April 18, 1950 J. D. ATKINSON, JR 2,504,944

APPARATUS FOR PURIFYING RAW COTTON LINTERS

Filed March 10, 1947 2 Sheets-Sheet 1

Fig. 1.

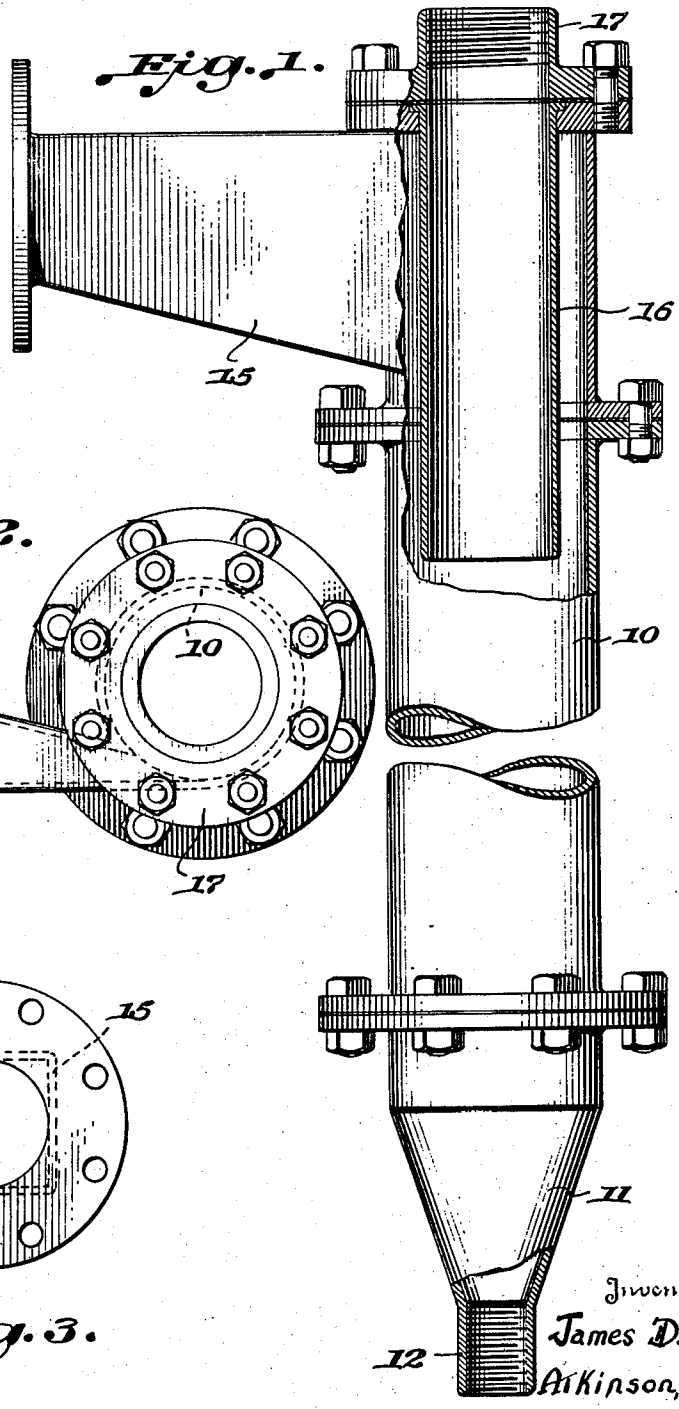


Fig. 2.

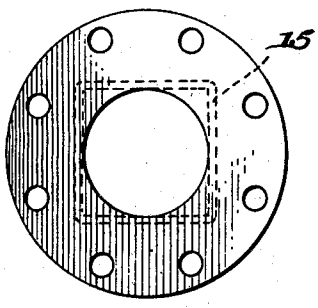


Fig. 3.

Inventor
James D. Atkinson, Jr.

By Watson, Cole, Grindle & Watson
Attorneys.

