April 26, 1966 R. V. BRAUN ETAL 3,247,965

VERTICAL CENTRIFUGAL SCREEN FOR PULP STOCK

Filed May 7, 1963 2 Sheets-Sheet 1

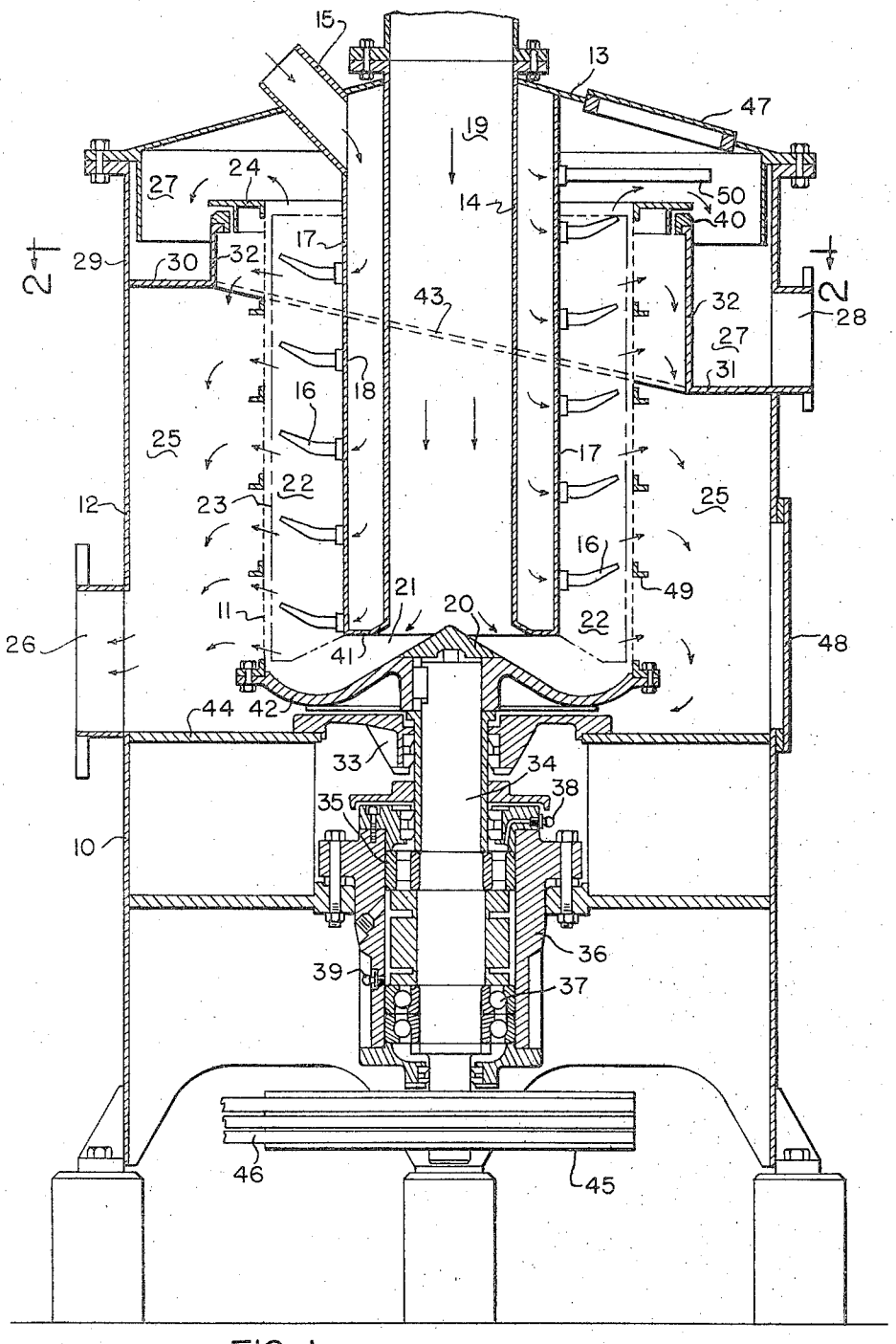


FIG. 1

VERTICAL CENTRIFUGAL SCREEN FOR PULP STOCK

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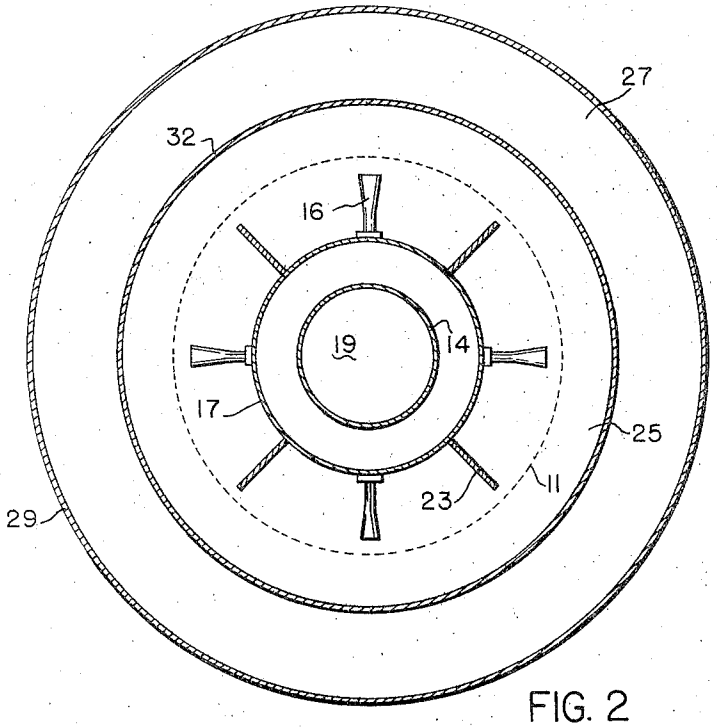


FIG. 2

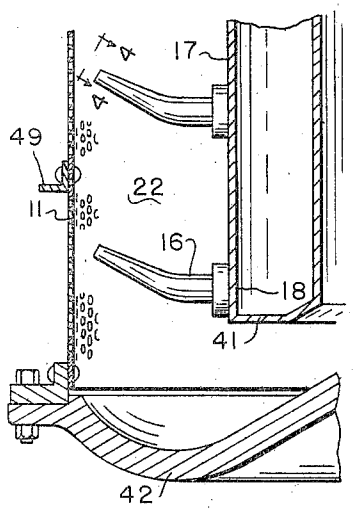


FIG. 3

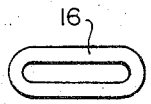


FIG. 4

United States Patent Office 3,247,965
Patented Apr. 26, 1966

3,247,965

VERTICAL CENTRIFUGAL SCREEN FOR PULP STOCK

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Filed May 7, 1963, Ser. No. 278,672
3 Claims. (Cl. 209—240)

This invention relates to an improved mechanism for screening papermaking pulp fibers. More specifically it relates to an improved vertical centrifugal screen for pulp stock.

It is a primary object of the invention to provide highly effective means for continuously screening pulp or paper stock by centrifugal action.

An equally important object is to provide a screening device which is capable of closely controlling the amount of coarse stock removed whereby selectively screened stock of any desired quality may be obtained.

Another object is to provide an improved screening device employing submerged jets for improved screening efficiency.

Still another object is to provide a high capacity, self-cleaning apparatus which effectively separates coarse material, normally unfit for papermaking, from acceptable stock.

Other objects and advantages will become apparent to persons skilled in the art, upon examination of the accompanying drawings and description, without departure from the concepts herein taught as defined in the appended claims.

In the drawings, in which like parts are identified by the same reference numerals.

FIGURE 1 is a sectional view of a preferred embodiment of the screening apparatus.

FIGURE 2 is a horizontal section taken on line 2—2 of FIGURE 1.

FIG. 3 is an enlarged section showing the nozzle and screen arrangement in more detail.

FIG. 4 is a section taken on line 4—4 showing the preferred nozzle configuration.

