employed, as shown herein. Heretofore, when a water-lubricated bushing was employed to support the upper end of the impactor shaft, any wear of this bushing and/or the shaft, caused a misalignment and frequently vibration of the shaft and its disk which further aggravated wear of both bushing and shaft, and interfered with its efficient operation and functioning, particularly at the speeds of about 1000 r.p.m. employed.

The separation of individual fibres from wastepaper materials without injury to the fibres themselves can best be accomplished by a series of impacts or shock effects on the fibrous materials while they are immersed in water or other liquid. It can also be accomplished by rubbing the fibrous materials between two metallic and/or other surfaces, but this tends to degrade or weaken the fibres themselves and is objectionable in the disintegration of most fibrous materials.

Considering the impactor members themselves, as shown in FIGS. 5 to 9 inclusive, there are shown two structures, one shown in FIGS. 5 and 6, and the other in FIGS. 7 and 8. The structure shown in FIGS. 5, 6 and 9 is provided at its outer edge with a plurality of upstanding and radially extending bars 41, having outwardly and downwardly sloping grooves 42 therebetween. The bars cooperate with a fixed annulus 50 within and secured to the bottom of the tank closely surrounding disk 40 and underlying the outwardly extending ends of bars 41. The annulus 50 is provided with a plurality of bars 52 having therebetween grooves 51 formed between bars 52 extending thereacross at an angle of about 30 degrees to the radius with their outer ends displaced forwardly in the direction of disk rotation with respect to their inner ends. These grooves and bars cooperate with bars 41 to disintegrate fibrous material in the mixture by a shearing action, the direction of flow, because of the slot angle, tending to be somewhat outward.

In FIGS. 5 and 6, the rotary impactor bars 41 project over stationary impactor bars 52. The space 50*a* between the moving bars 41 and the stationary bars 52 is adjustable as indicated in FIG. 4, whereby an adjustment of the adjusting screw 200 moves the bracket 201 upwardly or downwardly, carrying with it the two bearing mountings 202 and 203 which, in turn, support the shaft 46, on which is mounted the disk 40, thereby varying the space or distance 50*a* between the rotating bars 41 and the stationary bars 52. A slot 50*b* in the base of the mounting bracket 50 may be provided in order to permit any dilution water introduced into the space 40*a* to escape when the pulper is completely drained. In operation, however, the space 40*a* is completely filled with a fibre and dirt-free water introduced through pipe 21, as previously described.

Preferably, although not necessarily, the rotating bars 41 are mounted radially in order that they may have the greatest impact action on the fibrous materials as they are fed downwardly under action of the spiral feeding member 38. The spiral feeding member 38 is preferably rotated in a direction opposite to that of the impactor member 40, so that the maximum impact effect is obtained when the fibrous materials reach the impactor disk and the impactor bars 41.

Also, preferably, the working surfaces of the impactor bars 41 and 52 are faced or covered with a hard, durable material, as indicated at 41*a* of FIG. 9, which material can be readily replaced, maintaining the surfaces of the impactor bars in efficient working condition.

In the arrangement shown in FIGS. 5 and 6, the stationary impactor bars 52 mounted on the stationary member 50 are preferably located at an angle, opposing the radial or centrifugal movement of the fibrous materials under the urge of the impactor bars 41. This secures the maximum surface impact effect between the two bars 41 and 52, when and as they are used in this manner.

Another arrangement of rotating the impactor members which has been found to work efficiently and require somewhat less power, is that shown in FIGS. 7 and 8. In this case, the rotating impactor bars 41′ are made somewhat shorter than the impactors bars shown in FIGS. 5 and 6, and terminate short of the annulus 50′ adjacent its tapered inner edge, and the height of the impactor bars 52′ supported in stationary member 50′ is made somewhat higher than in the structure shown in FIGS. 5 and 6. The angle, also, of the stationary impactor bars 52′ is reversed from that shown in FIG. 5, having their outer ends displaced rearwardly in the direction of disk rotation so that the fibrous materials and particularly those which are almost completely defibered, being thrown outwardly and radially by the rotary impactor bars 41′, strike the stationary impactor bars 52′ at an angle and are further urged outwardly, due to the angle or position of the impactor bars 52′, as shown in FIG. 7.

