Sept. 5, 1967 A. J. FELTON ET AL 3,339,851

PAPER MACHINERY

Original Filed Oct. 27, 1961 2 Sheets-Sheet 1

FIG-1

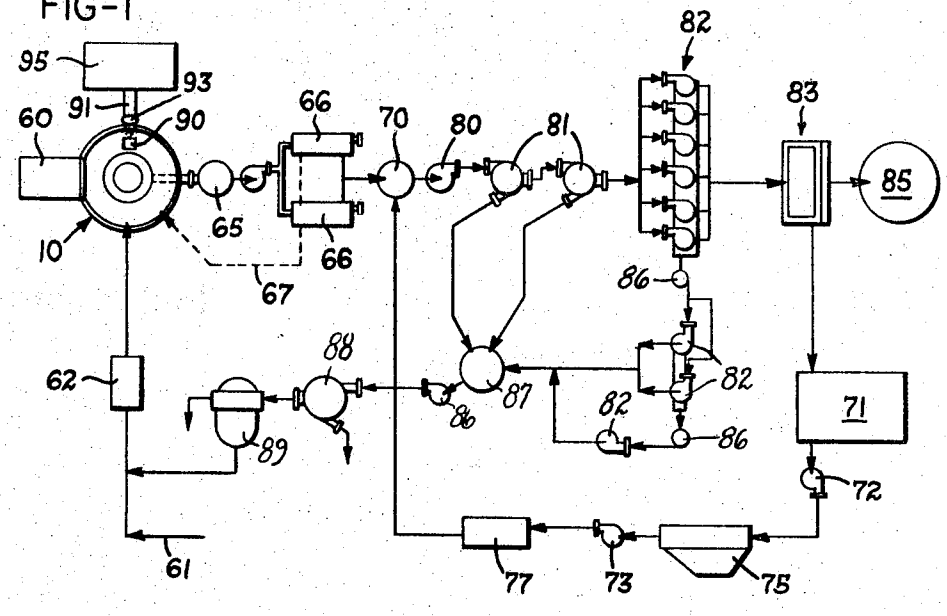
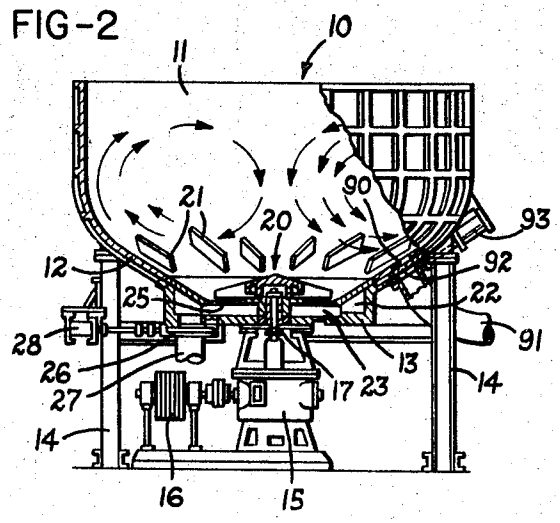


FIG-2



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Original Filed Oct. 27, 1961 2 Sheets-Sheet 2

