Nov. 14, 1939. E. COWLES 2,180,080

APPARATUS FOR REFINING PAPER STOCK

Filed July 5, 1935 3 Sheets-Sheet 1

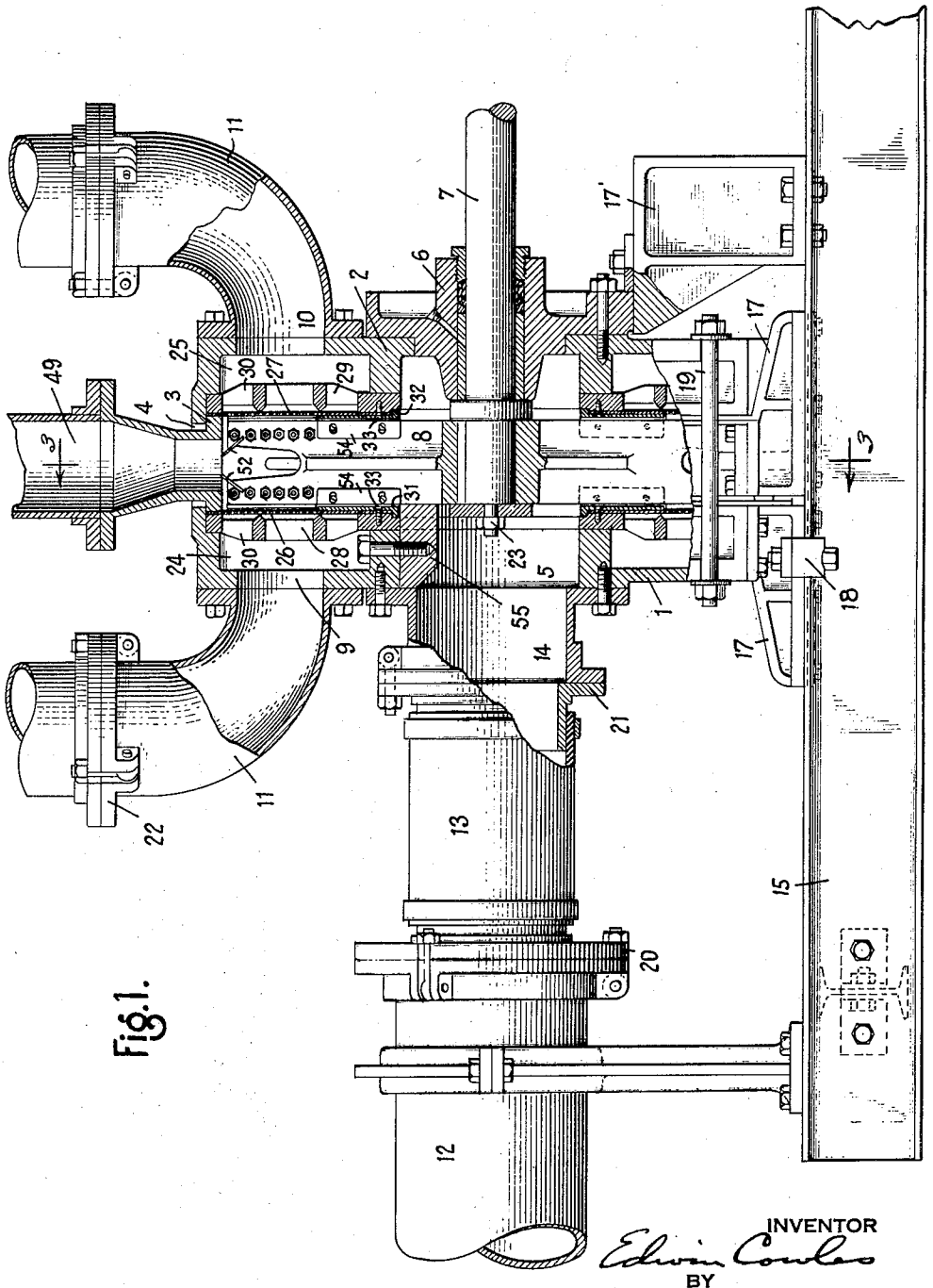

Fig. 1.

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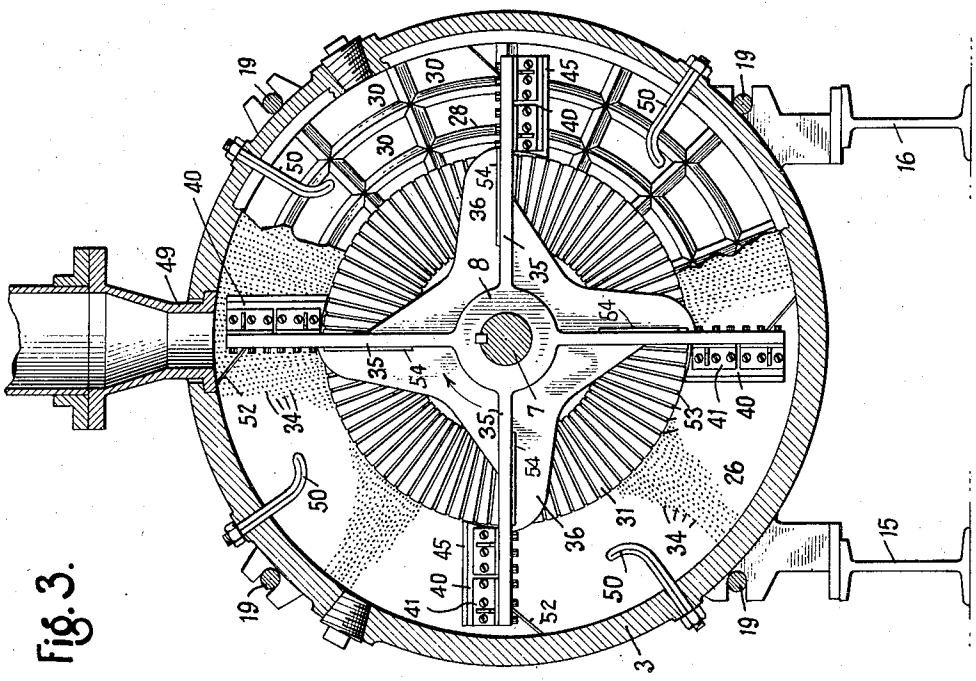

Fig. 3.

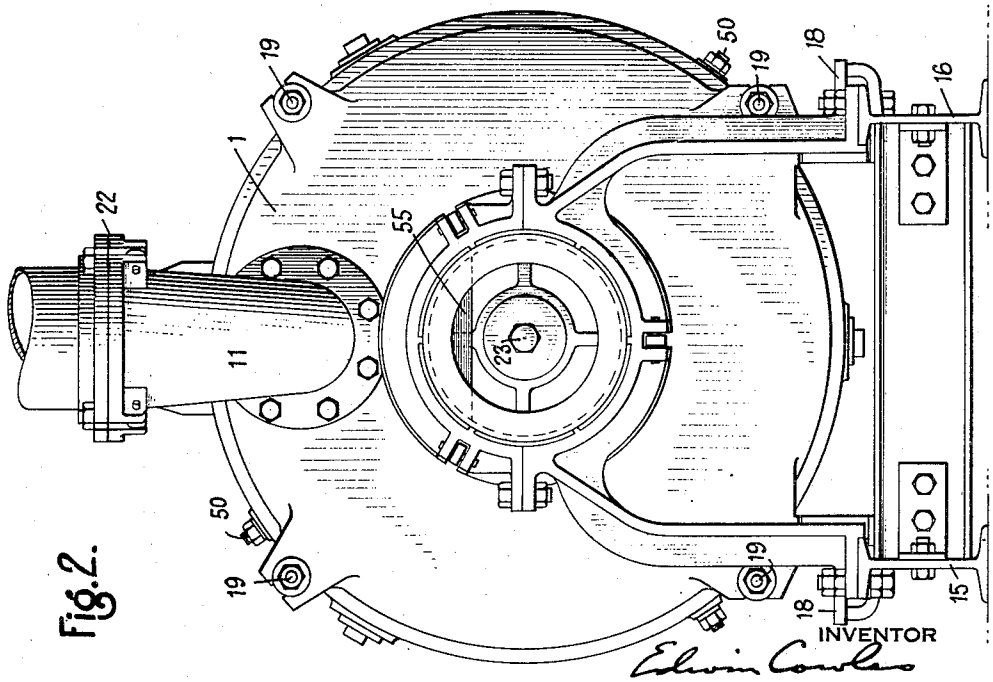

Fig. 2.