In both arrangements of FIGS. 5 and 6, and also in FIGS. 7 and 8, there is a segregation or separation of the relative condition of the materials to be disintegrated in that the larger materials which have been impacted only once or twice by the rotary impactor bars 41 or 41′ are deflected outwardly and take path A, as shown in FIG. 1, whereas the materials that have been more finely divided or more completely separated pass outwardly and downwardly through the slotted areas 42 between the impactor members 41 or 41′ and thereby the reaction between the rotating and stationary impactor members is effective only as the material is more completely disintegrated. This is found to be particularly efficient in the final separation of one fibre from another and, as indicated above, there is a separating or classifying action performed within the disintegrating area itself, as also is performed or accomplished in the tank itself by the two paths of the larger undisintegrated particles and the smaller or completely disintegrated particles or fibres.

In FIGS. 3 and 3*a* there are shown two sets of separating or screening mechanisms located in the tank wall opposite or away from the disintegrating section. The number of screen sections which may be utilized depends on the size of the pulper tank, the amount of power which may be applied to the disintegrator disk or the amount of disintegrated material which has to be separated, and the degree of fineness which the separating mechanism is called upon to perform. Hence, the pulper tank may have, under certain conditions, only a single screening position located directly opposite the V-shape portion of the pulper tank, it may have two as is shown, or it may have three or more. Regardless of the number of screening positions, the pulper tank, the design of the involute section opposite the disintegrator disk, and the arrangement of the deflectors 26′, 120, 124 and 126 are such that the more finely disintegrated materials are projected uniformly by all screen or separating areas.

For selectively removing fibres from the mixture, as best shown in FIG. 1, suitable screens 64 are mounted in the flat screen portions 17 and 19 of end wall 18, such screens 64 further including an outwardly spaced wall 17′ or 19′ having mounted therein a vibratory diaphragm 68, which may be operated by any suitable means not

shown, to selectively remove fibres through a screen into the enclosure between said screen and diaphragm **68**. Suitable means, including a water inlet **65** and an outlet **67** and interconnecting pipe **66** as well as an outlet circulating pump **69** are provided for removal of the selected fibres to storage or further use. The vibratory diaphragm **68** and its operating means are important to the operation of the pulper of the invention, both in stock selection and in freedom from screen clogging.

Thus, as shown in FIGS. 12 and 13, the vibrating or pulsating diaphragm **68** moves alternately in and out to draw disintegrated materials through the openings in screen **64**, and alternately frees these openings by pushing a small quantity of the diluted screened material back through these openings thereby permitting a new portion of disintegrated materials to be drawn through the screen openings on a second outward pulsation. To provide fresh materials for the second screen or pulsating screening motion, the rapid movement of the more completely disintegrated fibrous materials as previously described, is passing upwardly by the screen in the disintegrator tank side, as indicated by the arrows, so that on each pulsation, a fresh or new area or section of defibred materials is acted upon by the separating mechanism, thereby enabling the removal of most of the satisfactorily disintegrated materials from the disintegrator tank as rapidly as they have been thoroughly prepared by the disintegrating mechanism.

With the arrangement of FIGS. 12–13, the volume indicated at D is a relatively dead annular area around the screening area. When the diaphragm **68** then is moved inwardly, there is a flow parallel to the screen openings and generally perpendicular to the diaphragm and screen face. With some fibres, this action tends to cause the deposit of fibres around the screen openings and on the screen and to lodge them in the openings thereof. Eventually, there may be few openings which are not covered or plugged after a few hours of operation.