FIG-3

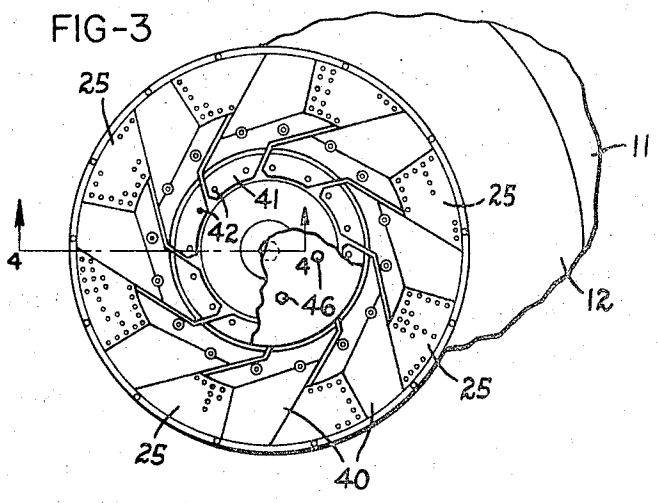


FIG-4

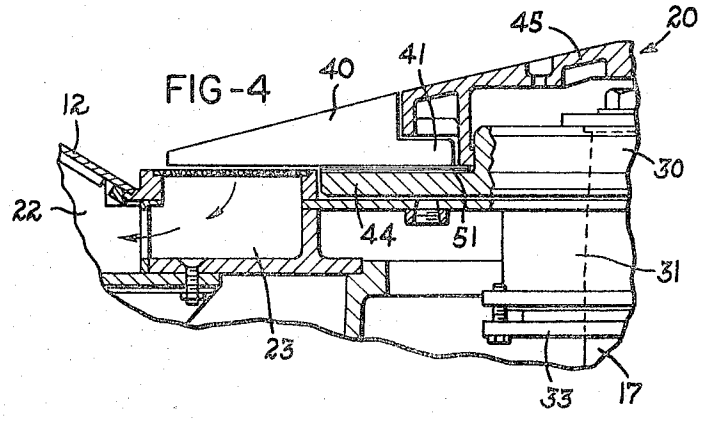


FIG-5

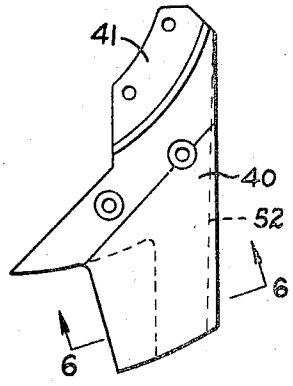
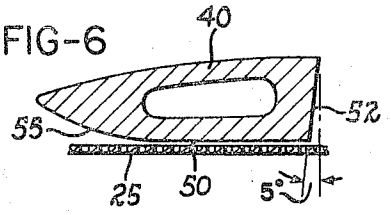


FIG-6



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PAPER MACHINERY

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Continuation of abandoned application Ser. No. 148,255, Oct. 27, 1961. This application Sept. 8, 1965, Ser. No. 485,872

6 Claims. (Cl. 241—46)

This invention relates to the recovery of plastic coated waste paper materials. This application is a continuation of our application Ser. No. 148,255, filed Oct. 27, 1961, and now abandoned.

There has in recent years been a great and continuing increase in the use of plastic coated paper materials, including both sheet and board, particularly for use in packaging of all kinds. Polyethylene, polyvinyl chloride and other films and coating are laminated or deposited on paper and board made from high quality bleached pulp, and the waste material from such coated papers, including both used articles and the cuttings blanked from larger sheets, constitute a valuable source of fiber for the user of waste paper. The fiber content is usually of very high quality, and the waste material can be obtained at low cost, but the user must be able to separate the plastic and fiber effectively and economically in order to realize these advantages.

It is a primary object of the present invention to provide a system for carrying out recovery operations on plastic coated papers, including both sheet and board materials, to recover both the fiber and the plastic for reuse.

It is a particular object of the invention to provide pulping apparatus especially adapted for the recovery of both fiber and plastic from plastic coated paper materials which will effect substantially complete separation of the fiber from the plastic with minimum attrition of the plastic and therefore minimum inclusion of plastic fragments in the recovered fiber.

Among other objects of the invention are the provision of a system and apparatus as outlined above which may be operated on either a continuous or batch basis, the provision of such a system and apparatus which are equally successful in handling clean and dirty waste materials, including printed materials requiring deinking along with the other recovery operations, and particularly the provision of such a system and apparatus which are economical to produce and to operate.