In the screening of pulp fibers it is desirable to separate the fibers into their individual discrete form. The stock as fed to screens normally contains varying amounts of splinters and fiber bundles, and it is the primary purpose of the screening operation to remove such undesirable coarse material so that a uniformly clean stock is presented to the paper machines. While the problem of obtaining clean stock exists for all types of fibers, it is especially troublesome with groundwood fibers. Conventional horizontal screens as presently used in the industry for groundwood fibers normally remove about 5% of the total amount fed to the screen. Attempts to remove greater percentages with horizontal screens generally cause plugging which often results in broken plates and damaged machinery. The screen of this invention permits removal of up to 25% of the total stock fed to the screen without undesirable plugging or damage. At the same time, proportionately more of the coarse material is removed. Thus, much cleaner accepted stock is obtained to provide higher quality paper. The rejects can be suitably refined or otherwise reduced to suitable fiber size and returned for rescreening and eventual acceptance.

In FIG. 1, a suitable frame-like structure **10** provides support for a rotatable screening element **11** enclosed in housing **12**. Fixed to and depending from roof **13** of the housing **12** is a generally cylindrical double-walled member **14** of lesser diameter than screening element **11** and concentrically disposed with respect thereto, with a major portion of member **14** enclosed by screen **11**.

Double-walled member **14** functions as a fluid manifold for wash or shower water introduced therein through coupling fixture **15** for delivery in the form of pressurized jets through a plurality of nozzles **16** preferably arranged in plural arrays, each array comprising a suitable number of nozzles **16** axially spaced one from the other, with the arrays being circumferentially spaced from the other as shown in FIG. 2.

As shown, nozzles **16** extend obliquely from outer walls **17** of member **14** to which they are ported by apertures **18**, with the nozzles of each circumferentially spaced array being mounted preferably at an angle of about 60° from the vertical plane, and extending toward but short of the foraminous wall of screen element **11**. While the angle of the nozzles are shown at 60° from the vertical, this angle may be adjusted as desired for optimum results.

The outer wall of member **14** may also be provided with circumferentially spaced vertical baffles **23** which extend outwardly toward the screen wall. These baffles assist in maintaining turbulence in the stock slurry further to insure against potential build-up of stock on the screen and avoid plugging.

In operation, unscreened stock is fed downwardly by suitable means through passageway **19**, axially defined by the inner walls of member **14**, to the interior of screening element **11**, while the element is being rotated at suitable speeds. The stock flow is spread by conical hub **20** defining the lower closed end of screening element **11** to effect uniform distribution of stock through circumferential passageway **21** defined by the lower end **41** of member **14** and the floor **42** of screening element **11**, from where the stock rises under feed pressure and centrifugal force generated by the rotating screen through annular channel **22** formed between the periphery of the outer walls **17** of member **14** and the foraminous wall of screen element **11**. The centrifugal force acting on the stock slurry creates a vorticular pattern in the flow so that the stock is directed away from the walls of member **14**, leaving that area practically void, but does cover substantially all of the surface of screening element **11**.

Thus, continuous feeding of unscreened stock in the manner above-described results in substantially uniform stock distribution throughout the effective screening area. Centrifugal force generating by the rotating screen element causes acceptable fibers to pass through the foraminous screen, while fluid pressure generated through nozzles **16** assists rejected stock in upward movement over rim **24** into rejects chamber **27** for subsequent disposal.

Simultaneously with feeding of unscreened stock, wash water maintained under continuous pressure provides upwardly directed jet streams through each of the nozzles **16**. The efficiency of the screen is increased if the nozzles **16** are so arranged that a line, joining the tips from one array of nozzles to the next in the direction of screen rotation, forms an upwardly spiraling helix. Such an arrangement assures a continuous upward movement of stock and rejects, and prevents formation of dead areas which might develop if the nozzles were arranged on the same horizontal plane for each array.

The total volume of liquid supplied to the screen is regulated to insure that the entire working area of the screen is substantially covered by the slurry. The underwater jets from nozzles **16** thus provide sufficient turbulence within the slurry to maintain separation between acceptable and unacceptable materials while at the same time assist the unacceptable material in its upward movement to overflow annular rim **24** of the screen element **11** where it enters rejects chamber **27**.

As noted above, accepted fibers flow through foraminous walls of screen **11** and into lower annular chamber **25** from where they are removed through conduit **26**.

Unaccepted material or tailings which comprise shives, splinters, and fiber bundles are caused to travel up the inside of foraminous screen **11**, flowing over rim **24** into upper annular chamber **27** for discharge through conduit **28**.

Double-walled member **14** may also be provided with optional shower fixtures, such as is shown at **50**, to provide dilution water to assist in flushing out rejected stock.