One means for avoiding this effect is by reducing the screen area, as shown in FIG. 14, wherein the opening defining wall edges **17***a* define an opening smaller than the area of diaphragm **68**, with a correspondingly smaller screen **64***a* in said opening. However, this expedient may not provide the screening area desired.

A better arrangement may be provided, as shown in FIG. 15, wherein a diaphragm **68***a* larger than the screen **64** is mounted in wall **17'**, the rigid central portion of the diaphragm being about equal to the screen opening. Alternatively, as shown in FIG. 16, a diaphragm **68***b* having an overlapping **U** or **S** shaped edge may be provided of suitable configuration to cooperate with a suitable screen **64***a*. These latter expedients have proved to eliminate the screen plugging problems, even with difficult materials. Thus, by using a diaphragm having an active area (that is, the portion thereof which moves over the complete stroke of its actuating means) at least as large as that of the screen, the deleterious effect of the partially inactive edge portions of the diaphragm are eliminated. The use of a free edge support, such as that of **68***b*, enables the inactive edge portion largely to be eliminated.

The pulsation or movement of the flexible diaphragm **68**, **68***a*, or **68***b* is preferably accomplished by the hydraulic mechanism described in some detail in my Patent No. 2,796,006 in which the amount of diaphragm motion as well as its speed in either direction can be readily controlled and regulated. This means that an alternate pressure and partial suction can be applied to the enclosure between the flexible diaphragm **68** and the screening or separating member **64**. This adjustment or rate of motion, distance of motion, and relative motion, enables the operator to utilize the screening or separating mechanism to the best advantage depending on the character of waste fibre and/or other materials which are being prepared.

In FIGS. 2 and 10 are shown the liquid level control and recirculatory means of the structure of FIG. 1, such being generally similar to that shown in said Patent No. 2,796,006. With this arrangement, a central inlet tube **70** is provided connected to outlet **67**, and a coaxial outer tube **72** surrounds said inlet tube **70** and has its bottom connected to the outlet pipe **79** which leads from the pulper to a reservoir or following pulp molding or the like machine. A double-walled pipe member is slidably mounted between the central and outer tubes, said pipe member having an inner wall **74** spaced from an outer wall **76** to provide an opening therebetween, with inner and outer seals **73** and **77** between the relatively sliding surfaces. Means for moving the double-walled pipe member is provided in the form of a rack **75** mounted thereon operable by a pinion **78** operated by any suitable means not shown. Pipe **66** is provided between outlet **67** and inlet **65**, with a valve **66***a* therein.

It is desirable to provide a movement or circulation within the enclosure between the diaphragm **68** and screen **64** in order that the separated materials do not stratify or tend to segregate within this space. To provide for this, the circulating pump **69** draws a portion of the materials through pipe **67** from the bottom of said enclosure and returns them to the top of said enclosure by means of pipe **66**, the amount of flow being controlled by valve **66***a*.

In the structure shown in FIGS. 2 and 10, the overflow inner tube **74** is moved up and down by means of rack **75**, and pinion **78** also carries with it the outer overflow tube **76**. The relative height or relationship between the inner and outer tubes is always the same regardless of the relative height of the tubes to the stock level in the tank. This enables the operator to observe the character and quality of screened fibrous materials being removed in that the top of the overflow tube **74** is always at the same distance below the top of the outer tube **76**, this in contradistinction to the arrangement shown in Patent No. 2,796,006, in which it is difficult to observe the overflow conditions, as the outer tube always extends to the top or above the top of the distintegrator tank itself.

There is one objection, however, to either of the overflow methods shown in FIG. 10 or in the prior patents, in that the falling screened fibrous materials have a tendency to entrain air in with the fibrous materials, which must, of necessity, be removed before these materials are utilized.