April 18, 1950 J. D. ATKINSON, JR 2,504,944

APPARATUS FOR PURIFYING RAW COTTON LINTERS

Filed March 10, 1947 2 Sheets-Sheet 2

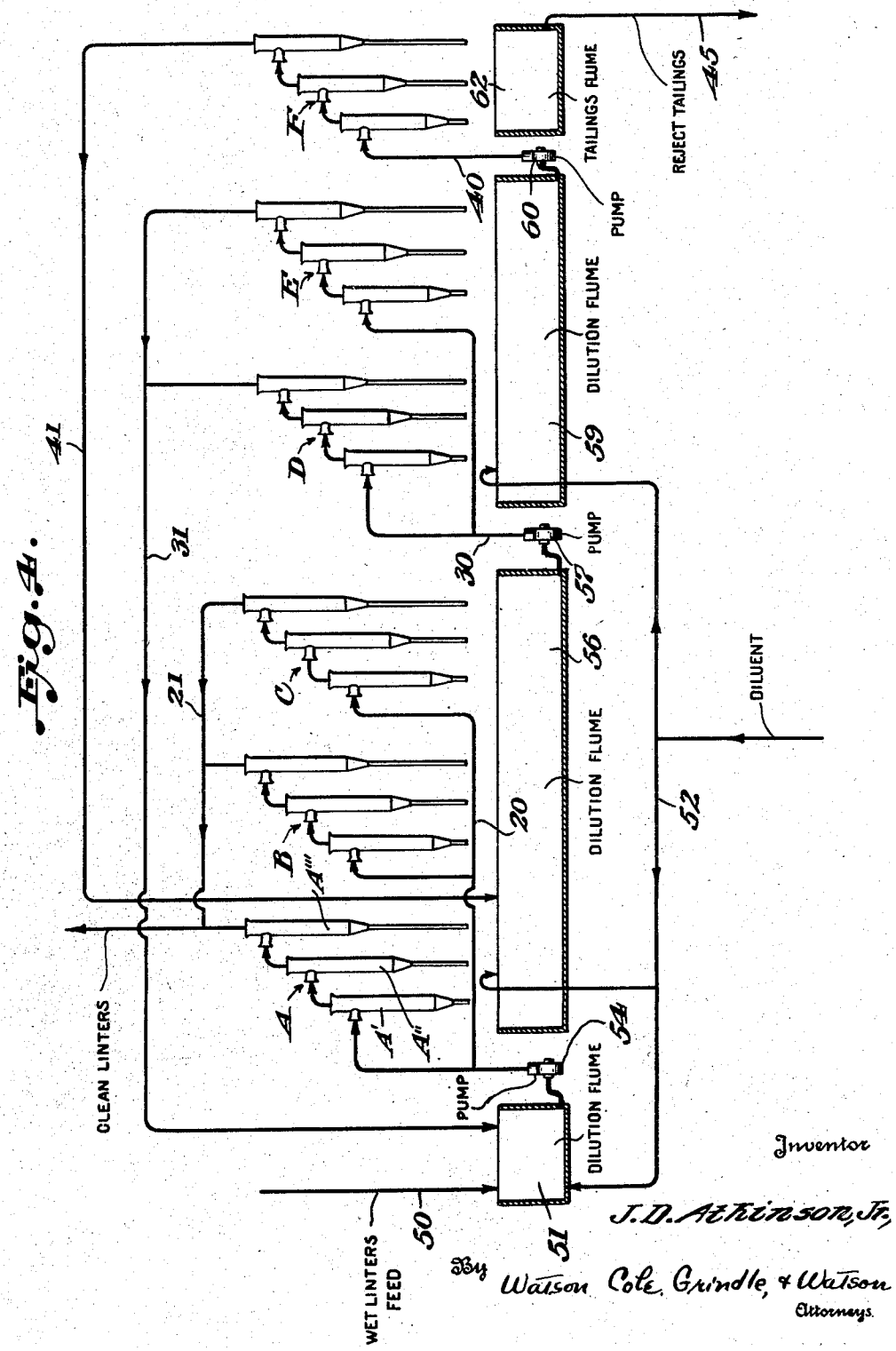


Fig. 4.

Inventor
J. D. Atkinson, Jr.
By Watson Cole, Grindle & Watson
Attorneys.

Patented Apr. 18, 1950 2,504,944

UNITED STATES PATENT OFFICE

2,504,944

APPARATUS FOR PURIFYING RAW COTTON LINTERS

James D. Atkinson, Jr., Memphis, Tenn., assignor to Buckeye Cotton Oil Company, Memphis, Tenn., a corporation of Ohio

Application March 10, 1947, Serial No. 733,679

5 Claims. (Cl. 209—211)

1

This invention relates to methods and apparatus for use in the processing of raw or unpurified cotton linters as removed from the cottonseed, for instance in the production of cellulose pulp. The principal object of the invention is the provision of an efficient continuous method for the cleaning of such raw cotton linters as a step preliminary to the conventional processing of the linters to form pulp.

The desirability of preliminary cleaning of raw linters has long been recognized, and certain methods heretofore employed have achieved some measure of success in removing foreign solids which ordinarily accompany the linters, including hull pepper, shale (fragments of boll, hulls, leaves, cotton stalk, and similar matter, and particularly matter not dissolved in the conventional alkaline processing of linters to form pulp), and dust from various sources. The dry cleaning methods used for this purpose were, however, relatively inefficient, involved a substantial linters loss, and failed to dispose of the dust problem. Earlier wet cleaning methods, for instance those which find utility in the cleaning of cellulose pulp, have proved inoperative for the cleaning of raw cotton linters. Cleaning units of the wet cyclone type, constructed as heretofore proposed, become plugged by the linters, which contain long fibers, have pronounced matting tendencies, and contain a large percentage of foreign material, often in excess of twelve per cent. As a result, much of the supply of cotton linters as received from the cutting mill is either incapable of yielding high quality pulp by conventional processing methods, or is regarded as an uneconomical source of such pulp.

The present invention contemplates the cleaning of linters while in suspension in liquid, preferably water, improved apparatus based on the liquid cyclone principle having proved highly efficient in the preparation of linters for the treatment employed in the usual pulp processing steps. As a result, it is now possible to produce high quality pulp from second cut linters or from low grade linters heretofore considered unsuitable as a starting material in the production of high quality pulp. Dust losses have been substantially eliminated, the cost of processing operations such as bleaching has been reduced, and the quality of the cellulose pulp and the products derived therefrom have been materially improved.

The basic unit of the system proposed by the present invention is simple to construct. It consists essentially of an elongated cylindrical chamber, disposed generally vertically, and formed at its lower end to provide a downwardly tapering conical portion leading to a discharge orifice for tailings, the chamber being unobstructed to permit free circulation of fluid therein. At its upper end the chamber is provided with a tangential inlet passage and an axially disposed outlet passage, the latter extending downwardly within the chamber to a point substantially below the inlet passage. When a liquid suspension of linters is introduced in the chamber through the inlet passage, the entering liquid flows downwardly in a helical path about the periphery of the chamber, and is returned upwardly in a path adjacent the chamber axis, being discharged through the outlet passage. Reversal of flow occurs near the lower end of the chamber and results in separation of a substantial percentage of foreign solids, even though the specific gravity of most of such solids differs from that of the linters by less than 5%, values common in the case of vegetable impurities in cotton linters. The separation, from the bulk of the linters in suspension, of those solid impurities which are only slightly more dense than the linter fibers is dependent upon the continuous discharge of a substantial fraction of the suspension through the discharge orifice at the lower end of the tapering portion of the separating chamber, this discharge fraction being referred to as tailings.

2

In order that the linters may be effectively cleaned in an operation involving a large volume of linters, it is desirable to employ a considerable number of units for the character aforementioned. In the preferred embodiment of the invention, these units are arranged to provide several stages in which the linters are successively treated, the tailings from each stage except the last being delivered to a succeeding stage, the tailings from the last stage being removed from the system, and the partially cleaned linters withdrawn from the second and each succeeding stage being returned to the immediately preceding stage for recirculation. Clean linters from the output of the first stage are delivered for processing into cellulose pulp in conventional manner.

In the first cleaning stage, I preferably employ a plurality of groups of units, the groups being connected in parallel, each group comprising a plurality of units connected in series with a single pump. Succeeding stages are similarly arranged, but include a diminishing number of groups of units, to compensate for withdrawal from the system of clean linters in suspension and for the rejection of the tailings from the last

stage. Such a system of units of the liquid cyclone type modified to embody the principles of the invention is found to be highly efficient in the production of clean linters, even though the starting material consists principally of highly contaminated sweepings.

In the practice of the invention, it has been found that the concentration of the linters suspension is fairly critical. The optimum consistency is about 0.5% by weight of the original dry linters in the suspension, and with increase of consistency above 1%, the efficiency of the cleaning operation falls off rapidly. Performance of the cleaning operation with suspensions of concentration substantially less than 0.5% are more efficient from the standpoint of cleaning, but are uneconomical because of the relatively large volume of liquid which must be handled.

I have also found that the efficiency of the individual cleaning unit is affected by the velocity of flow of the suspension, which is conveniently measured in terms of the pressure drop between the inlet and outlet of the unit and by the rate at which the tailings are withdrawn. In general, the pressure drop may vary within the range of 12 to 60 pounds per square inch, and for optimum results a pressure difference of at least about 17 to 20 pounds is desirable. Tailings in amount ranging from 2% to 12% of the incoming suspension should be continuously withdrawn from the chamber. Tailings in amount as high as 30% may be thus drained, since cleaning is thereby improved. However, increase in the percentage of tailings withdrawn requires a corresponding increase in the number of cleaning units employed, and the draining of more than about 10% of the suspension is, generally speaking, not practical. Likewise, drainage of less than 1% results in ineffective cleaning and is unprofitable.

Within the limits above indicated, conditions of operation may be varied substantially to accommodate the character of the material which is to be treated and to secure the optimum efficiency from the individual cleaning unit employed, having due regard to the dimensions of the unit. The correct mode of practicing the invention can be determined by reference to the specific example hereinafter described specifically and shown in detail, it being understood that this example is merely illustrative and that limitation of the scope of the invention as defined in the appended claims is not thereby intended.

In the drawings,

Figure 1 is a side elevation, partly in section, of a preferred form of separating unit for use in the practice of the invention;

Figure 2 is a plan view of the structure shown in Figure 1;

Figure 3 is an end elevation of the inlet passage shown in Figures 1 and 2; and

Figure 4 is a schematic illustration of a cleaning system employing multiple units of the liquid cyclone type.

Referring now to Figures 1 to 3, inclusive, in which is illustrated a preferred type of cleaning unit, it will be observed that the cleaning takes place within a cylindrical casing 10, having a diameter which is only a fraction of its length. In one structural embodiment which has been found highly satisfactory, a 6-inch casing having a length of 63 inches was employed. In general, the casing should be of a length from ten to eleven times its diameter, in order to insure maximum separating action, but a length varying between five to fifteen times the diameter may be employed. Secured to the lower end of the casing 10 is a downwardly tapering member 11, the casing 10 and member 11 being unobstructed throughout and being in open communication, and defining together the chamber or zone in which the desired separation is effected. Member 11 is provided at its lower end with a threaded nipple 12, defining a discharge orifice for the continuous discharge of tailings.

The separating chamber remains substantially filled with a liquid suspension of linters while in operation, the suspension being continuously introduced into the chamber through an inlet passage 15, being partly clarified within the chamber, and being withdrawn through an outlet passage 16, the latter communicating with a threaded nipple 17 through which the clarified suspension leaves the casing 10. Inlet passage 15 may be rectangular in transverse section, as shown in the drawings, and is either secured to or formed integrally with the upper portion of the casing 10, so as to introduce the suspension in a direction tangential to the casing. The outlet passage 16 extends within casing 10 to a point substantially below the inlet passage 15. For proper operation, the outlet passage 16 should extend beyond the lower side of the inlet passage 15 by at least about two inches, and is preferably substantially longer than this, in order to prevent flow of suspension directly from the inlet passage into and out of the outlet passage. With the construction shown, the velocity of the incoming liquid causes liquid flow within the casing 10 in a downward direction and in a substantially helical path adjacent the periphery of the casing. As the incoming liquid approaches the lower end of the casing 10, it tends to reverse its direction of flow, moving upwardly adjacent the axis of casing 10 and toward and through the outlet passage 16, and thence out through the nipple 17. Adjacent the point of reversal of flow direction, foreign solids entrained in the liquid suspension tend to separate and to continue their downward movement, such separation being promoted by continuous withdrawal of contaminated liquid, containing foreign matter and some linters, through the discharge orifice defined by the nipple 12. As heretofore explained, continuous withdrawal of tailings in amount ranging from 2% to 12% of the circulated suspension is preferred, although it is possible under some conditions to operate the unit satisfactorily while withdrawing as much as 30% or 40% of the liquid as tailings.

In general, the width of the opening affording communication between the inlet passage 15 and the casing 10 should be about equal to the width of the annular space defined by the casing 10 and the outlet passage 16, and the ratio of the inlet and outlet areas should be of the order of from 1:2 to 1:1, the area in transverse section of the casing 10 being about four times the area of the inlet opening. It will be appreciated, however, that considerable variation in structural design and dimensions of the unit is permissible without sacrifice of efficiency, and that the dimensional relationship suggested herein is intended principally as a guide in the design of units differing substantially in size and arrangement from that illustrated in the drawings.

For operation of the separating unit on a commercial scale, and in an efficient manner, the use of multiple units is highly desirable. A preferred method for overcoming the difficulties

presented by large scale operation is illustrated in Figure 4, in which the material is treated in a plurality of stages, three such stages being shown. In each stage the linters suspension is passed through at least one group of separators of the liquid cyclone type, preferably constructed in the manner described by reference to Figures 1 and 3, inclusive, the separating units being arranged in series in each group. For example, the first stage of separating units is shown as including three parallel groups of units, designated respectively, A, B, and C. Each group includes three units in series, the units of group A being designated A', A'', and A''', arranged in series in the group, each group being supplied by a single pump. Thus a liquid suspension delivered to and partially cleaned in unit A' is fed to unit A'', and the further clarified suspension withdrawn from unit A'' is fed to unit A'''. That part of the suspension withdrawn from the outlet of unit A''' consists essentially of clean linters, and may be supplied to a pulp processing system for conversion to cellulose pulp in conventional manner. The three groups of units A, B and C, each including three units arranged in series, are connected in parallel, receiving the uncleaned linters suspension from a common inlet pipe **20** and discharging clean linters into a common outlet pipe **21**. Tailings from all of the units of the first stage are discharged directly downwardly into a common dilution flume **56**, from which they are pumped continuously and without settling of solids to the units of the second stage.

A similar arrangement is provided in the second stage, except that the number of groups of units is less, two being shown. Thus groups D and E each include three cleaning units arranged in series, the two groups being fed from a common inlet pipe **30** supplied from flume **56** and discharging into a common outlet pipe **31**. Tailings from all of the units in this stage are discharged downwardly into a common dilution flume **59**, from which the units of the third stage are fed. The third stage as illustrated includes only one group of units, indicated at F. The units of this stage are supplied with suspensions through inlet pipe **40** from flume **59**, and discharge of partly cleaned linters is effected through pipe **41**, tailings being discharged into flume **62** and thence into tailings pipe **45**. The tailings from this last stage contain only a very small percentage of linters and may be discarded. Alternatively, these tailings may be treated to recover useful components, for instance fibrous materials, hull fragments, and the like, but in any event they are withdrawn from the system of cleaning units just described.

It will be appreciated that the number of groups of units in each stage and the number of units in each group may vary widely from that illustrated in Figure 4, but that in general it is desirable to decrease the number of groups of units employed in successive stages, since the amount of material being handled is reduced by discharge of cleaned or partially cleaned linters from each stage, and by removal from the system of the tailings from the last stage. For the same reason, the size of successive units in a series group may decrease. Instead of, or in addition to, decreasing the number of series groups in successive stages, the size of the units of the series groups for successive stages may be decreased.

As is hereinbefore indicated, it is important to maintain the consistency of linters within specified limits during the cleaning operation, and the invention contemplates adjustment of consistency prior to feeding the suspension to each of the several cleaning stages. Thus the linters, wetted with a liquid such as water in a suitable apparatus, are fed through pipe **50** into dilution flume **51**, water being introduced in the flume from supply line **52** to the extent required to adjust the consistency to the correct value, usually to a consistency between about 0.3% and about 1.0%. From flume **51** the linters suspension is supplied through a centrifugal pump **54** or other suitable constant volume device to inlet pipe **20** which supplies the cleaning unit of the first stage. Tailings from the first stage discharge into a second dilution flume **56**, similarly supplied with water from supply line **52**, whereby the desired consistency is again established. From flume **56** the material is fed by pump **57** to inlet pipe **30** which supplies the linters suspension to the second stage of cleaning units, which includes groups D and E. The partly cleaned linters discharged from the second stage are fed through outlet pipe **31** to dilution flume **51**, and are thus subjected to further cleaning by the units of the first stage. Tailings from the second stage are discharged into dilution flume **59**, the consistency is again adjusted, and pump **60** delivers the suspension through inlet pipe **40** to the units F of the third stage. The partly cleaned linters discharged from this stage are returned through outlet pipe **41** to dilution flume **56** for recleaning in the second stage. This repeated cleaning of the linters insures removal of a maximum quantity of foreign material and the loss of a minimum quantity of usable linters.

As is hereinbefore mentioned, proper operation of the cleaning unit is dependent, among other things, on the maintenance of an adequate drop in pressure across each unit. It has been found that when identical or essentially similar units are arranged in series, as in each of the several groups in the several stages, and are supplied by a single pump, the pressure drop across the series of units is fairly uniformly allocated to the several units of the series, unless the rate of withdrawal of tailings is high. Thus if three series units are employed, and a total pressure drop of about 50 pounds is provided across the units, the drop in each unit is about 17 pounds, which is ordinarily entirely adequate. Since the pressure existing at the lower end of each unit of a series group is greater than that in the succeeding unit, corresponding variation in the size of the tailings discharge openings is required, the first unit of the series having the smallest tailings outlet, in order that the percentage of tailings discharged from each of the several units may be maintained within appropriate limits as hereinbefore indicated.

It will be noted that the suspending liquid is maintained in rapid motion throughout the system; settling of solid material resulting in substantial fiber loss by reason of the slight difference in density between desired and undesired solids is thereby avoided. The tailings from each of the units (except the tailings to be discarded), including all of the entrained solids, are conveyed to succeeding units for further separation.

While the invention finds its principal use in the cleaning of raw linters for pulp manufacture, it will be understood that the practice of the invention is not necessarily restricted to such use.

