Nov. 19, 1968 H. A. DELCELLIER 3,411,721

REFINING AND SCREENING APPARATUS

Filed Sept. 2, 1966 2 Sheets-Sheet 1

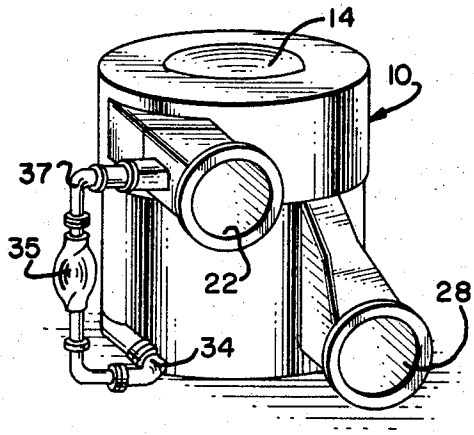

FIG. 2

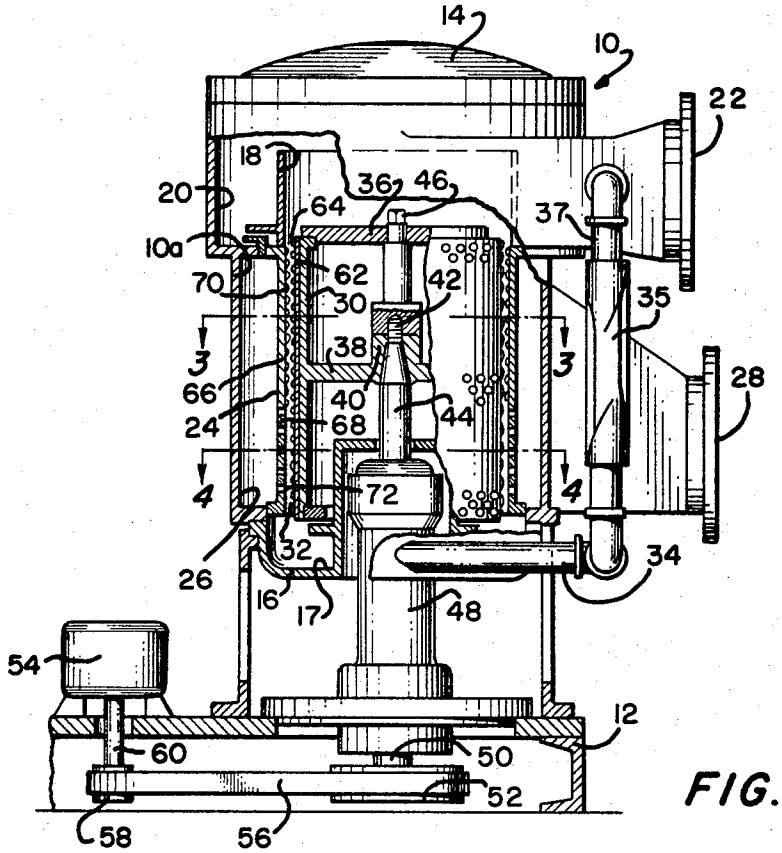

FIG. 1

INVENTOR.
HENRI A. DELCELLIER
BY
Robert R. Paquin
ATTORNEY

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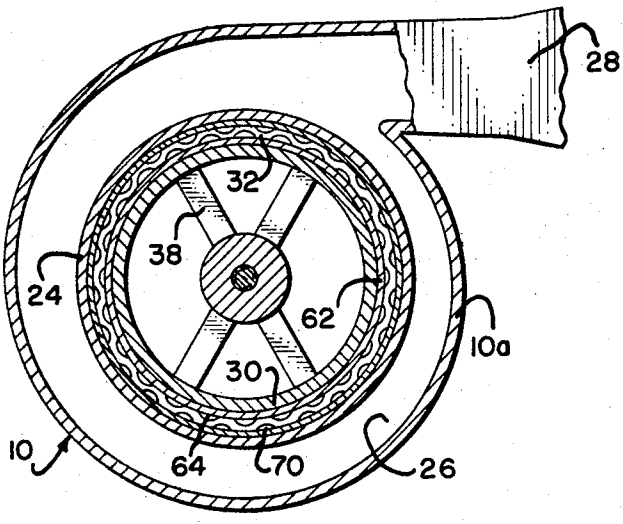

FIG. 3

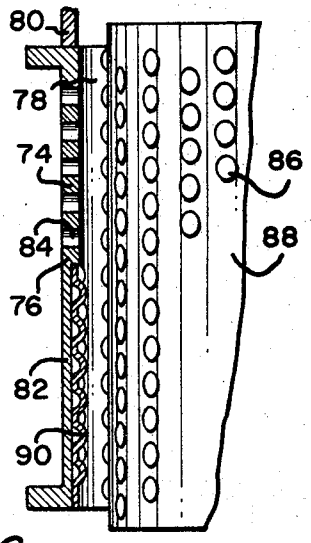

FIG. 6

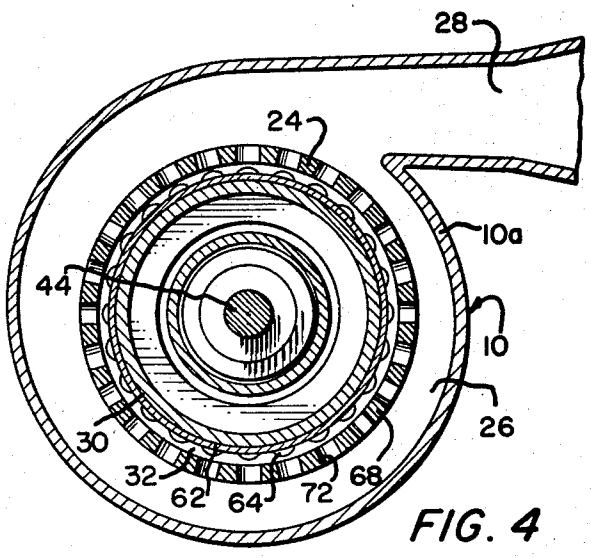

FIG. 4

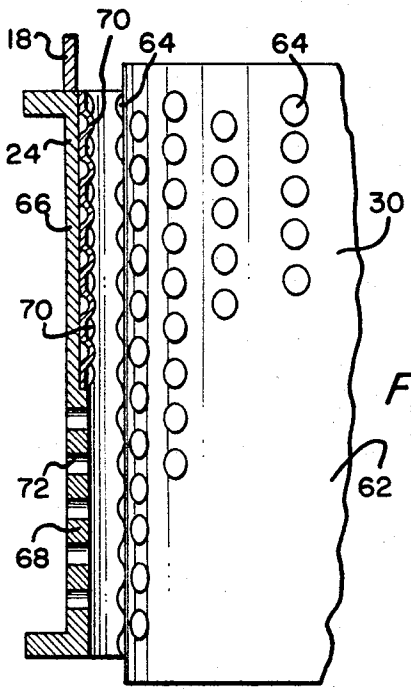

FIG. 5

INVENTOR.
HENRI A. DELCELLIER
BY
Robert R. Paquin
ATTORNEY

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REFINING AND SCREENING APPARATUS

Henri A. Delcellier, Beaurepaire, Quebec, Canada, assignor to Canadian Ingersoll-Rand Company Limited, Montreal, Quebec, Canada, a corporation of Canada

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18 Claims. (Cl. 241—97)

This invention relates to pulp and paper making machinery and has more particular reference to the provision of a new and improved apparatus for refining and screening paper pulp fluid.

Conventionally, numerous machines have been provided for refining paper pulp fluid by dispersing the shives and slivers of pulp fibers in the pulp fluid, or deflaking small flakes of paper, to reduce these to their component pulp fibers. These refining machines have frequently employed rotating and rubbing surfaces to effect their dispersing and deflaking actions and have usually been of the single disc, double disc, plug, sonic, and supersonic types.

Conventionally, also, numerous machines have been provided for screening paper pulp fluid to remove shives or slivers of pulp fibers from the pulp fluid. These screening machines, however, have always been separate from the refining machines, thus requiring the employment of separate machines for the refining and screening processes. This requirement for separate machines for the accomplishment of the refining and screening processes has necessitated that paper mills devote an uneconomically large area to the placement of the separate machines and has required large monetary outlays for their purchase.

An object of the present invention is to provide a new and improved apparatus of unitary construction which is particularly constructed and arranged to perform the dual functions of refining and screening paper pulp fluid.

Another object of the invention is to provide a new and improved refining and screening apparatus of the type set forth which is particularly constructed and arranged to provide supplemental refining of the portion of the pulp fluid rejected by the screening section of the apparatus to refine such to a state wherein it may be accepted by the screening section of the apparatus.

Another object is to provide a new and improved refining and screening apparatus of the type set forth which is relatively simple and economical in construction and highly efficient and dependable in operation.

The foregoing objects, and the other objects and advantages of the invention which will be apparent from the following description taken in connection with the accompanying drawings, are obtained by the provision of a paper pulp fluid refining and screening apparatus comprising a first working member and a second working member. The second working member opposes the first working member and is spaced from the first working member to provide a passage between the working members. The first and second working members are relatively rotatable by a means which is provided for effecting relative rotation of the working members. A pulse generating means is carried by one of the working members within the passage therebetween and cooperates with a pulse generating means carried by the other of the working members within the passage therebetween, during relative rotation of the working members, to create shock pulses for refining paper pulp fluid passing through the passage between the working members. A screening means communicates with the passage between the working members for screening paper pulp fluid passing through the passage and, also, communicates with an accepts outlet means which discharges paper pulp fluid accepted by the screening means from the passage. Paper pulp fluid is supplied to the passage between the working members by an inlet means which communicates with the passage; and paper pulp fluid rejected by the screening means is discharged from the passage between the working members by a rejects outlet means which communicates with the passage.

Referring to the drawings wherein two embodiments of the invention have been given for the purposes of illustration:

FIG. 1 is an elevational view, partially broken away and in section, of an apparatus embodying the present invention;

FIG. 2 is a partial, perspective view of the apparatus embodying the present invention shown in FIG. 1;

FIG. 3 is an enlarged sectional view taken on line 3—3 of FIG. 1, looking in the direction of the arrows;

FIG. 4 is an enlarged sectional view taken on line 4—4 of FIG. 1, looking in the direction of the arrows;

FIG. 5 is an enlarged, fragmentary elevational view of the working members of the apparatus illustrated in FIGS. 1 through 4; and

FIG. 6 is an enlarged, fragmentary elevational view of the working members of an apparatus which is an alternative embodiment of the invention.

Referring more particularly to the drawings wherein similar reference characters designate corresponding parts throughout the several views, the embodiment of the paper pulp fluid refining and screening apparatus illustrated in FIGS. 1 through 5 comprises a housing designated generally at **10** which projects vertically from a horizontally extending supporting base **12**. The housing **10** includes annular side walls **10***a* and encloses a working cavity which is defined by the annular side walls **10***a*, a dome plate **14** which forms the upper end of the housing **10**, and a closure plate **16** which extends transversely within the housing **10** vertically above the supporting base **12**. The closure plate **16** is formed with an annular concavity which provides an annular rejects gutter **17**.

An annular baffle plate **18** is disposed within the upper end of the working cavity and cooperates with the side walls **10***a* of the housing **10** to define an annular inlet gutter **20**. The baffle plate **18** terminates in spaced relationship to the dome plate **14** to permit fluid communication between the annular inlet gutter **20** and the portion of the working cavity which is circumferentially enclosed by the baffle plate **18**. An inlet conduit **22** tangentially communicates with the annular inlet gutter **20** to introduce into the annular inlet gutter **20** the paper pulp fluid to be refined and screened. A gutter trap conduit (not shown) may be connected to the outer circumference of the annular inlet gutter **20** for removing from the latter any heavy debris entering the annular inlet gutter **20** with the paper pulp fluid passing through the inlet conduit **22**, such heavy debris being normally thrown against the outer circumference of the annular inlet gutter **20** by centrifugal force.

A stationary, outer or second working member **24** is fixedly carried by the walls **10***a* of the housing **10** below the baffle plate **18**. The outer working member **24** is formed of generally cylindrical configuration and longitudinally extends in a vertical direction within the working cavity. The upper longitudinal end of the outer working member **24** abuts the baffle plate **18**; the lower longitudinal end of the outer working member **24** terminates vertically above the annular rejects gutter **17**. The outer working member **24** is spaced from the walls **10***a* of the housing **10** to provide an annular cavity **26** between the walls **10***a* and the outer working member **24**. The annular cavity **26** is suitably sealed adjacent its vertically upper and lower ends to prevent commingling of paper pulp fluid therein with that in the annular inlet gutter **20** and the annular rejects gutter **17**. A primary or accepts outlet conduit **28** tangentially communicates with

the annular cavity **26** to discharge refined and screened paper pulp fluid from the housing **10**.

A rotatable inner or first working member **30**, concentric with the outer working member **24**, extends vertically within the outer working member **24**. The inner working member **30** is formed of generally cylindrical configuration and extends throughout the length of the outer working member **24**. The inner working member **30** is radially spaced from the outer working member **24** to provide a relatively narrow, annular fluid passage **32** between the inner and outer working members **30** and **24**, respectively. The annular fluid passage **32** communicates at its opposing longitudinal ends with the portion of the working cavity circumferentially enclosed by the baffle plate **18** and the annular rejects gutter **17**.

A secondary or rejects outlet conduit **34** tangentially communicates with the annular rejects gutter **17** immediately above the closure plate **16** for discharging paper pulp fluid passing to the annular rejects gutter **17** from the latter. As illustrated in FIGS. 1 and 2, the rejects outlet conduit **34** preferably is connected by a passage conduit **37** to the inlet conduit **22** to return its discharged paper pulp fluid through the inlet conduit **22** to the working cavity for further refining and screening. In the embodiment of the invention, illustrated in FIGS. 1 through 5, a fluid pump **35** is provided for urging the paper pulp fluid discharged by the rejects outlet conduit **34** through the passage conduit **37** to the inlet conduit **22**. Alternatively, however, the rejects outlet conduit **34** could be suitably connected to otherwise dispose of its discharged paper pulp fluid.

The inner working member **30** is closed at its upper end by an end cover **36** which prevents paper pulp fluid from passing internally of the inner working member **30**. The inner working member **30** is formed to include a plurality of radially extending spider arms **38**, located substantially midway between its ends, which terminate at a central hub **40**. The hub **40** is detachably connected to the threaded upper end **42** of a vertically extending driving shaft **44** by a mounting nut **46** which, as illustrated in FIG. 1, is accessible externally of the end cover **36**.

The driving shaft **44** is rotatably supported by a vertically extending bearing column **48** which contains a plurality of vertically spaced sets of ball bearings (not shown) or other suitable bearing means and has its lower end **50** extending below the bearing column **48**. The lower end **50** of the driving shaft **44** extends into the supporting base **12** and fixedly carries a driven pulley **52** within the supporting base **12**. The driving shaft **44** is rotatable by a variable speed driving motor **54** carried by the supporting base **12** through an endless driving belt **56** which extends longitudinally around the driven pulley **52** and an aligned driving pulley **58** fixedly carried by a shaft **60** rotatable by the driving motor **54**. It will be seen that, as the inner working member **30** is rotatable by the driving motor **54**, the speed of the rotation of the inner working member **30** may be readily and simply adjusted by the variance of the operating speed of the driving motor **54**.

The refining and screening processes are performed by the inner and outer working members **30** and **24**, respectively. More specifically, the inner working member **30** is formed with an imperforate annular wall **62** which carries a pulse generating means formed by a plurality of spaced surface deformations upon its outer circumference. These surface deformations may be formed in the configuration of either depressions or protrusions and are shown in this illustrated embodiment of the invention as being a plurality of spaced globular protrusions **64**. The protrusions **64** extend into the annular fluid passage **32** to create pulses in the paper pulp fluid flowing through the annular fluid passage **32** during the rotation of the inner working member **30**. The protrusions **64** are disposed throughout the outer circumference of the inner working member **30** and extend throughout the length of the annular fluid passage **32**. Similarly, if the spaced surface deformations on the outer circumference of the inner working member **30** are formed in the configuration of depressions, they would be disposed throughout the circumference of the inner working member **30** and throughout the length of the annular fluid passage **32**.

The outer working member **24** is formed to include an imperforate wall portion **66** adjacent the end of the annular fluid passage **32** communicating with the portion of the working cavity which is circumferentially enclosed by the baffle plate **18**, and a perforate wall portion **68** adjacent the end of the annular fluid passage **32** communicating with the annular rejects gutter **17**. The imperforate wall portion **66** of the outer working member **24** includes a pulse generating means formed by a plurality of spaced surface deformations on its inner circumference. These surface deformations, similar to those on the outer circumference of the inner working member **30**, may be formed in the configuration of either depressions or protrusions. These deformations, again similar to those on the inner working member **30**, are shown in this illustrated embodiment of the invention as being a plurality of spaced globular protrusions **70** which extend into the annular fluid passage **32**.

The protrusions **70** on the outer working member **24** extend throughout the length and circumference of the imperforate wall portion **66** of the outer working member **24**. The protrusions **70** cooperate with adjacent opposing ones of the protrusions **64** on the inner working member **30**, during the rotation of the latter, to alternatively compress and release the paper pulp fluid passing through the annular fluid passage **32**. That is, as the inner working member **30** rotates, the volume of the annular fluid passage **32** disposed between adjacent ones of the protrusions **70**, **64** varies to provide an alternative compressing and releasing of the paper pulp fluid passing through the annular fluid passage **32**. This alternative compressing and releasing action creates pulses which reduce the shives and slivers, or pulp flakes, in the paper pulp fluid into their component pulp fibers.

The perforate wall portion **68** of the outer working member **24** includes a plurality of spaced screening openings or apertures **72**. The screening openings **72** communicate the annular fluid passage **32** with the annular cavity **26** and screen paper pulp fluid passing through the annular fluid passage **32** after such paper pulp fluid has been refined by the adjacent opposing protrusions **70**, **64** on the outer and inner working members **24** and **30**, respectively. The protrusions **64** located on the inner working member **30** adjacent and opposing the screening openings **72** facilitate the screening action of the screening openings **72** during the rotation of the inner working member **30** by agitating the paper pulp fluid passing the screening openings **72** and homogenizing such paper pulp fluid. More specifically, the rotation of the inner working member **30** causes the protrusions **64** located adjacent the screening openings **72** to propel paper pulp fluid passing the screening openings **72** towards the latter, while achieving fluidization and homogenization of the paper pulp fluid.

Thus, the protrusions **70** on the outer working member **24** and the adjacent opposing ones of the protrusions **64** on the inner working member **30** refine the paper pulp fluid passing through the annular fluid passage **32** by breaking down the shives and slivers of pulp fibers therein to their component pulp fibers. The screening openings **72** in the outer working member **24** and the adjacent opposing ones of the protrusions **64** on the inner working member **30** cooperate to screen the refined paper pulp fluid and remove all of the paper pulp fluid which is sufficiently refined from the annular fluid passage **32** intermediate the ends thereof. The paper pulp fluid that is not sufficiently refined to be accepted by the screening openings **72** passes through the annular fluid passage **32** to the annular rejects gutter **17**. From the annular rejects gutter **17** it is directed by the rejects outlet conduit

34 and the passage conduit 37 to the inlet conduit 22 from whence it is reconducted to the annular fluid passage 32 for further refining by the cooperating protrusions 70, 64.

The operation of the embodiment of the invention illustrated in FIGS. 1 through 5 is believed to be apparent from the foregoing description. However, a brief description of the operation of this embodiment of the invention will now be given for the purposes of clarity and completeness of description. It will be assumed for the purposes of the following description that the inlet conduit 22 is suitably connected to a continuously flowing source of paper pulp fluid (not shown) and the accepts outlet conduit 28 is suitably connected to an apparatus (not shown) adapted to receive refined and screened paper pulp fluid.

In the operation of this embodiment of the invention, paper pulp fluid flowing through the inlet conduit 22 flows into the annular inlet gutter 20 and thence passes over the baffle plate 18 into the annular fluid passage 32 between the inner and outer working members 30 and 24, respectively. With the inner working member 30 rotating under the control of the driving motor 54, the paper pulp fluid is alternatively compressed and released, or pulsed, by the cooperating protrusions 64 and 70. Thus, the shives and slivers of pulp fibers in the paper pulp fluid are reduced to their component pulp fibers and the paper pulp fluid is refined.

This refined paper pulp fluid passes in the annular fluid passage 32 to a position intermediate the screening openings 72 in the outer working member 24 and the adjacent ones of the protrusions 64 on the inner working member 30. The portion of the refined paper pulp fluid which has been sufficiently refined to be accepted by the screening openings 72 passes through the screening openings 72 into the annular cavity 26 from whence it is discharged through the accepts outlet conduit 28. The portion of the refined paper pulp fluid rejected by the screening openings 72 continues through the annular fluid passage 32 into the annular rejects gutter 17 from whence it is discharged by the rejects outlet conduit 34 to the passage conduit 37 which redirects it to the inlet conduit 22 for further refining and screening. Thus, the portion of the paper pulp fluid rejected by the screening openings 72 is continuously re-refined and rescreened until it is reduced to a size which may be accepted by the screening openings 72. Due to this construction, only completely refined and screened paper pulp fluid is discharged by this embodiment of the invention. Alternatively, however, should the rejects outlet conduit 34 not be connected to a passage conduit 37 communicating with the inlet conduit 22, other suitable treatment or disposal of the rejected paper pulp fluid would be necessitated.

FIG. 6 illustrates a paper pulp fluid refining and screening apparatus which is an alternative embodiment of the present invention. This embodiment of the invention differs from that illustrated in FIGS. 1 through 5 and hereinbefore described only in its relative location of the perforate and imperforate wall portions of the outer working member. Thus, in FIG. 6 only a fragmentary portion of the inner and outer working members has been shown; and it will be understood that the remainder of the apparatus is essentially as hereinbefore described with reference to FIGS. 1 through 5.

In the embodiment of the invention illustrated in FIG. 6, the perforate wall portion 74 of the outer working member 76 is located at the end of the annular fluid passage 78 communicating with the portion of the working cavity circumferentially enclosed by the baffle plate 80. The imperforate wall portion 82 of the outer working member 76 is located adjacent the end of the annular fluid passage 78 communicating with the annular rejects gutter (not shown). Thus, paper pulp fluid passing through the annular fluid passage 78 is screened by the screening openings or apertures 84 in the imperforate wall portion 74 and the protrusions 86 on the inner working member 88 and then, subsequently, refined by the protrusions 90 on the imperfoate wall portion 82 and the protrusions 86. The refined paper pulp fluid is preferably reconveyed to the annular fluid passage 78 for further screening and refining until it is accepted by the screening openings 84.

The operation of this embodiment of the invention is believed to be apparent from the foregoing description.

From the foregoing, it will be seen that I have provided new and improved means for accomplishing all of the objects and advantages of my invention. It will be understood, however, that, although only two embodiments of my invention have been illustrated and described in detail, my invention is not limited merely to these described embodiments, but includes other embodiments and variations which utilize the concepts and teachings of my invention.

By way of specific example, and not by way of limitation, the outer working member could be rotatable by a driving motor and the inner working member maintained stationary. Furthermore, the screening openings could be provided in the inner working member, providing that an accepts outlet conduit is suitably connected to the interior of the inner working member for conveying refined and screened paper pulp fluid therefrom. Similarly, it will be seen that many other embodiments and variations can be constructed in accordance with the concepts and teachings of the beforedescribed embodiments of my invention.

Having thus described my invention, I claim:

1. An apparatus for refining and screening paper pulp fluid, comprising:
   - a first working member;
   - a second working member opposing said first working member and spaced from said first working member to provide a passage between said working members;
   - said first and second working members being relatively rotatable;
   - means for effecting relative rotation of said first and second working members;
   - pulse generating means carried by one of said working members within said passage between said working members;
   - pulse generating means carried by the other of said working members within said passage between said working members and cooperating with said pulse generating means carried by said one of said working members during relative rotation of said working members to create pulses for refining paper pulp fluid passing through said passage;
   - screening means communicating with said passage between said working members for screening paper pulp fluid passing therethrough;
   - inlet means communicating with said passage between said working members for supplying paper pulp fluid to said passage;
   - accepts outlet means communicating with said screening means for discharging paper pulp fluid accepted by said screening means from said screening means; and
   - rejects outlet means communicating with said passage between said working members for discharging paper pulp fluid rejected by said screening means from said passage.

2. A paper pulp fluid refining and screening apparatus according to claim 1, wherein said inlet means and said rejects outlet means communicate with said passage adjacent opposing ends thereof, and said screening means forms a wall of said passage.

3. A paper pulp fluid refining and screening apparatus according to claim 2, wherein a fluid passage means communicates said rejects outlet means with said inlet means to return paper pulp fluid discharged through said rejects outlet means to said inlet means.

4. A paper pulp fluid refining and screening apparatus

according to claim 2, wherein said other of said working members includes an imperforate portion and a perforate portion, said pulse generating means carried by said other of said working members is carried by the imperforate portion thereof, and the perforate portion of said other of said working members forms said screening means.

5. A paper pulp fluid refining and screening apparatus according to claim 4, wherein said pulse generating means carried by said one of said working members extends throughout the combined lengths of said imperforate and perforate portions of said other of said working members.

6. A paper pulp refining and screening apparatus according to claim 4, wherein said imperforate portion of said other of said working members is located adjacent said inlet means, and said perforate portion thereof is located remote from said inlet means.

7. A paper pulp refining and screening apparatus according to claim 4, wherein said perforate portion of said other of said working members is located adjacent said inlet means, and said imperforate portion thereof is located remote from said inlet means.

8. An apparatus for refining and screening paper pulp fluid, comprising:

an inner working member;

an outer working member disposed circumferentially around said inner working member and spaced from said inner working member to provide an annular passage between said working members;

said inner and outer working members being relatively rotatable;

means for effecting relative rotation of said inner and outer working members;

a plurality of spaced surface deformations disposed upon one of said inner and outer working members within said annular passage;

a plurality of spaced surface deformations disposed upon the other of said inner and outer working members within said annular passage and cooperating with said surface deformations upon said one of said working members during relative rotation of said working members to create shock pulses for refining paper pulp fluid passing through said annular passage;

said other of said working members including a plurality of screening apertures communicating with said annular passage intermediate the ends thereof for screening paper pulp fluid passing through said passage;

inlet means communicating with said annular passage on one side of said surface deformations and screening apertures on said other of said working members for supplying paper pulp fluid to said annular passage;

accepts outlet means communicating with said screening apertures for discharging paper pulp fluid accepted by said screening apertures from said screening apertures; and

rejects outlet means communicating with said annular passage on the opposing side of said surface deformations and screening apertures on said other of said working members from said inlet means for discharging paper pulp fluid rejected by said screening apertures from said annular passage.

9. A paper pulp fluid refining and screening apparatus according to claim 8, wherein a fluid passage means communicates said rejects outlet means with said inlet means for returning paper pulp fluid passing through said rejects outlet means to said inlet means.

10. A paper pulp fluid refining and screening apparatus according to claim 8, wherein said surface deformations carried by said one of said working members are disposed upon such throughout the combined lengths of said surface deformations and screening apertures on said other of said working members.

11. A paper pulp fluid refining and screening apparatus according to claim 8, wherein said other of said working members includes an imperforate portion adjacent said inlet means and a perforate portion remote from said inlet means, said surface deformations carried by said other of said working members are carried by said imperforate portion thereof, and said perforate portion of said other of said working members contains said screening apertures.

12. A paper pulp fluid refining and screening apparatus according to claim 8, wherein said other of said working members includes a perforate portion adjacent said inlet means and an imperforate portion remote from said inlet means, said surface deformations carried by said other of said working members are carried by said imperforate portion thereof, and said perforate portion of said other of said working members contains said screening apertures.

13. An apaparatus for refining and screening paper pulp fluid, comprising:

a rotatable inner annular working member;

an outer annular working member disposed circumferentially around said inner working member and spaced from said inner working member such that said inner and outer working members form opposing side walls of an annular passage which extends longitudinally between said working members;

means operatively connected to said inner working member for rotating said inner working member relative to said outer working member;

said outer working member including a first portion adjacent one of the ends of said annular passage and a second portion remote from said one end of said annular passage;

a plurality of spaced surface deformations carried by said inner working member in said annular passage throughout the length of said first and second portions of said outer working member;

a plurality of spaced surface deformations carried by said first portion of said outer working member within said annular passage and cooperating with said surface deformations upon said inner working member during rotation of said inner working member to create shock pulses for refining paper pulp fluid passing through said annular passage;

said second portion of said outer working member including a plurality of screening apertures communicating with said annular passage intermediate the ends thereof for screening paper pulp fluid passing through said annular passage;

inlet means communicating with said one of said ends of said annular passage for supplying paper pulp fluid thereto;

accepts outlet means communicating with said screening apertures in said outer working member for discharging paper pulp fluid accepted by said screening apertures from said screening apertures; and

rejects outlet means communicating with the end of said annular passage opposite to said one end thereof for discharging paper pulp fluid rejected by said screening apertures from said passage.

14. A paper pulp fluid refining and screening apparatus according to claim 13, wherein said first portion of said outer working member is imperforate.

15. A paper pulp fluid refining and screening apparatus according to claim 14, wherein a fluid passage means communicates said rejects outlet means with said inlet means for returning paper pulp fluid discharged by said rejects outlet means to said inlet means.

16. An apparatus for refining and screening paper pulp fluid, comprising:

a rotatable inner annular working member;

an outer annular working member disposed circumferentially around said inner working member and spaced from said inner working member such that said inner and outer working members form oppos-

ing side walls of an annular passage which extends longitudinally between said working members;

means operatively connected to said inner working member for rotating said inner working member relative to said outer working member;

said outer working member including a first portion adjacent one of the ends of said annular passage and a second portion remote from said one end of said annular passage;

a plurality of spaced surface deformations carried by said inner working member in said annular passage throughout the length of said first and second portions of said outer working member;

a plurality of spaced surface deformations carried by said second portion of said outer working member within said annular passage and cooperating with said surface deformations upon said inner working member during rotation of said inner working member to create shock pulses for refining paper pulp fluid passing through said annular passage;

said first portion of said outer working member including a plurality of screening apertures communicating with said annular passage intermediate the ends thereof for screening paper pulp fluid passing through said annular passage;

inlet means communicating with said one of said ends of said annular passage for supplying paper pulp fluid thereto;

accepts outlet means communicating with said screening apertures in said outer working member for discharging paper pulp fluid accepted by said screening apertures from said screening apertures; and

rejects outlet means communicating with the end of said annular passage opposite to said one thereof for discharging paper pulp fluid rejected by said screening apertures from said passage.

17. A paper pulp fluid refining and screening apparatus according to claim **16**, wherein said second portion of said outer working member is imperforate.

18. A paper pulp fluid refining and screening apparatus according to claim **17**, wherein a fluid passage means communicates said rejects outlet means with said inlet means for returning paper pulp fluid discharged by said rejects outlet means to said inlet means.

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