With the structure as shown in FIG. 11, instead of determining the relative level of the screened fiber stock as compared to the level in the pulper tank by means of an overflow arrangement which tends to cause air to be entrapped in the pulp, a float is set to a predetermined level to operate a valve to discharge stock. More specifically, circulating pump **69'** of axial flow or other suitable type is employed to circulate stock between outlet **67'** and inlet **65'** through a pipe **66'**, but such pipe is also extended upwardly as a separate branch **80** into the top of the pulper tank above the surface of the stock therein. Preferably, a sloping plate **82** is provided within said tank between the termination of pipe **80** and the stock surface to reduce admittance of air. To establish the level in the tank, a reservoir **84** is provided connected to outlet **67'** by a pipe **81**. The lower end of said reservoir is provided with a valve **86** leading to an outlet **79'**. The valve **86** has an upwardly extending operating rod **87** having adjustably mounted thereon a float **88** for adjusting the height of the float on the rod to establish a desired level. The float **88** has rod **87** extending therethrough, with a pulley **87***a* mounted thereon beneath said float and a pair of pulleys **87***b* and **87***c* mounted above the float, the top of the rod being secured by a pivoted link **83**. Fixed pulleys **83***a* and **83***b* are also mounted. An endless cable **85** incorporating the float therein is trained around said pulleys and outside an adjusting pulley **90**, which may be moved to establish the float

height. If desired, a valve 89 may be provided in the discharge so that it becomes unnecessary to change the adjusted float position in order to shut down the machine.

To establish a reasonably continuous flow of screened fibrous materials through the screening or separating member 64, it is necessary to establish a differential head between the level within the disintegrator tank 16 and the level of the screened fibrous stock in standpipe 84. This is, of course, accomplished by means of float 88 which is movable on connecting rod which, in turn, actuates the float control valve 86, located near the bottom of the standpipe 84. Any degree of differential head can be obtained by moving the float 88 relative to the connecting rod 87 and the float control valve 86.

It is important that the level of the liquid-fibre mixture in the disintegrator tank be maintained at a predetermined level in order that the screening differential DH be also maintained. The level control device illustrated in Patent No. 2,796,006 left much to be desired in this particular connection.

With the structure of FIG. 11, screened fibre may be returned to the pulper tank itself, which is accomplished through pipe 80 under control of valve 80*b*. This is sometimes desirable when it is necessary or desirable to reduce the freeness or drainage rate of the fibrous materials being prepared for some specific use or purposes. This means that a certain portion of the screened fibrous materials can be returned through the disintegrator tank and reacted upon again by the impactor mechanism, thereby effecting a further fibrillation or treatment of the individual fibres which affects their drainage rate and improves their use for certain purposes.

The actual removal of the screened fibrous materials from the screening or separating mechanism or screen 64 is accomplished through pipe 81 and standpipe 84. The size of the pipe 67′ is made substantially larger than the pipe 81 which goes to the standpipe 84 so that an ample quantity of stock can be recirculated by the circulating mechanism 61′, either through pipe 66′ and 65′ or up through pipe 80 without detracting from the amount of screened fibrous materials which can pass through pipe 81 and reach standpipe 84. Valve 65*b* controls flow through pipe 65′.

The pulsating motion of the flexible diaphragm 68 as previously described and which is accomplished preferably by the mechanism disclosed in Patent No. 2,796,006, not only imparts a pulsation of varying pressure and/or suction on the separating or screening member 64, but also tends to cause a pulsation in any pipe or connection to the enclosure between the screen and diaphragm. The circulating system, including pipe 67′, circulator 69′, pipe 66′ and 65′ is self-contained, so that any pressure imparted through said enclosure is neutralized by the fact that these pipes connect to this enclosure, one at the bottom and one at the top.

The overflow pipe 80 is made intentionally fairly long so that the pulsation tending to vary the flow through this pipe is minimized, and also can be further controlled by valve 80*b*.

Similarly, the length of pipe 81 can be varied so that it will minimize the tendency for the pulsations which are primarily for purposes of drawing stock through the screen 64 and cleaning the inner surface from being neutralized by a pulsation in the standpipe 84. This is relatively important in order that the operation of the flexible diaphragm 68, operated by the hydraulic mechanism previously mentioned, react very largely in the operation of the screening or separating member 64 rather than being dissipated elsewhere.