Additional objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawings:

FIG. 1 is a diagrammatic plan view illustrating a complete system in accordance with the invention;

FIG. 2 is a view partly in side elevation and partly broken away in vertical section showing the pulping apparatus in accordance with the invention which is incorporated in the system of FIG. 1;

FIG. 3 is a plan view on a larger scale of a portion of the bottom of the apparatus of FIG. 2 including the rotor;

FIG. 4 is an enlarged fragmentary view in radial section on the line 44 of FIG. 3 with the vane shown in elevation;

FIG. 5 is an elevational detailed view in plan of one of the component vanes of the rotor of FIG. 3; and

FIG. 6 is a sectional view taken on the line 6—6 of FIG. 5 and including a fragment of the associated screen plate.

Referring to the drawings, which illustrate a preferred embodiment of the invention, the pulper which is indicated at **10** is generally of the construction disclosed in Martindale Patent No. 2,371,837, issued Mar. 20, 1945, to the assignee of this application. This pulper includes a tub or vat having a cylindrically extending upper wall portion **11**, an inwardly tapered lower wall portion **12** and a bottom wall **13**, and it is carried by supports **14** of any suitable character. Arranged below the tub is a gear drive **15** which may be directly connected to a suitable prime mover and is shown as driven by a pulley **16** from a suitably located motor (not shown), and the gear drive **15** drives a vertical shaft **17** which supports a rotor indicated generally at **20** for rotation centrally of the bottom portion of the tub.

In operation, the rotor **20** provides an effective circulation outwardly and then upwardly along the outer portions of the tub in a generally vortical pattern providing a return flow toward the impeller, as indicated by the arrows in FIG. 2, and stationary guide plates **21** are shown on the wall portion **12** to guide the upward flow of the partially pulped stock. Adjacent the bottom of the tub is an annular chamber or compartment **22** below the lower end of the tapered wall portion **12**, and a connecting inner annular compartment **23** is partitioned from the space above the impeller by an annular perforate screen or extractor plate **25** which permits the passage to the compartment **23** of particles which have been sufficiently reduced in size to pass through the perforations of this screen **25**. For preferred operation in the practice of the invention, the perforations in this screen **25** are of relatively small size of the order of one-eight inch in diameter, and the stock passing therethrough may be withdrawn from the compartment **22** continuously or batch-wise, by way of the conduit **27** and control valve **26**, which has an operating cylinder **28**.

The structure of the rotor **20** and its cooperative relation with the screen plate **25** are particularly important in the practice of the present invention. As best seen in FIGS. 3–6, the rotor **20** is of essentially the same construction shown in the copending application of R. F. Vokes, Ser. No. 17,282, filed Mar. 24, 1960, Patent No. 3,073,535, and assigned to the same assignee as this application. The rotor includes a rotor body **30** having a depending skirt **31** which is received in driven relation over the upper end of the shaft **17**, and this connection is provided with suitable bearings and packing as indicated by the packing gland **33**.

The rotor body **30** carries a plurality of vanes **40** which project outwardly therefrom in overhanging relation with the annular screen plate **25**. As best seen in FIGS. 4 and 5, each vane **40** includes a flange portion **41** by which it is bolted at **42** to the annular surface portion **44** of the rotor body **30**. A rotor cap **45** covers the top of the rotor body **30** and is secured thereto as by bolts **46** to form an essentially smooth outline on the rotor limiting its pumping action to the leading edge surfaces of the several vanes **40** as now described.

Referring particularly to FIGS. 5 and 6, the working portion of the vane **40** which projects beyond the rotor body **30** has a substantially flat under surface area **50** which is parallel with the working surface of the screen plate **25**. In assembling the rotor, the vanes **40** are lo-

cated in predetermined spaced relation with the surface of the screen plate **25** by means of one or more shims **51** positioned between the under side of the vanes and the upper surface of the rotor body portion **44** as shown. It is important in the practice of the invention that an appreciable but accurately controlled clearance be maintained between the surface **50** and the screen plate, and tests indicate that a clearance of the order of .075 inch provides the desired results of minimum attrition of the plastic material.