In many other fields in which cotton linters may be employed, preliminary cleaning of the raw linters effects substantial economies and materially improves the characteristics of the end product, and such additional uses of the invention are contemplated herein.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A unit for separating foreign solids from raw cotton linters suspended in a liquid, comprising a generally vertically disposed, elongated unobstructed cylindrical casing having a length of from about five to about fifteen times its diameter and having at its lower end, in unobstructed communication therewith, means defining a discharge orifice, an inlet member at the upper end of said casing and being disposed tangentially of said casing, and a cylindrical outlet member disposed coaxially within said casing, said outlet member being of substantially less diameter than said casing to define with the latter an axially directed annular passage, and having such length as to extend from the upper end of said casing to a point substantially below said inlet member, said casing having an inlet opening of which the width is substantially equal to the width of said annular passage, said inlet opening affording communication between said casing and said inlet member, the ratio of areas of the inlet and outlet members being between 1:2 and 1:1, and such that a liquid suspension of linters introduced through said inlet member is caused to flow in a generally helical path downwardly in and peripherally of the casing, and to return upwardly along the axis of said casing to discharge through said outlet member, and means for continuously discharging a substantial fraction of the liquid, together with entrained foreign material, through said discharge orifice.

2. A separating unit as claimed in claim 1 in which said casing has a length from 10 to 11 times its diameter.

3. Apparatus for purifying raw cotton linters comprising, in combination, a plurality of separating units, said units being constructed as claimed in claim 1 and being arranged in series, means conveying a liquid suspension of linters to the inlet member of the first separating unit, means conveying partly clarified suspension from the outlet member of each unit except the last of the series to the inlet member of the succeeding unit of the series, and a single pump in series with the said units for forcing the suspension through all of the units of the series.

4. Apparatus for purifying raw cotton linters comprising, in combination, a plurality of separating units, said units being constructed as claimed in claim 1, such separating units being allocated to a plurality of successive separating stages, at least the first of such stages including a plurality of separating units arranged in parallel, a succeeding stage including a less number of separating units arranged in parallel, means delivering a liquid suspension of linters to the separating units of the first stage, means withdrawing the clarified suspension from the separating units of the first stage as cleaned linters, means for discharging continuously tailings including foreign matter and lint in suspension from the separating units in each stage, and delivering such tailings from each stage except the last stage to the separating units of the succeeding stage, means delivering the partly clarified suspension from the separating units of each such succeeding stage to the separating units of the preceding stage, means withdrawing from the system the tailings from the last stage, and devices preceding each stage for introducing liquid to restore the solid to liquid consistency of the suspension delivered to such stage.

5. Apparatus for purifying raw cotton linters comprising, in combination, a plurality of separating units, said units being constructed as claimed in claim 1, such separating units being allocated to a plurality of successive separating stages, each stage including at least one group of separating units arranged in series, at least the first of such stages including a plurality of such series groups of separating units arranged in parallel, a succeeding stage including a less number of such series groups of separating units arranged in parallel, means delivering a liquid suspension of linters to the first separating unit of each series of the first stage, means delivering the partly clarified suspension from each separating unit except the last unit of each of said series groups in each stage to a succeeding separating unit of the same series group, means withdrawing the clarified suspension from the last separating unit of each of the series groups of the first stage as cleaned linters, means for discharging continuously tailings including foreign matter and lint in suspension from the separating units in each stage, and delivering such tailings from each stage except the last stage to the first separating unit of each series group of the succeeding stage, means delivering the partly clarified suspension from the last separating unit of each of the series groups of each such succeeding stage to the first separating unit of each of the series groups of the preceding stage, and means withdrawing from the system the tailings discharged from the separating units in the last stage.

JAMES D. ATKINSON, JR.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
936,563	Rendall	Oct. 12, 1909
1,197,946	Pardee	Sept. 12, 1916
1,669,820	Grant et al.	May 15, 1928
2,104,537	Ellis	Jan. 4, 1938
2,136,281	Dickinson	Nov. 8, 1938
2,312,706	Freeman	Mar. 2, 1943
2,377,524	Samson et al.	June 5, 1945

FOREIGN PATENTS

Number	Country	Date
757,461	France	Dec. 27, 1933