In order to feed clear or white water into tank 12 as wastepaper or the like is added, a suitable input water control system has been provided as is best shown in FIGS. 1, 2, 2*a* and 3. This system includes a fairly large independent water tank 130 located on the outside of the disintegrating tank 12, in which is located a float 132 connected by a rod 134 to operate a float control valve 136 of the type shown in FIG. 11. This admits water to tank 130 from its input pipe 138, and the tank in turn admits water to the disintegrating tank in accordance with the setting of float 132 through four controlled openings. Two of these openings 142 enter the disintegrating tank 12 somewhat below the pulp level and somewhat above the screening or separating section. In other words, this water is introduced into the stream which is going back over the top of the mixture in the disintegrating tank back to the disintegrating mechanism. All or a part of this water, however, is passed by pipe 143 through two openings 144, one on each side of the disintegrator tank 12 at its bottom in the side walls adjacent the screens. This arrangement gives the operator considerable flexibility of operation in that he may add the make-up or added water necessary to keep the disintegrator tank supplied, either before the material passes the separating or screening member, or as it is being returned to the disintegrating mechanism.

In operation, the impactor disk rotates at high speed to disintegrate the fibrous material and impel the mixture around the involute in the direction of its increasing radius and thence along side portion 26. At the end thereof the mixture is deflected upwardly by end wall portion 18′ past screens 64 for selective removal of fibre and to provide a strong flow to aid in keeping the screens clean. Thereafter, the mixture, together with any unpulped material is moved downwardly by screw 38, and the cycle is repeated. At the same time, any metallic or other heavy materials are circulated into the vicinity of opening 13 and fall into the tubular valve element 100 from which they may be removed periodically as above described.

The junk dump valve of the invention, shown in FIGS. 1 and 12–17, has proved to be much improved in operation over that in Patent No. 2,796,006. In that patent, two sliding valves are shown, one above the other, with the idea that the upper valve is left open, allowing the junk to accumulate on top of the lower valve, then the upper valve is shut and the lower valve open. Experience, however, has indicated that these valves tend to stick, and are extremely difficult to operate.

In the device shown in detail in FIGS. 1 and 17–22, heavy metallic materials which find their way into wastepaper, in the form of clips, staples, used in the manufacture of corrugated boxes, are distributed across the bottom of the disintegrator tank by the circulating means already described, and sweep across the opening 13 in the bottom of this tank, which opening is directly above a rotary chamber into which these heavy materials fall by gravity.

It will be noted in FIG. 1 that the deflectors 120 which effect a separation or classification of the pulped materials within the disintegrator tank, have an opening underneath the ends which are closest to the screening mechanism, and over the opening to the junk remover which allows for a certain amount of cross-circulation and turbulence to occur in the area over the junk remover opening 13. This encourages the heavier materials to find their way into this opening and into the hollow chamber or space 101 in the junk remover cylinder.

The junk remover consists primarily of an outer case in which is a rotating hollow cylinder, the rotating cylinder being supported by bearings on each end, thoroughly lubricated, the cylinder itself being just out of contact with the case. Grease lubircation is provided not only for the bearings at each end of the cylinder, but also in the space between the ends of the cylinder and the case and on outer edge of the cylinder beyond the opening 93.

More specifically, the valve includes a cylindrical housing 92 arranged to be bolted to the underside of bottom 12 beneath its opening 13, such housing having an upper inlet 93 adjacent said opening, a lower dump drain opening 94, a side stock drain 95 and a side water inlet 96.