The leading edge surface **52** of each vane **40** is essentially flat in vertical section and of substantial area, extending along the vane inwardly to the flange **41**. In addition, this leading edge surface **52** is arranged to incline toward the working surface of the screen plate so that as each vane rotates with the rotor, the surface **52** will not only produce a pumping action urging the stock tangentially outwardly, but it will force the stock downwardly towards the perforations in the screen plate **25**. Satisfactory results from this standpoint have been obtained with the vane surface **52** inclined at an angle of the order of 5° as shown. The trailing end portion of each vane curves upwardly from the area **50** as indicated at **55** in FIG. 6, and this has the result of exerting a lifting action with respect to the screen plate **25** and its perforations in response to rotation of the vane.

With this construction of the rotor and vanes **55** as just described, it will be seen that the vanes are essentially the only elements having a pumping action on the stock material within the tub. Furthermore, the action of these vanes produces maximum forces of hydraulic shear in the stock with minimum mechanical action such as might cause attrition of plastic material in the stock. This latter result is especially obtained by constructing the screen plate **25** as shown with an essentially smooth surface except for the multiple perforations therethrough.

Another important characteristic of the invention is that as the vanes revolve with the rotor in operation, each vane produces first a pressure force downwardly through the screen plate as its surface **52** moves along the plate, and this is followed immediately by an upward force in the opposite direction induced by the trailing face **55**. The cumulative result as produced by all of the vanes is therefore a continuous pulsating action on the screen plate which periodically forces stock downwardly through the perforations and then lifts away the larger pieces of sheet material which would otherwise tend to felt over and block the perforations.

FIG. 1 shows a complete system for continuous recovery operations on plastic coated waste paper materials which incorporates a pulper **10** having the structural and operational characteristics described in connection with FIGS. 2–6. The pulper **10** is indicated as receiving the waste materials from a conveyor indicated diagrammatically at **60** which may be of any suitable type. A continuous supply of fresh water is provided for the tub **10** from a source **61**, and this water supply system may be provided with a heat exchanger **62** if it is desired to heat the water as discussed in more detail hereinafter.

With the system of FIG. 1 operating continuously, a mixture of water and fiber particles of sufficiently small size for passage through screen plate **25** flows continuously from the chamber **22** to a regulating box **65** of conventional construction for maintaining a desired continuous liquid level within the tub **10**. If the waste material includes ink printed on the fiber, as distinguished from on the plastic coating, it is desirable to add sufficient caustic (NaOH) to maintain approximately 4% concentration in the tub, and caustic may also be used to speed the pulping operation. If caustic is present, then it is preferably removed as soon after the stock leaves the tub as possible, and FIG. 1 shows a pair of screw presses **66** connected in parallel to receive the stock from the regulating box **65**, and a return line **67** for the caustic solution leads from the presses **66** back to the tub for reuse.

The stock leaving the presses **66** is delivered to a mix box **70**, and if no caustic is used in the tub, the presses **66** may be omitted and the mix box **70** connected directly to the output of the regulating box **65**. Water is added at the mix box **70** to bring the consistency of the stock sufficiently low for ready screening, for example .5%. The water supply system is shown as including a white water chest **71** from which the water is conveyed by pumps **72** and **73** through a clarifier **75** of suitable construction and a heat exchanger **77** (if needed) to the mix box **70**.

A pump **80** supplies the stock from the mix box **70** to one or more pressure screens **81** shown as connected in series, and particularly satisfactory results for this purpose have been obtained with these screens constructed in accordance with Martindale Patent Re. 24,677, issued July 28, 1959 to the assignee of this application. The screens **81** remove any small particles of plastic and other foreign material from the stock, and the reject material therefrom may be collected for disposal as waste or may be further diluted and rescreened if it contains sufficient fiber to warrant such treatment. The clean stock accepted by the screens **81** is shown as conducted for further cleaning purposes to a battery of centrifugal cleaners **82** of any conventional construction, and the reject material removed by these cleaners may be further treated or treated as waste as desired. The clean stock from the cleaners **82** is delivered to a vacuum washer **83** from which the wash water is returned to the white water chest **71**, while the cleaned stock is delivered to a storage chest **85** ready for further use if desired.