The upper annular rejects chamber **27** is provided with an inclined floor **43**, attached to the outside walls **29** of housing **12** and defining a high point **30** and a low point **31** to aid flow of unaccepted material by gravity to discharge conduit **28**. The interior circumference of inclined floor **43** is provided with an upwardly extending flange **32** which extends in close proximity to screen reinforcing rim **24**. The top edge of flange **32** is provided with suitable bearing material **40** to stabilize the rotating screen should temporary imbalance develop as the screen is rotated during operation.

Preferably, the rotating screen assembly is also provided with a self-purging water seal arrangement **33** where the screen assembly is rotatably supported in floor **44** housing **12** to prevent back flow of fibers therethrough. Alternatively, packed or greased fittings may be used but are not as desirable.

Drive shaft **34** is suitably supported by antifriction bearings **35** mounted in cast iron housing **36** and by duplex angular contact bearing **37**. Lubrication is supplied through grease fittings **38** and **39**.

The drive shaft may be provided with any conventional or convenient means for rotation. As shown, the lower end of drive shaft **34** is connected to pulley **45** which is driven by belt **46** by means of a suitable power source, not shown.

Outer casing **12** may also be provided with suitably located access and inspection ports shown at **47** in the roof and **48** in the side.

The rotating screen element **11** is variable in speed so that different rates of flow and various selected stock types may be accommodated. For a 24" diameter screen, speeds in the range of 500 to 1000 r.p.m. have been found effective. It is obvious that suitable rotational speeds would vary with the diameter selected.

Screen baskets are removable and can be made with perforations varying in size and shape to meet particular needs. For example, a screening element with smaller perforations is employed for groundwood fibers, while an element having larger perforations is used for chemical pulp fibers. The perforations may be provided by any suitable punching, drilling or other method.

In one embodiment especially suited for screening groundwood, the wall screening element **11** comprises .050" thick Monel sheet stock with .045" diameter holes spaced .090" at the centers. Wall thickness, size of openings and spacing may be varied in a reasonable range as desired, depending upon the type of fibers being screened.

The screen is also provided with non-perforated vertically spaced reinforcing rings **49** attached by rivets or other suitable means. Two such rings have proved to be sufficient reinforcement when .050" wall thickness is used.

Most rotary pulp screens now in use consist of a rotating impeller element mounted on a horizontal shaft concentrically within a stationary perforated screen. Unscreened stock enters in one end, accepted stock is forced through the perforations in the fixed screen by the impellers while rejected stock is discharged from the opposite end.

Vertical screens are not now in common use. Such screens with fixed or rotating screening elements have been proposed, but generally have not been satisfactory.

The present vertical rotating basket screen differs basically from the prior art in that the entire working surface of the foraminous screen basket is covered by the slurry. In addition, upwardly directed hydraulic jets create a turbulence in the outer vorticular wall of the flowing stock slurry to maintain separation of fibers while assisting upward movement of the rejected stock. Also, when optional vaned inserts or baffles are employed, they remain stationary while the screen rotates. The exact nature of the screening action developed by the defined structure is not known, but it has been found that this type of screen rejects substantially more of the undesired coarse fiber than conventional horizontal screens having similar size perforations.

It has been theorized that one reason for the larger rejection rate and higher efficiency is due to the manner in which the fibers are presented to the screen perforations. Conventional screens are believed to orient the fiber to a position perpendicular to the screen, thus allowing larger size fibers to pass through. Since the present screen operates with the screening area fully covered by the stock slurry, and the direction of fiber flow is upward, the greater proportion of individual fibers flow parallel to the screen and unwanted larger sized fibers therefore will not pass through.

The following data clearly demonstrate the advantages of the vertical screen of this invention over conventional horizontal screens.

A pulp mixture was prepared containing 80% screened poplar groundwood fibers and 20% groundwood fiber rejects as obtained from a conventional horizontal rotary screen. Equal portions of this controlled mixture were fed at a consistency of about 0.5% to a vertical screen as herein described and to a conventional horizontal screen. Each of the screens were equipped with screening plates having identical hole sizes. In this case, the hole size was .045".

Stock feed was adjusted so that the screens rejected about 5% of the total stock fed to them. Rejects from both screens were then subjected to fractionation to determine the size distribution in each case.