A tubular rotary valve element **100** is mounted for rotation within said housing, said valve element **100** having two openings **102** and **104** spaced at 90 degrees from one another for connection to any two adjacent openings in the housing. As shown, valve element **100** is rotatably mounted in suitable bearings in the end plates **98** of housing **92** by means of its end stub shafts **106** and has a suitable handle **108** for rotating it to any desired position. A sealing member **110** is installed in housing **92** for sealing the relatively rotating surfaces of housing and valve element between openings **94** and **96**. Suitable lubricating means is also provided for the bearings, end surfaces and marginal sealing surfaces, all removed from the area exposed to pulp, junk, etc. For example, in FIGS. 18 and 20, it is shown in pulping position with the water inlet **96** in communication with tank bottom opening **13**; in FIG. 21 it is shown in dump position with the water inlet **96** in communication with the dump drain opening **94** and with the tank opening **13** closed so as to wash out accumulated unwanted metallic material; and in FIG. 22 it is shown in drain position with the tank opening **13** in communication with the stock drain **95**. Preferably, the housing and valve elements should be of a hardened material or have hardened edges thereon at their various openings so that metallic pieces, such as staples and wire that tend to hang up can be sheared off without jamming or damage to the mechanism. Stainless steel or other material of suitable hardness is preferred.

As previously indicated, regardless of the kind of material used, this rotary device is far preferable to any sliding device, in that it is easily operated at any time, and the introduction of water through port **96** just before dumping, very largely removes any fibrous materials which may have found their way through opening **93**. Also, additional water can be introduced in the dump position through opening **96** to accelerate the removal of the metallic, dirt or other material which has accumulated within the cylinder.

The operation of diaphragm **68**, being fully described in said Patent No. 2,796,006 will not be repeated herein except to say that it acts selectively to move fibres through a screen **64**, such fibres thereafter being taken away through outlet **67**. Thereafter, the fibres are passed through the level control means, which operates in a manner fully set forth above. Wastepaper to be pulped is fed into the top of the apparatus by any suitable means (not shown) while the necessary water is fed into the tank by means the operation of which is fully set forth above.

Thus it will be seen that the novel tank and element arrangement, as well as the control systems, of the present invention have provided a greatly improved pulper especially useful for the rapid and efficient disintegration of dry fibrous waste materials, particularly those including unwanted metallic material such as staples and wire which must be removed without stopping the pulper. It will be apparent to those skilled in the art that various modifications may be made within the spirit of the invention and the scope of the appended claim.

I claim:

A pulper comprising a tank adapted to contain a mixture of liquid and fibrous material to be pulped, said tank having a bottom wall, a side wall providing a horizontal cross section throughout the major portion of its length in the form of an acute V with a circularly rounded apex and generally straight sides diverging at an angle of about 40 degrees and of a length about three times the radius of said circular apex, with the portion of said side wall adjacent the bottom wall being displaced outwardly in the general form of a volute from a point adjacent the junction of said circular apex and said side around said apex to a maximum of about one and one-half the radius of said circular apex and thereafter at a decreasing distance along the other side to merge therewith adjacent the end thereof, and an end wall extending between the ends of said side wall providing a pair of flat screen portions in the form of a shallow V of about 140 degrees with apex outward, with said flat screen portions being of about twice the radius of said circular apex, a rotatable screw feeding device extending downwardly into said tank generally concentric with the axis of said circular apex to feed a stream of mixture downwardly, an impactor disk within the volute of said tank and having a radius of about half the circular radius of said apex subjacent to and coaxial with the screw feeding device and rotatable independently thereof, and means for rotating the feeding device and the impactor disk with said impactor disk rotating at high speed in the direction of the increasing radial spacing of the volute portion of the tank whereby the fibrous material is disintegrated and the mixture in the tank is caused to circulate past the end wall screen portions of said tank for selective removal of fibers therefrom.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,021,080 February 13, 1962

Merle P. Chaplin

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 12, line 68, for "lubircation" read -- lubrication --; column 14, lines 15, 28 and 34, for "volute", each occurrence, read -- involute --.

Signed and sealed this 19th day of June 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents