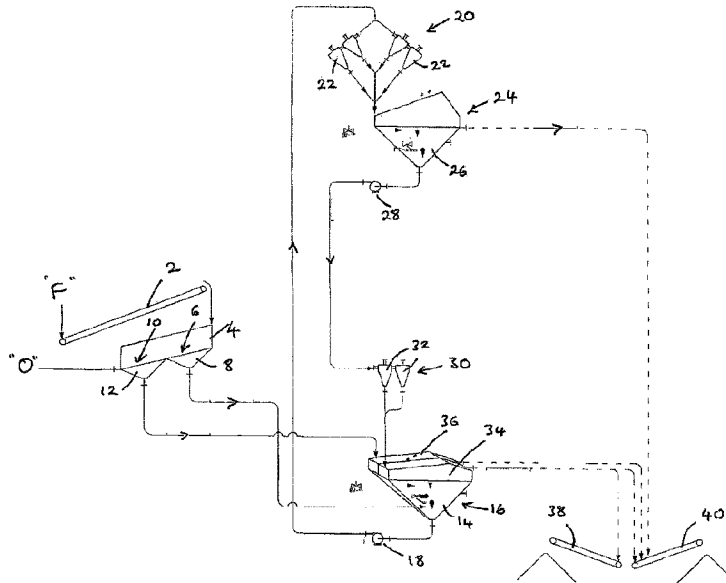




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(54) Titre : METHODE ET APPAREIL POUR NETTOYER ET CLASSER LE SABLE
(54) Title: METHOD AND APPARATUS FOR WASHING AND GRADING SAND



(57) **Abrégé/Abstract:**

A method and apparatus for washing and grading sand comprising a first grading screen adapted to separate a feed material into a fine fraction and a coarse fraction, said coarse fraction having a greater particle size than said fine fraction, a first fines separation stage, comprising one or more hydrocyclones, adapted to receive said fine fraction entrained in water, downstream of said first grading screen to thereby remove fine contaminants, a first dewatering screen having a deck adapted to dewater said fine fraction downstream of said first fines separation stage to provide a fine sand product, and a second dewatering screen having a deck adapted to dewater said coarse fraction downstream of said first grading screen to provide a coarse sand product.

ABSTRACT

A method and apparatus for washing and grading sand comprising a first grading screen adapted to separate a feed material into a fine fraction and a coarse fraction, 5 said coarse fraction having a greater particle size than said fine fraction, a first fines separation stage, comprising one or more hydrocyclones, adapted to receive said fine fraction entrained in water, downstream of said first grading screen to thereby remove fine contaminants, a first dewatering screen having a deck adapted to dewater said fine fraction downstream of said first fines separation stage to provide 10 a fine sand product, and a second dewatering screen having a deck adapted to dewater said coarse fraction downstream of said first grading screen to provide a coarse sand product.

Method and Apparatus for Washing and Grading Sand

FIELD OF THE INVENTION

- 5 This invention relates to a method and apparatus for washing and grading sand and in particular to a method and apparatus for washing and grading coarse sand for use in the manufacture of concrete.

BACKGROUND OF THE INVENTION

10

Aggregate is a broad category of coarse particulate material used in construction, such term encompassing sand, gravel and crushed stone. The term "sand" typically covers aggregate having a grain sand of between 0.075mm and 4.75mm while the term "gravel" typically covers aggregate having a grain size of between 4.75mm and 15 76.2mm. Aggregates, in particular sands, are typically washed and graded on a combination of vibrating screens, to grade and dewater material, and hydrocyclones, to remove fine contaminants, to produce washed aggregate products having a predetermined grain size or range of grain size.

- 20 A typical vibrating screen comprises a frame, defined by a pair of substantially parallel side walls interconnected by transversely extending bridging members, upon which is mounted a polyurethane deck having small openings or slots for water and undersize particles to pass through. The frame is typically mounted on a base via resilient linkages and the frame, and thus the deck, is typically vibrated by 25 means of a pair of counter rotating rotors defining eccentric masses, driven by one or more drive motors, to impart circular or reciprocating vibrating motion to the deck. Such screens can be used for washing and grading and/or dewatering aggregate, oversize material passing over the deck of the screen to be collected from a downstream end of the screen while water and undersize material is collected in a 30 sump of the screen for subsequent processing.

A hydrocyclone is a device used to separate particles in a liquid suspension based on the ratio of their centripetal force to fluid resistance, facilitating the separation and removal of fine contamination from aggregates, sand in particular. A

hydrocyclone typically comprises a cylindrical section having an inlet for supplying a feed slurry into the hydrocyclone tangentially, and a conical base. Outlets are provided at upper and lower ends of the hydrocyclone. Underflow, containing the coarser fraction (typically a sand product), passes out of the lower outlet while
5 overflow, containing the finer fraction (typically fine contaminants, such as clay and silt) and most of the water, passes out of the outlet at the upper end of the hydrocyclone.

A coarser specification of sand is required to manufacture concrete in the US
10 market when compared to that normally required for the European market. The American Society for Testing and Materials (ASTM) specifies a specific grade of sand for use in concrete products. This specification is referred to as C33. This coarse sand is typically in the grain size range of 2mm to 8mm. The larger particle size of the C33 sand compared to the sand products typically used for concrete
15 production in Europe exacerbates wear with regards to hydrocyclones used to classify the sand and remove silt, increasing downtime and maintenance costs for the customer. In the US, sand having a grain size less than 2mm is typically used as masonry sand rather than for concrete production.

20 SUMMARY OF THE INVENTION

According to a first aspect of the present invention there is provided a method of washing and grading sand comprising the steps of separating a feed material into a fine fraction and a coarse fraction, said coarse fraction having a greater particle size
25 than said fine fraction, passing said fine fraction entrained in water to a first fines separation stage, comprising one or more hydrocyclones, to thereby remove fine contaminants therefrom before passing said fine fraction, carried in the under flow from said one or more hydrocyclones, to a first dewatering screen to be dewatered thereon and collected as a fine sand product, and passing said coarse fraction to a
30 second dewatering screen to be dewatered thereon and collected as a coarse sand product.

Preferably at least a portion of said fine fraction downstream of said first dewatering screen is added to the coarse sand product. At least a portion of said fine fraction downstream of said first dewatering screen may be collected as a fine sand product.

- 5 Preferably said feed material is separated into said fine fraction and said coarse fraction on a first grading screen. In one embodiment said first grading screen may comprise an inclined deck comprising a first deck portion having apertures of a first size through which said fine fraction of the feed material, entrained in water, passes to be collected in a first sump region and a second deck portion, downstream of
10 said first deck portion, through which said coarse fraction of the feed material, entrained in water, passes to be collected in a second sump region, wherein oversize waste material passes over said first and second deck portions and is discharged from a distal end of the deck of said first grading screen.
- 15 The fine fraction may be passed through a further dewatering screen downstream of said first fines separation stage, said further dewatering screen having a deck with an aperture size selected such that the fine fraction passes through said deck and is collected in a sump of said further dewatering screen. Preferably oversize material passing over the deck of said further dewatering screen is added to said coarse
20 sand product. Undersize material collected in the sump of the further dewatering screen, comprising said fine fraction, may be passed, entrained in water, through a second fines separation stage, comprising one or more further hydrocyclones, before being passed onto said first dewatering screen.
- 25 In a preferred embodiment said first and second dewatering screens may comprise first and second sides of a laterally divided split deck dewatering screen. Said fine fraction of the feed material may be supplied to a sump of the split deck dewatering screen before being pumped, entrained in water, to said first fines separation stage. A portion of said fine fraction from said first side of the split deck watering screen
30 may be added to said coarse sand product downstream of said split deck dewatering screen. Said fine and coarse fractions may be delivered from the respective first and second sides of said split deck dewatering screen onto a conveyor assembly comprising first and second conveyors being mounted adjacent said split deck dewatering screen for receiving material from a discharge end of

respective sides thereof, said conveyor assembly being displaced along an axis extending transverse to the deck of the split deck dewatering screen to vary the proportion of material falling from each of said first and second sides of the split deck dewatering screen onto each of said first and second conveyors to thereby vary the amount of said fine fraction added to said coarse fraction to form said coarse sand product. The first conveyor may collect a fine sand product from said first side of the split deck dewatering screen.

In one embodiment said fine fraction may comprise sand having a particle size up to approximately 2 mm and said coarse fraction may comprise sand having a particle size greater than approximately 2 mm.

According to a further aspect of the present invention there is provided an apparatus for washing and grading sand comprising a first grading screen adapted to separate a feed material into a fine fraction and a coarse fraction, said coarse fraction having a greater particle size than said fine fraction, a first fines separation stage, comprising one or more hydrocyclones, adapted to receive said fine fraction entrained in water, downstream of said first grading screen to thereby remove fine contaminants, a first dewatering screen having a deck adapted to dewater said fine fraction downstream of said first fines separation stage to provide a fine sand product, and a second dewatering screen having a deck adapted to dewater said coarse fraction downstream of said first grading screen to provide a coarse sand product.

In one embodiment said first grading screen may comprise an inclined deck comprising a first deck portion having apertures of a first size through which said fine fraction of the feed material, entrained in water, can pass to be collected in a first sump region and a second deck portion, downstream of said first deck portion, through which said coarse fraction of the feed material, entrained in water, can pass to be collected in a second sump region, wherein oversize waste material can pass over said first and second deck portions to be discharged from a distal end of the deck of said first grading screen.

The apparatus may further comprising a further dewatering screen downstream of said first fines separation stage, said further dewatering screen having a deck with an aperture size selected such that the fine fraction passes through said deck to be collected in a sump therebeneath, wherein oversize material passing over the deck of said further dewatering screen is added to said coarse sand product. The sump of the further dewatering screen may include or be associated with a pump adapted to pump the fine fraction, entrained in water, to a second fines separation stage, comprising one or more further hydrocyclones, upstream of said first dewatering screen.

10

In a preferred embodiment said first and second dewatering screens comprise first and second sides of a laterally divided split deck dewatering screen. The fine fraction of the feed material may be supplied to a sump of the split deck dewatering screen, said sump including or being associated with a pump adapted to pump said fine fraction, entrained in water, to said first fines separation stage. Preferably said fine and coarse fractions are delivered from the respective first and second sides of said split deck dewatering screen onto a conveyor assembly comprising first and second conveyors mounted adjacent said split deck dewatering screen to receive material from a discharge end of respective sides thereof, said conveyor assembly being displaceable along an axis extending transverse to the deck of the split deck dewatering screen to vary the proportion of material falling from each of said first and second sides of the split deck dewatering screen onto each of said first and second conveyors to thereby vary the amount of said fine fraction added to said coarse fraction to form said coarse sand product. The first conveyor may be adapted to collect a fine sand product from said first side of the split deck dewatering screen.

The water and fine contamination overflowing from the upper ends of the hydrocyclones of the or each fines separation stages may be passed to a water treatment system to be treated and subsequently reused in the grading and/or dewatering screens. The water treatment system may comprise a settling tank wherein sludge is collected in a lower end of said settling tank for subsequent removal, treatment and disposal, water overflowing from the settling tank being collected in a water storage reservoir for subsequent reuse. The water treatment

system may include a mixing and dosing apparatus adapted to add a flocculent to the waste water upstream of the settling tank.

BRIEF DESCRIPTION OF THE DRAWINGS

5

Figure 1 is a schematic illustration of an apparatus for washing and grading sand in accordance with an embodiment of the present invention;

Figure 2 is a schematic illustration of the sand washing and grading system of
10 Figure 1 with the addition of such a water treatment and recycling system;

Figure 3 is a perspective view of the first grading screen of the apparatus of Figure 1; and

15 Figure 4 is a perspective view of the remainder of the apparatus of Figure 1.

DETAILED DESCRIPTION OF THE DRAWINGS

An apparatus for washing and grading sand in accordance with an embodiment of
20 the present invention, with particular application to the production of C33 grade coarse sand, is illustrated schematically in Figures 1 and 2. Figures 3 and 4 comprise perspective views of the actual apparatus.

A feed material "F" is delivered from a feed conveyor or pump 2 onto an upper end
25 of an inclined deck of a first grading screen 4 adapted to separate the feed material, to which water is added, into a fine fraction and a coarse fraction. In the embodiment shown, the deck of the first grading screen 4 preferably comprises a first or upper deck portion 6 having apertures of a first size through which the fine fraction of the feed material, for example 0 mm to 2 mm particle size, can pass to be
30 collected in a first sump region 8 beneath said first deck portion 6, and a second or lower deck portion 10, downstream of said first deck portion 6, through which the coarse fraction of the feed material, for example 2 mm to 8 mm particle size, can pass to be collected in a second sump region 12. Oversize waste material "O" can pass over said first and second deck portions 6, 10 of the first grading screen to be

discharged from a distal end of the deck of said first grading screen for collection and further treatment and/or disposal.

The fine fraction collected in the first sump region 8 of the first grading screen 4 and
5 entrained in water, is pumped to a sump 14 of a split deck dewatering screen 16 (or
may flow under gravity to the sump 14) before being pumped, via a first slurry pump
18, to a first fines separation stage 20, comprising a plurality of hydrocyclones 22
arranged in parallel.

10 An underflow from the first fines separation stage 20, comprising the fine fraction
from which some or all of fine contamination has been removed, is passed onto the
deck of a primary dewatering screen 24 adapted to separate and dewater further
coarse material from the fine fraction. For example, the deck of the primary
dewatering screen may have an aperture size of 0.8mm such that the fine fraction,
15 comprising 0 mm to 0.8mm sand, may pass through the deck while coarser material
(typically 0.8 mm to 2 mm sand) is dewatered and passes over the deck. Such
oversize coarse material is preferably added to the coarse fraction to define a
coarse sand product, as will be described below. The undersize material,
comprising the remainder of the fine fraction and water, is collected in a sump 26 of
20 the primary dewatering screen 24 and is pumped, via a second slurry pump 28, to a
second fines separation stage 30, comprising further one or more further
hydrocyclones 32, for the removal of any remaining fine contamination from the fine
fraction of the feed material. In the embodiment described above the deck of the
primary dewatering screen 24 may have an aperture of approximately 0.8 mm,
25 although this may be varied as required.

An underflow of the second fines separation stage 30, comprising the cleaned fine
fraction (or example 0 mm to 0.8 mm sand), is passed onto a first side 34 of the split
deck dewatering screen 16.

30

The coarse fraction from the second sump region 12 of the first grading screen 4 is
passed onto a second side 36 of the split deck dewatering screen 16.

A fine sand product, for example having a particle size of 0 mm to 0.8 mm, is delivered from the first side 34 of the split deck dewatering screen 16 onto a first conveyor 38. Such fine sand product may be supplied to customers as masonry sand.

5

A coarse sand product, for example having a particle size of between 0.8 mm and 8 mm, is delivered from the second side 36 of the split deck dewatering screen 16 onto a second conveyor 40. Oversize material from the primary dewatering screen 24 is preferably also added to the coarse sand product on the second conveyor 40.

10

In a preferred embodiment, a portion of the fine fraction from the first side 34 of the split deck dewatering screen 16 may be added to the second conveyor 40 to be blended with the coarse sand product, as required. This may be achieved by mounting the first and second conveyors 38,40, or at least a feed mechanism thereof, to be displaceable along an axis extending transverse to the deck of the split deck dewatering screen 16 to vary the proportion of material falling from each of said first and second sides 34,36 of the split deck dewatering screen 16 onto each of said first and second conveyors 38,40 to thereby vary the amount of said fine fraction added to said coarse fraction to form said coarse sand product.

20

The underflow that is washed through the deck apertures of the primary dewatering screen 24 is pumped through the second fines separation stage and discharged onto the first side 34 of the split deck dewatering screen 16 to produce a fine masonry sand. This masonry sand is then collected by the first conveyor 38 and stockpiled.

25

The two conveyors 38,40 can be moved in relation to the two sides 34,36 of the split deck dewatering screen 16, allowing for fine masonry sand to be blended back into the C33 coarse concrete sand if the specification allows, helping to increase the amount of valuable product produced.

30

Water and fine contamination overflowing from the upper ends of the hydrocyclones 22,32 of the first and second fines separation stages 20,30 may be passed to a water treatment system, preferably comprising a settling tank wherein sludge is

collected in a lower end of said settling tank for subsequent removal, treatment and disposal, water overflowing from the settling tank being collected in a water storage reservoir and delivering water from said storage reservoir to be supplied to one or more of the first grading screen 4, primary dewatering screen 24 and split deck
5 dewatering screen 16 (in particular to control the water content in the sump 14 thereof). The waste water may be dosed with a flocculent before being added to the settling tank.

Figure 2 illustrates the combination of the sand washing and grading system of
10 Figure 1 with the addition of such a water treatment and recycling system. As discussed above, the overflow from the hydrocyclones 22,32 of the first and second fines separation stages 20,30 may be passed into a settling tank 50. A suitable flocculent may be added to waste water upstream of the settling tank 50 to facilitate the settling out of the sludge from the water via a mixing and dosing apparatus 60
15 upstream of the settling tank 50. Figure 4 illustrates the water treatment and recycling system in more detail.

Sludge collected in the bottom of the settling tank 50 may be pumped for treatment and/or disposal, for example to a sludge pond, via a suitable pump 52, while water
20 overflowing from the settling tank 50 is collected in a water storage reservoir 54, from which it may be recycled for use in the washing and grading processes.

A controller may be provided for controlling the addition of water to the water storage reservoir 54 from a separate water supply to maintain the water level within
25 the water storage reservoir 54, if required.

In a preferred embodiment the water storage reservoir 54 is arranged around the periphery of the settling tank 50. The settling tank 50 may have a double skinned outer wall such that the water storage reservoir 54 is defined between said double
30 skins of the outer wall of the settling tank 50.

Note that the deck aperture sizes and sand particle sizes of the respective fine and coarse sand products quoted above can vary from project to project and the sizes quoted are used as an example only.

Main benefits of the above described embodiments of the present invention:

5 Only smaller material (for example 0 mm to 2 mm in the case of the first fines separation stage and 0 mm to 0.8 mm in the case of the second fines separation stage) is pumped through the hydrocyclones 22,32 of the first and second fines separation stages 24,30 and associated slurry pumps 18,28, reducing component wear, plant downtime, and hence cost of production for the customer.

10 The arrangement of the split deck dewatering screen 16 and first and second conveyors 38,40 facilitates adjustment and blending of the sand specification being produced.

The invention is not limited to the embodiments described herein but can be
15 amended or modified without departing from the scope of the present invention as defined by the appended claims.

CLAIMS

1. A method of washing and grading sand comprising:

5 separating a feed material on a first grading screen into a fine fraction and a coarse fraction, said coarse fraction having a particle size that is greater than said fine fraction, the first grading screen comprising:

an inclined deck comprising a first deck portion having apertures of a first size through which the fine fraction of the feed material, entrained in water, passes to be collected in a first sump region; and

10 a second deck portion, downstream of the first deck portion, through which the coarse fraction of the feed material, entrained in water, passes to be collected in a second sump region;

passing said fine fraction entrained in water to a first fines separation stage, comprising one or more hydrocyclones, to thereby remove fine contaminants therefrom before passing said fine fraction, carried in the under flow from said one or more hydrocyclones, to a first dewatering screen to be dewatered thereon and collected as said fine fraction;

passing said coarse fraction to a second dewatering screen to be dewatered thereon and collected as a coarse sand product;

20 passing oversize waste material over the first and second deck portions and discharging the oversize waste material from a distal end of the second deck portion of the first grading screen; and

adding a portion of the fine fraction downstream of the first dewatering screen to the coarse sand product.

25

2. The method as claimed in claim 1, further comprising the steps of:

i) passing said fine fraction through a further dewatering screen downstream of said first fines separation stage, said further dewatering screen having a deck with an aperture size selected to separate further coarse material from the fine fraction;

ii) passing a remaining fine fraction through said deck; and

iii) collecting said remaining fine fraction in a sump of said further dewatering screen.

3. The method as claimed in claim 2, further comprising adding coarse material that passes over the deck of said further dewatering screen to said coarse sand product.

4. The method as claimed in claim 2 or claim 3, further comprising:

5 collecting undersize material in the sump of the further dewatering screen, said undersize material comprising said fine fraction; and

passing said undersize material entrained in water, through a second fines separation stage, comprising one or more further hydrocyclones, before passing said undersize material onto said first dewatering screen.

10

5. The method as claimed in any one of claims 1 to 4, wherein said first and second dewatering screens comprise first and second sides of a laterally divided split deck dewatering screen.

15 6. The method as claimed in claim 1, wherein said first and second dewatering screens comprise first and second sides of a laterally divided split deck dewatering screen, the method further comprising supplying said fine fraction of the feed material to a sump of the split deck dewatering screen, and pumping said fine fraction of the feed material, entrained in water, to said first fines separation stage.