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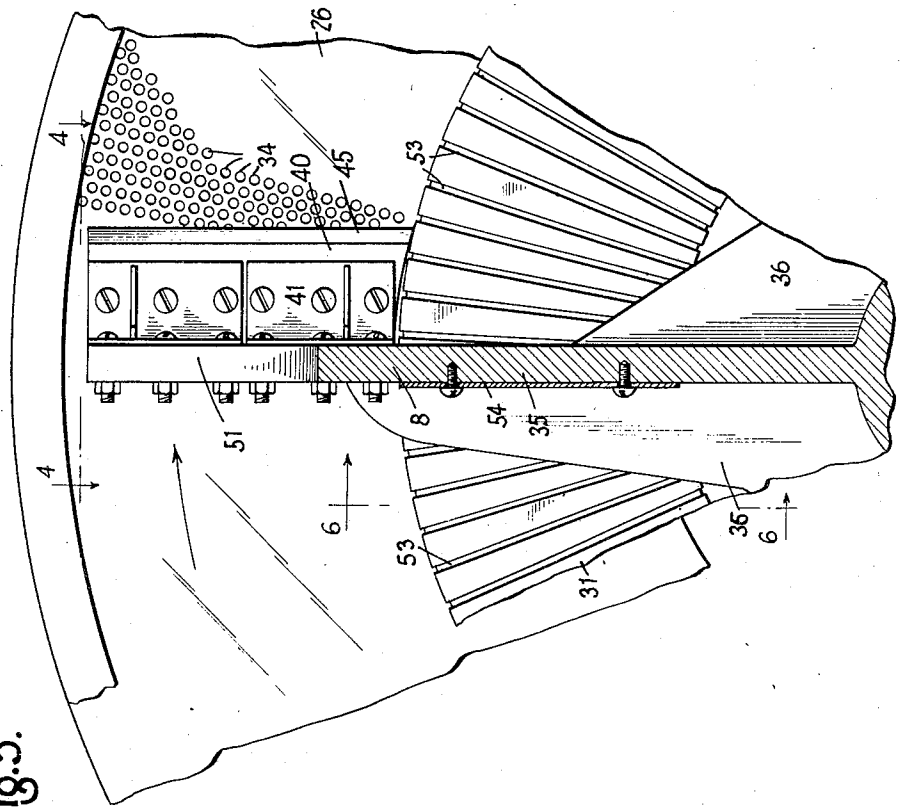

Fig.5.

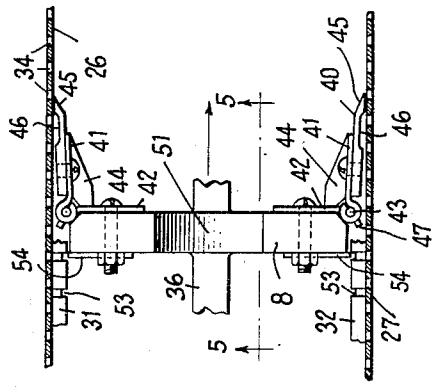

Fig.4.

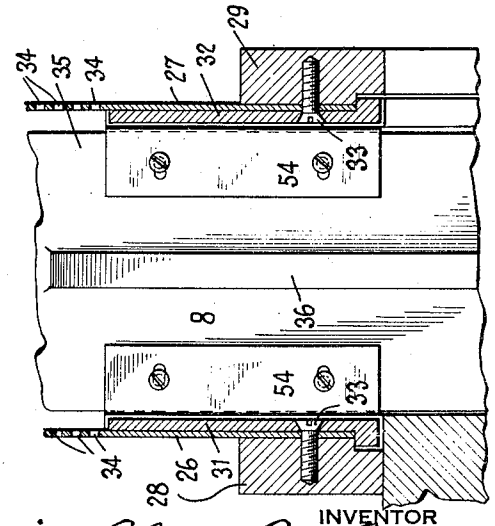

Fig.6.

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Patented Nov. 14, 1939

2,180,080

UNITED STATES PATENT OFFICE

2,180,080

APPARATUS FOR REFINING PAPER STOCK

Edwin Cowles, Hopewell, N. J., assignor to The Cowles Company, Princeton, N. J., a corporation of New Jersey

Application July 5, 1935, Serial No. 29,842

10 Claims. (Cl. 92—26)

This invention relates to apparatus for refining paper stock and constitutes an improvement in apparatus of the type disclosed in my previous Patent No. 2,033,123, dated March 10, 1936.

In the preparation of paper stock for use in paper making machines, it is necessary to completely defiber the fibrous material, and also to subject the fibers to a grinding, crushing action which improves the quality of the stock. If the stock is dirty, or if, as in the case of stock prepared from waste paper, it contains large quantities of trash and dirt, it is necessary to separate the trash and dirt from the fibrous material. In the usual processes for preparing paper stock, these operations are usually performed separately in separate pieces of apparatus. It is an object of the present invention to provide an apparatus which will perform, in whole or in part, and either singly or in combination, the functions of several pieces of apparatus which have been used for these purposes heretofore. Thus it is an object of the invention to provide an apparatus which will perform a defibering operation, or a grinding and crushing operation, or a separating operation, or various combinations of these operations depending upon the material being treated and the nature of the system or process in which the apparatus is incorporated. It is a further object of the invention to incorporate in the apparatus certain features adapted particularly for the treatment of waste paper stock which enable the apparatus to operate efficiently for long periods of time without becoming clogged, due to accumulations of trash or undefibered material.

Other objects and advantages of the invention will appear hereinafter.

A preferred embodiment of the invention selected for purposes of illustration is shown in the accompanying drawings, in which,

Figure 1 is a front elevation of the apparatus, partly in section in order to better illustrate the interior thereof.

Figure 2 is an end elevation.

Figure 3 is a section on the line 3—3 of Figure 1.

Figure 4 is an enlarged detailed sectional view on the line 4—4 of Figure 5 illustrating one of the impeller vanes and the attached scrapers.

Figure 5 is an enlarged detailed sectional view on the line 5—5 of Figure 4, and

Figure 6 is an enlarged detailed sectional view on the line 6—6 of Figure 5.

Referring to the drawings, the apparatus comprises a casing having opposed end plates 1 and 2 which are spaced by an annular ring 3 located therebetween and forming a chamber 4 for purposes hereinafter described. The end plate 1 is provided with an opening 5 constituting an inlet opening to the casing and the chamber 4, and the end plate 2 is provided with a bearing member 6 supporting a shaft 7 carrying an impeller 8 which rotates within the chamber 4. The plate 1 is also provided with an outlet opening 9 and the end plate 2 is provided with a similar outlet opening 10, the said openings being connected with similar outlet conduits 11.

The material to be fed to the apparatus is supplied through the conduit 12, then through a rubber hose connection 13, and through the conduit 14 to the inlet opening 5. Preferably the end plates 1 and 2 are carried on a framework comprising a pair of I-beams 15 and 16, the said end plate 1 being provided with shoes 17 which rest on the upper flanges of the I-beams and may be conveniently secured thereto by clamps 18. The ring 3 is also provided with shoes resting on the I-beams, while the end plate 2 is carried by a support 17', secured to the bearing member 6 and bolted to the I-beams. The end plates 1 and 2 and the annular ring 3 therebetween may be conveniently secured together by bolts 19.

By constructing and supporting the apparatus in this manner, convenient access to the interior of the apparatus for cleaning and repairs may be had by releasing the couplings 20 and 21, removing the hose connection 13, and then releasing the coupling 22 and the bolts 19 and clamps 18. Thus the end plate 1 may be slid out of place with its shoes 17 still resting on the I-beams, thus giving access to the interior of the casing. Similarly the ring 3 may be slid out of place while still supported on the I-beams. If desired, the impeller 8 may be removed from the shaft 7 by removing the nut 23.

The impeller may be driven in any suitable manner as by a pulley or motor connected to the shaft 7.

The end plate 1 is provided with an annular chamber or trough 24 and the end plate 2 is provided with a similar annular chamber or trough 25, which said chambers communicate with the outlet openings 9 and 10, respectively. Covering the said annular chambers so as to form one wall thereof are perforated screens 26 and 27 which are thus interposed between the inlet opening 5 and outlet openings 9 and 10 in such manner that material supplied to the apparatus through the conduit 12 cannot leave the appa-

ratus through outlet openings 9 and 10 without passing through the screens 26 and 27.

The said screens, which are in the form of annular disks, are supported from behind by the grids or frames 28 and 29 having large openings 30 therein so as not to interfere with the flow of material through the screens. The screens 26 and 27 are held rigidly in place, being clamped at their outer peripheries between the annular ring 3 and the supporting frames 28 and 29, which in turn are clamped between the end plates 1 and 2. The inner peripheries of the screens are fastened between the supporting frames 28 and 29 and screen retaining plates 31 and 32 by screws 33.

Any suitable type of screen may be employed, but I prefer to use sheet metal plates having perforations 34 punched therein, the said perforations preferably being arranged in radial lines converging toward the axis of the impeller, with the perforations of adjacent radial lines staggered or off-set as illustrated in Figure 5 so that perforations equidistant from the axis are spaced fairly widely. In treating certain classes of material, as for example, waste paper which contains large quantities of strings and stringy material, it has been found that there is a tendency for such stringy material to lace between perforations which are equidistant from the axis unless said perforations are spaced fairly widely. On the other hand, there is almost no tendency to lace between perforations which are not equidistant from the axis. With the described arrangement of perforations on radial lines which are offset, it is possible to use a larger number of perforations in a given area, thus increasing the capacity of the machine, while at the same time avoiding lacing.

The sizes of the perforations and the spacing between perforations must be varied depending upon the nature of the material treated and the consistency thereof in order to secure best results, but certain relationships have been found to be important. Thus the distance between centers of perforations equidistant from the axis should not be less than two times the diameter of the perforations if lacing is to be avoided, and preferably, near the outer periphery of the screens, this distance should be not less than three times. Furthermore the thickness of the screen plate should not exceed the diameter of the perforations. In the treatment of waste paper, I have found that perforations having a diameter of ⅛", spaced radially ¼" apart between centers, with perforations equidistant from the axis spaced approximately ½" apart between centers at the outer periphery of the screen give satisfactory results when treating waste paper stock at a consistency of 2% to 4%. In this case the thickness of the screen plate should be less than ⅛".

The impeller 8 comprises a plurality of radial vanes or paddles 35 which are reinforced by the web members 36. These vanes, which are preferably rotated at a rate sufficient to secure lineal velocities in the region of the screens in excess of 2000 feet per minute, serve to spin the material within the chamber 4 formed by the screens 26 and 27 and the annular ring 3. In treating certain classes of materials, the rotation of the vanes themselves in close proximity to the screens is sufficient to clear the screen perforations of fibrous material and also to produce a rubbing or crushing effect on the fibers between the edges of the vanes and the surface of the screens, which rubbing serves to defiber some of the undefibered material which may be supplied to the machine, and also serves to grind and crush the fibers between the edges of the blades and the surface of the screen. In treating some classes of materials, however, it has been found advisable to provide means which bear against the surfaces of the screens in order to increase the effectiveness of the action. In the embodiment illustrated, the said means are movably mounted on the impeller vanes and comprise scrapers 40 which are hinged to the vanes of the impeller, the scrapers being secured to hinge plates 41 which are pivotally connected to plates 42 by the hinge pin 43. The plates 42 are bolted to the impeller vanes.

It is desirable that means be provided to prevent the scrapers from being thrown upwardly away from the screen, and in the preferred embodiment stop plates 44, secured to plates 41 and perpendicular thereto, are provided which abut the plates 42 and prevent the scrapers from lifting more than a slight distance away from the screen. Inasmuch as the foot of the scraper which bears against the screen wears fairly rapidly from abrasion, the front face 45 of the scraper is preferably inclined backwardly so that as the scrapers move through the material a sharp leading edge is maintained. It has also been found advisable to cut away the under side of the scraper as indicated at 46 so that as wear occurs, the area of the scraper in contact with the screen does not increase substantially. It is also desirable to provide a stop 47 to prevent the scrapers from swinging too far in the direction of the screen as excessive wear occurs.

It will be observed that since the leading edge of each scraper is parallel to the radial vane of the impeller to which it is secured, but is offset therefrom, the edge of the scraper does not form a radial line. Consequently, in moving across the radial lines of perforations 34, the edge crosses the perforations lying in any given radial line successively rather than simultaneously and also produces a shearing action as it crosses each perforation. It will also be observed that while the scrapers are hinged to the impeller vane and are permitted slight movement toward and away from the screen, they are rigid and non-yielding in the direction of travel of the impeller vanes so that the impact against fibers which may be lodged in the screen perforations is non-yielding.

Inasmuch as only substantially completely defibered material can pass through the relatively small perforations in the screens, it will be apparent that if the material being treated contains large quantities of trash or undefibered material, the impeller chamber would soon become clogged unless an outlet is provided. Consequently an outlet conduit 49 is provided in the annular ring 3 through which material may be removed from the impeller chamber without passing through the screens. The rate of flow through the outlet conduit 49 may be controlled as desired by a valve (not shown).

In treating certain classes of materials, as for example, waste paper, in which considerable quantities of strings and stringy material are sometimes encountered, it has been found that such stringy material tends to form snarls in the impeller chamber in the spaces between adjacent vanes of the impeller. These snarls sometimes become too large to be ejected through the outlet opening 49, and accordingly I have provided prongs 50, mounted in the annular ring 3, which

project into the impeller chamber. The end edges of the impeller vanes are provided with notches 51 of sufficient size to clear the prongs, the result being either that the snarls which may form are pulled apart by the prongs cooperating with the notches 51, or else snarls are prevented from forming to any objectionable size.

Still another difficulty which is encountered in treating waste paper is the tendency for trash to accumulate and clog the outlet opening 49. In order to avoid this difficulty resilient members 52 are mounted on the impeller vanes in position to wipe the outlet opening so as to prevent such accumulations.

Another difficulty which has been encountered in treating such material is the tendency of stringy materials and rags to wind themselves around the impeller vanes in the area between the screen and the hub of the impeller. In order to overcome this difficulty, I have provided a roughened surface in the form of a series of radial grooves 53 in the surface of the screen retaining plate 31, and these grooves serve to abrade such material and prevent troublesome accumulations. If desired, adjustable cutting plates 54 may be mounted on the vanes and adjusted into close proximity to the surface of the screen retaining plate, thus improving the abrading action.

It has also been found that there is a tendency for fibrous material to lodge and accumulate on the front face of the hub and spokes of the impeller. In order to overcome this difficulty I flatten one side of the inlet opening, thus, in effect, making the opening eccentric to the axis of the impeller. This may be conveniently accomplished by providing a member 55 in the opening and extending into close proximity to the hub and vanes of the impeller. As the impeller rotates, this member tends to dislodge from the hub and vanes any fibrous material which tends to accumulate thereon.

In operation, fibrous material suspended in water is supplied to the machine through the conduit 12 and enters the impeller chamber where it is spun rapidly by the impeller. Defibered material and water tend to pass through the screens, but due to the relatively small size of the perforations in the screens, fibers tend to collect in the perforations in the form of small tufts which are engaged by the scrapers and are cut or mashed by the scrapers, thus clearing the perforations and permitting defibered material to pass through. At the same time a grinding, crushing action is produced on the fibers between the scraper and the screen which has a beneficial action on the fibers. Pronounced defibering action on undefibered material is also obtained. The defibered material and water which pass through the screens are removed through the conduits 11, and as previously explained, trash and undefibered material, carrying with it of course some defibered material, is removed through the outlet 49.

Apparatus of the type described has a variety of uses. It may be used in the manner previously described to separate defibered material from trash and undefibered material, and at the same time to defiber and refine the fibrous material by the grinding and crushing action. Or if the material being treated contains no trash or dirt, the apparatus may be used solely to secure the grinding and crushing action which is ordinarily accomplished in Jordans or beaters. When used for this purpose, the material may be recycled if necessary or desirable. Or, by introducing material at low consistency, the apparatus may be used solely for defibering. Or the apparatus may be used solely for the separation of trash. Other applications of the apparatus will occur to those skilled in the art.