Results were as follows:

Rejects	Mesh size of fractions separated				
	+28	+48	+100	+200	−200
Horizontal screen (percent retained)	41.4	18.4	17.7	10.5	12.0
Vertical screen (percent retained)	44.0	24.0	20.0	11.3	0.7

The figures show a marked difference in the size distribution of the rejected stock. Thus, the vertical screen rejects a substantially coarser fiber than the horizontal screen under the same conditions of operation. Note, especially, the larger difference in the −200 fraction. It is obvious, therefore, that the vertical screen is much more selective in operation permitting more of the acceptable sized stock to be carried through, while rejecting more of the unacceptable coarser fiber.

Hand sheet samples were made from the accepted material obtained from the conventional horizontal screen as well as from the accepted screened material obtained from the vertical screen. The sheets were dyed blue to more clearly show the presence of any shives or coarse material, since these coarse materials do not accept the dye and remain white. Visual examination of the dyed

sheets revealed that the sheet made up from fibers which passed through the horizontal screen contained a much larger amount of coarse fiber bundles than did the sheet made up from fibers obtained from the vertical screen.

The conclusion is that the vertical rotating screen has the ability to reject more of the coarser fibers and fiber bundles than conventional screens do, thus providing a smoother, cleaner paper sheet.

In other experiments, another comparative study was made with mechanical pulp fibers to determine if the vertical screen could improve the properties of pulp which had already been conventionally screened. The mechanical pulp with a consistency of about 0.5% was run through screens in the following sequence. First through a conventional horizontal screen with .045" perforations, then through a conventional screen with .033" perforations, and finally through a vertical rotating screen with .033" perforations. Samples of the accepted stock again were fractionated to determine size distribution after each screening step.

Results were as follows:

Screen used	Mesh size of separated fractions					Percent Rejects
	+28	+48	+100	+200	−200	
.045" Horizontal screen.....percent..	10.2	20.6	21.5	13.4	34.3	4.4
.33" Horizontal screen.....percent..	6.2	20.8	22.2	14.9	35.9	7.3
.033" Vertical screen.....percent..	0.0	8.5	25.8	19.8	45.9	27.0

It is noted that the percent rejects increased each time. However, the vertical screen rejected nearly four times as much as was rejected by the horizontal screen with identical sized openings. Most of the additionally rejected stock was in the undesirable coarse sizes. Hand sheets made from the accepted material were subequently printed with half tones and rotoprint to assess printability. In each case the sheets prepared from vertically screen pulp provided a smoother surface and were adjudged by visual assessment to be of improved printability over the sheets prepared from horizontally screened pulp. The printing was in sharp detail and had a minimum of skipped areas.

While perfect separation of coarse material is really never obtained, the selectivity of the vertical screen of this invention comes closer to obtaining optimum separation than has been possible hitherto. The major advantage of the screen is that the amount of rejects can be easily controlled to obtain almost any desired degree of cleanliness in the finished pulp to meet a large variety of end uses without penalty with respect to fiber losses.

Various methods may be employed to control the amount of rejects and the cleanliness of the accepted stock. For example, with a constant speed of rotation and a constant feed, more wash water will reduce the percent of rejects, while less wash water will increase percent of rejects. With a constant speed of rotation and a constant supply of wash water, increased rate of feed will result in more rejects and decreased rate of feed will result in less rejects. The flexibility in operation inherent in the screen of this invention provides a readily available degree of control over pulp quality.

It is evident that various modifications and changes may be made in the embodiments of the invention herein shown and described without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A vertical centrifugal pulp screening apparatus comprising:

(a) a base,

(b) a closed cylindrical casing supported on said base,

(c) a cylindrical screen mounted for concentric rotation within said casing, said screen having perforated walls, an open top with an outwardly extending peripheral flange and a closed imperforate bottom peaked in the center and curved upwardly at the periphery to join the perforated cylindrical walls of the screen, the interior of said screen being free of scraping devices,

(d) a stationary annular double-walled manifold concentric with said screen affixed to the roof of said casing and extending downwardly to a point short of the bottom of said screen, the inner wall of said manifold forming a conduit for directing a pulp suspension downwardly against the floor of said screen and upwardly against and through the perforated walls of said screen,

(e) upwardly angled nozzles in the outer wall of said manifold in communication with the interior thereof, said nozzles being circumferentially and vertically spaced from each other in the form of an upwardly spiraling helix and extending outwardly from said wall toward the perforated walls of said screen with the tips of said nozzles being in close proximity to, but short of, said perforated walls, said manifold and said nozzles providing means for supplying wash liquid interiorly against the walls of said screen,

(f) two annular chambers within said casing located one above the other, the upper chamber being in communication with the open top of said screen to receive and discharge rejected dirt and tailings, the lower chamber being in communication with the perforated walls of said screen to receive and discharge accepted pulp stock.