FIG. 1 shows the reject material from the cleaners **82** as delivered by a plurality of pumps **86** to a mix box **87** which also receives the reject material from the screens **81**. An additional pump **86** supplies this reject material from the mix box **87** to a series of screens **88** and **89** which in turn deliver the reusable material to the fresh water supply line **61** and dump the balance to drain.

In the continuous operation of the system of FIG. 1 as described, the fiber recovered from the plastic is continuously removed for further treatment while the plastic remains in the tub. It may be removed in a variety of suitable ways, for example by means of a continuous junk remover such as is shown in British Patent No. 713,501 of Nov. 24, 1954. FIG. 1 indicates diagrammatically a batch removal means for the plastic material comprising a single relatively large opening **90** in the tub wall portion **12** from which a pipe **91** controlled by a valve **92** having an operating cylinder **93** leads to a receptacle **95**. For preferred operation, the valve **91** would be opened only intermittently, after substantial plastic had accumulated in the tub, and the plastic removed from the receptacle **92** would require only a minimum of washing to remove such particles of fiber as might flow out from the tub therewith.

It is equally possible to operate only a portion of the system of FIG. 1 on a batch basis. Satisfactory results have been obtained in batch operation by first charging the tub with plastic coated papers and sufficient water to give a consistency of the order of 8%. After pulping for sufficient time, for example fifteen minutes, the tub is emptied by means of the valve **26** while the rotor continues to revolve, and the tub is then again filled with water and reemptied several times. The fiber has then been substantially removed from the tub, and the plastic can be separately removed by any suitable means, as by hand or fork or by the parts **90–93** as already described.

The inclusion and use of heat exchangers as shown in the system of FIG. 1 are optional depending upon the nature of the plastic coatings to be recovered. In general, optimum results are obtained if the temperature of the water is in a range such that the plastic material is soft and has a high degree of flexibility, but the temperature should not be so high as to soften the plastic to the point of disintegration by the hydraulic shear forces developed in the tub. On the other hand, some plastics tend to

shatter too readily if the water temperature is too low, and this result is undesirable since it produces particles of small enough size for discharge through the perforations of the extractor plate. Illustrative examples of temperatures which produce satisfactory results include 90–120° F. for polyethylene and 180–200° F. for polyvinyl chloride. Optimum temperature conditions for other materials can be readily established by sample testing, and it may also be found that results are improved with some materials with the aid of chemical additives in the water.

Another characteristic of the waste material which should be noted in establishing operating conditions is the presence or absence of ink on the fiber and whether the coating is on one or both sides of the paper. As already noted, it is desirable to include caustic in the tub when the waste material has ink on the fiber, since this has the advantage of effecting deinking at the same time as the separation of the fiber from the plastic. Single coated sheets are more readily separated at lower temperatures because of the increased ease of penetration by the water, and it will therefore usually be found that less time and power is required for double coated materials with the aid of elevated temperatures and/or caustic in the tub.

Practice of the invention has also been found to be desirable and effective for the recovery of plastic coated papers of the type wherein a resin material is directly incorporated with the fibers to increase wet strength. Recovery operations on this type of waste material require the addition to the tub of a suitable chemical for effecting release of the resin component from the fibers. For example, if the resin used is of the urea or melamine type, satisfactory results are obtained by the addition of alum to the water, and if the wet strength resin is of the Kymene type, sodium hypochlorite is an appropriate chemical. Otherwise, the operating conditions and results are substantially the same as already described.

While the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. Apparatus for treating plastic coated waste paper material to separate the fiber from the remainder of the material, comprising a tub for receiving a mixture of said waste material and water, a screen plate forming a part of the bottom of said tub and having multiple holes therethrough, means defining a compartment below said screen plate and communicating with the interior of said tub only through said holes, a rotor mounted for rotation on a central vertical axis within said tub and including a hub having vanes extending outwardly therefrom in overlying relation with said screen plate, means for driving said rotor, each of said vanes having a leading face portion of substantial area to subject such mixture to hydraulic shear causing separation of the fibers from the plastic coating and reduction of the fibers to particle size small enough to pass through said holes, means maintaining said rotor with said vanes in predetermined spaced relation with the surface of said screen plate providing a clearance therebetween minimizing mechanical attrition of the plastic material between said vanes and said screen plate, the under surface of each of said vanes being smooth and including an essentially flat area substantially parallel with the upper surface of said screen plate and said screen plate having an essentially smooth upper surface and said holes therein being of relatively small diameter to avoid sharp edges on said plate surface capable of catching the plastic material and causing tearing or cutting thereof and to permit passage into said compartment only of particles of correspondingly small size, and means for removing from said compartment liquid and particles of fiber carried thereby of sufficient size for passage through said holes.