It will be understood that the invention may be variously modified and embodied within the scope of the subjoined claims.

I claim as my invention:

1. Apparatus for refining paper stock, comprising, in combination, a casing, a pair of screens in said casing, said screens lying in parallel spaced planes, said casing having an inlet opening on one side of said screens, and an outlet opening on the opposite side of each screen, and an impeller having vanes rotatable in the space between said screens on an axis perpendicular to said screens, said impeller vanes having scrapers mounted thereon bearing laterally against each of said screens.

2. Apparatus for refining paper stock, comprising, in combination, a casing, a screen in said casing, said casing having inlet and outlet openings on opposite sides of said screen, an impeller rotatable within said casing, said impeller having vanes, scrapers hingedly mounted on one edge of said vanes and bearing against said screen, said vanes each having an indentation cut in another edge, and a fixed prong mounted on said casing and projecting into said indentations as the impeller is rotated.

3. Apparatus for refining paper stock, comprising, in combination, a casing, a screen in said casing, said casing having inlet and outlet openings on opposite sides of said screen, an impeller rotatable within said casing, said inlet opening being flattened on one side to provide an abutment in contact with and swept by said impeller to engage and dislodge material tending to lodge on said impeller.

4. Apparatus for refining paper stock, comprising, in combination, a casing, a screen in said casing, said casing having inlet and outlet openings on opposite sides of said screen, and an impeller rotatable within said casing, said screen being flat and lying in a plane perpendicular to the axis of said impeller, said screen having perforations arranged in radial lines converging toward the axis of said impeller.

5. Apparatus for refining paper stock, comprising, in combination, a casing, a screen in said casing, said casing having inlet and outlet openings on opposite sides of said screen, and an impeller rotatable within said casing, said screen being flat and lying in a plane perpendicular to the axis of said impeller, said screen having perforations arranged in radial lines converging toward the axis of said impeller, the perforations in adjacent radial lines being staggered radially.

6. Apparatus for refining paper stock, comprising, in combination, a casing, a screen in said casing, said casing having inlet and outlet openings on opposite sides of said screen, and an impeller rotatable within said casing, said screen being flat and lying in a plane perpendicular to the axis of said impeller, said screen having perforations arranged in radial lines converging toward the axis of said impeller, the circumferential distance between the centers of perforations radially equidistant from the axis being at least two times the diameter of said perforations.

7. Apparatus for refining paper stock, comprising, in combination, a casing, a screen in said casing, said casing having inlet and outlet openings on opposite sides of said screen, and an impel-

ler rotatable within said casing, scrapers mounted on said impeller bearing against said screen, said screen being flat and lying in a plane perpendicular to the axis of said impeller, said screen having perforations arranged in radial lines converging toward the axis of said impeller, the edges of said scrapers being arranged at an angle to said radial lines, whereby they cross said perforations successively.

8. Apparatus for refining paper stock, comprising, in combination, a casing, a screen in said casing, said casing having inlet and outlet openings on opposite sides of said screen, and an additional outlet opening on the same side of the screen as the inlet opening, an impeller rotatable within said casing, and a resilient member secured to said impeller and adapted to wipe said last named outlet opening as said impeller rotates.

9. Apparatus for refining paper stock, comprising, in combination, a casing, a screen in said casing, said casing having inlet and outlet openings on opposite sides of said screen, scrapers mounted on said impeller and bearing against said screen as the impeller rotates, and plates having roughened surfaces lying closely adjacent said impeller in planes perpendicular to the axis thereof and serving to abrade material tending to lodge on said impeller.

10. Apparatus for refining paper stock, comprising in combination, a casing, a flat screen in said casing, said casing having an inlet opening on one side of said screen and an outlet opening on the opposite side of said screen, and an impeller having vanes rotatable within said casing on an axis perpendicular to said screens, said impeller vanes having scrapers mounted thereon bearing laterally against said screen.

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