2. A vertical centrifugal screen for cleaning pulp stock comprising:

(a) a vertical cylindrical casing,

(b) a perforated cylinder rotatably mounted within said casing and having an open top with an outwardly extending peripheral rim and an upwardly dished imperforate floor having an inverted cone-shaped center,

(c) a centrally disposed double-walled annular manifold affixed to the roof of said casing and extending downwardly short of the floor of said cylinder,

(d) a stock supply conduit coincident with the inner wall of said manifold for downwardly supplying stock interiorly of said cylinder,

(e) upwardly angled nozzles circumferentially and vertically spaced from each other in the outer wall of said manifold and extending outwardly toward and spaced from the wall of said perforated cylinder,

(f) supply means connected to said manifold to provide wash liquid for expulsion through said nozzles,

(g) an annular chamber between said cylinder and the wall of said casing to receive accepted stock which passes through said perforated cylinder,

(h) a discharge opening for accepted stock in the wall of said casing adjacent the floor thereof,

(i) a sloping ring in a plane angularly disposed to the axis of said casing annularly attached to the inside upper portion of said casing wall below the rim of said cylinder and extending inwardly toward the wall of said cylinder, the inner circumference of said ring having an annular flange extending upwardly underneath and in close proximity to said rim and forming a slidable seal with said rim, said ring and flange forming a downwardly sloping channel to receive rejected stock which flows over said rim after rejection by said perforated cylinder,

(j) and a discharge opening for said rejected stock in the wall of said casing adjacent the lower race of said ring.

3. A vertical centrifugal screen for cleaning pulp stock comprising:

(a) a vertical cylindrical casing,

(b) a perforated cylinder rotatively mounted axially within said casing, said cylinder having an open top with an outwardly extending peripheral rim and an upwardly dished imperforate floor having an inverted cone-shaped center,

(c) a centrally disposed double-walled annular manifold affixed to the roof of said casing and extending downwardly short of the floor of said cylinder,

(d) upwardly angled nozzles circumferentially and vertically spaced from each other in the outer wall of said manifold and extending outwardly toward and spaced from the wall of said perforated cylinder,

(e) vertically extended baffle members affixed to the outer wall of said manifold, extending outwardly in close proximity to, but short of, said perforated cylindrical wall, and circumferentially spaced between the vertically spaced nozzles,

(f) a stock supply conduit coincident with the inner wall of said manifold for downwardly supplying stock interiorly of said cylinder,

(g) supply means connected to said manifold to provide wash liquid for expulsion through said nozzles,

(h) an annular chamber between said cylinder and the wall of said casing to receive accepted stock which passes through said perforated cylinder,

(i) a discharge opening for accepted stock in the wall of said casing adjacent the floor thereof,

(j) a sloping ring in a plane angularly disposed to the axis of said casing annularly attached to the inside upper portion of said casing wall below the rim of said cylinder and extending inwardly toward the wall of said cylinder, the inner circumference of said ring having an annular flange extending upwardly underneath and in close proximity to said rim and forming a slidable seal with said rim, said ring and flange forming a downwardly sloping channel to receive rejected stock which flows over said rim after rejection by said perforated cylinder,

(k) and a discharge opening for said rejected stock in the wall of said casing adjacent the lower race of said ring.

References Cited by the Examiner

UNITED STATES PATENTS

568,821	10/1896	Waring	210—213
1,037,597	9/1912	Coppage	209—270
1,163,275	12/1915	Spangenberg	209—270

FOREIGN PATENTS

787,825	7/1935	France.
951,830	4/1949	France.
599,615	7/1934	Germany.
754,716	2/1953	Germany.
809,967	3/1959	Great Britain.

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