2. Apparatus as defined in claim 1 wherein said leading face portion of each of said vanes is inclined downwardly to exert pressure through such mixture toward the upper surface of said screen plate and said holes therethrough, and wherein the trailing portion of said smooth under surface of each of said vanes is contoured to diverge upwardly from said screen plate to exert a lifting force on solid particles in such mixture away from said holes.

3. Apparatus as defined in claim 2 wherein said clearance between said vanes and the surface of said screen plate is of the order of .075 inch, and said holes through said screen plate are round holes of the order of ⅛ inch in diameter.

4. Apparatus for separating thermoplastic film from the cellulose substrata of thermoplastic coated broke, comprising a mixing receptacle having an upstanding side wall which terminates in downwardly inclined bottom walls having an annular opening therein, an annular perforate bed plate spanning and forming a top for said annular opeing, said inclined wall terminating at and in the horizontal plane of the outer periphery of said annular perforated plate, a rotatable impeller means having zero pitch propeller blades each including a flat lower face in spaced parallelism with and in close proximity to the top of said perforated bed plate and having a flat leading edge, said impeller means being located centrally of said opening and extending substantially entirely across said perforated bed plate, means for rotating said impeller means whereby said blades will effect a continuous mixing and violent agitation of a water and coated broke mixture contained in the receptacle and create hydraulic shear effective to break the bond between the thermoplastic film and the cellulose substrata and strip cellulose fibers from the film and produce a slurry of pulp and de-fibered film in the receptacle, valve means for controlling the flow of fluid through said perforated plate and opening, and said location of said blades of said impeller means being such with respect to said perforated bed plate as to produce a venturi action when said valve means is open whereby to elevate de-fibered film in the mixture away from said perforated bed plate to facilitate the flow of pulp carrying water therethrough.

5. An apparatus as set forth in claim 4, wherein the said close proximity of said lower face of said impeller means to the top of said perforated bed plate is such as to give a clearance of the order of .075 inch.

6. Apparatus for treating waste paper material to separate the fiber from the remainder of the material, comprising a tub for receiving a mixture of said waste material and water, a screen plate forming a part of the bottom of said tub and having multiple holes therethrough, means defining a compartment below said screen plate and communicating with the interior of said tub only through said holes, a rotor mounted for rotation on a central vertical axis within said tub and including a hub having vanes extending outwardly therefrom in overlying relation with said screen plate, means for driving said rotor, each of said vanes having a leading face portion of substantial area to subject such mixture to hydraulic shear causing separation of the fibers from the remainder of the material and reduction of the fibers to particle size small enough to pass through said holes, means maintaining said rotor with said vanes in predetermined spaced relation with the surface of said screen plate providing a clearance therebetween minimizing mechanical attrition of the material between said vanes and said screen plate, the under surface of each of said vanes being smooth and including an essentially flat area substantially parallel with the upper surface of said screen plate, said screen plate having an essentially smooth upper surface and said holes therein being of relatively small

diameter of the order of ⅛ inch to avoid sharp edges on said plate surface capable of catching material and causing tearing or cutting thereof and to permit passage into said compartment only of particles of correspondingly small size, means for withdrawing from said compartment liquid and particles of fiber carried thereby of sufficiently small size for passage through said holes, and the trailing portion of said smooth under surface of each of said vanes being contoured to diverge upwardly from said screen plate for exerting a lifting force on solid material in the mixture away from said screen plate to prevent blocking of said holes therein while liquid is being withdrawn from said compartment.

No references cited.

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