20

7. The method as claimed in claim 6, further comprising delivering said fine and coarse fractions from the respective first and second sides of said split deck dewatering screen onto a conveyor assembly comprising first and second conveyors being mounted adjacent said split deck dewatering screen for receiving
25 material from a discharge end of respective sides thereof, said conveyor assembly being displaced along an axis extending transverse to the deck of the split deck dewatering screen to vary a proportion of material falling from each of said first and second sides of the split deck dewatering screen onto each of said first and second conveyors to thereby vary an amount of said fine fraction added to said coarse
30 fraction to form said coarse sand product.

8. The method as claimed in claim 7, further comprising collecting a fine sand product from said first side of the split deck dewatering screen onto the first conveyor.

9. The method as claimed in any one of claims 1 to 8, wherein the first grading screen is adapted such that said fine fraction produced therefrom has a particle size of up to 2mm, said coarse fraction having a particle size greater than 2mm.

5

10. An apparatus for washing and grading sand, said apparatus comprising:

a first grading screen adapted to separate a feed material into a fine fraction and a coarse fraction, said coarse fraction having a greater particle size than said fine fraction, said first grading screen having an inclined deck comprising:

10 a first deck portion having apertures of a first size through which said fine fraction of said feed material, entrained in water, can pass to be collected in a first sump region; and

a second deck portion, downstream of said first deck portion, through which said coarse fraction of said feed material, entrained in water, can pass to be collected in a second sump region;

15 wherein oversize waste material can pass over said first and second deck portions to be discharged from a distal end of said first grading screen;

a first fines separation stage comprising one or more hydrocyclones, adapted to receive said fine fraction entrained in water, downstream of said first grading screen, to thereby remove fine contaminants;

20 a first dewatering screen having a third deck adapted to dewater said fine fraction downstream of said first fines separation stage to provide a fine sand product; and

25 a second dewatering screen having a fourth deck adapted to dewater said coarse fraction downstream of said first grading screen to provide a coarse sand product.

11. The apparatus as claimed in claim 10, further comprising a further dewatering screen downstream of said first fines separation stage, said further dewatering screen having a fifth deck with an aperture size selected to separate further coarse material from the fine fraction, said further coarse material passing over said fifth deck of said further dewatering screen to be subsequently added to said coarse sand product.

12. The apparatus as claimed in claim 11, wherein a sump of the further dewatering screen includes or is associated with a first pump adapted to pump the fine fraction, entrained in water, to a second fines separation stage, comprising one or more further hydrocyclones, upstream of said first dewatering screen.

5

13. The apparatus as claimed in any one of claims 10 to 12, wherein said first and second dewatering screens comprise first and second sides of a laterally divided split deck dewatering screen.

10 14. The apparatus as claimed in claim 10, wherein said first and second dewatering screens comprise first and second sides of a laterally divided split deck dewatering screen and wherein said fine fraction of the feed material is supplied to a sump of the split deck dewatering screen, said sump including or being associated with a second pump adapted to pump said fine fraction, entrained in water, to said first
15 fines separation stage.

15. The apparatus as claimed in claim 13 or claim 14, wherein said fine and coarse fractions are delivered from the respective first and second sides of said split deck dewatering screen onto a conveyor assembly comprising first and second
20 conveyors mounted adjacent said split deck dewatering screen to receive material from a discharge end of respective sides thereof, said conveyor assembly being displaceable along an axis extending transverse to the deck of the split deck dewatering screen to vary a proportion of material falling from each of said first and second sides of the split deck dewatering screen onto each of said first and second
25 conveyors to thereby vary an amount of said fine fraction added to said coarse fraction to form said coarse sand product.

16. The apparatus as claimed in claim 15, wherein said first conveyor is adapted to collect a fine sand product from said first side of the split deck dewatering screen.

30

17. The apparatus as claimed in any one of claims 10 to 16, wherein water and fine contamination overflowing from an upper end of the hydrocyclones of said first fines separation stage is passed to a water treatment system to be treated and subsequently reused in said first grading screen; said first dewatering screen; said

second dewatering screen; said first grading screen and said first dewatering screen; or said first grading screen and said second dewatering screen.

18. The apparatus as claimed in claim 17, wherein said water treatment system
5 comprises a settling tank wherein sludge is collected in a lower end of said settling tank for subsequent removal, treatment and disposal, and water overflowing from said settling tank is collected in a water storage reservoir for subsequent reuse.

19. The apparatus as claimed in claim 18, further comprising a mixing and dosing
10 apparatus adapted to add a flocculent to the waste water upstream of the settling tank.

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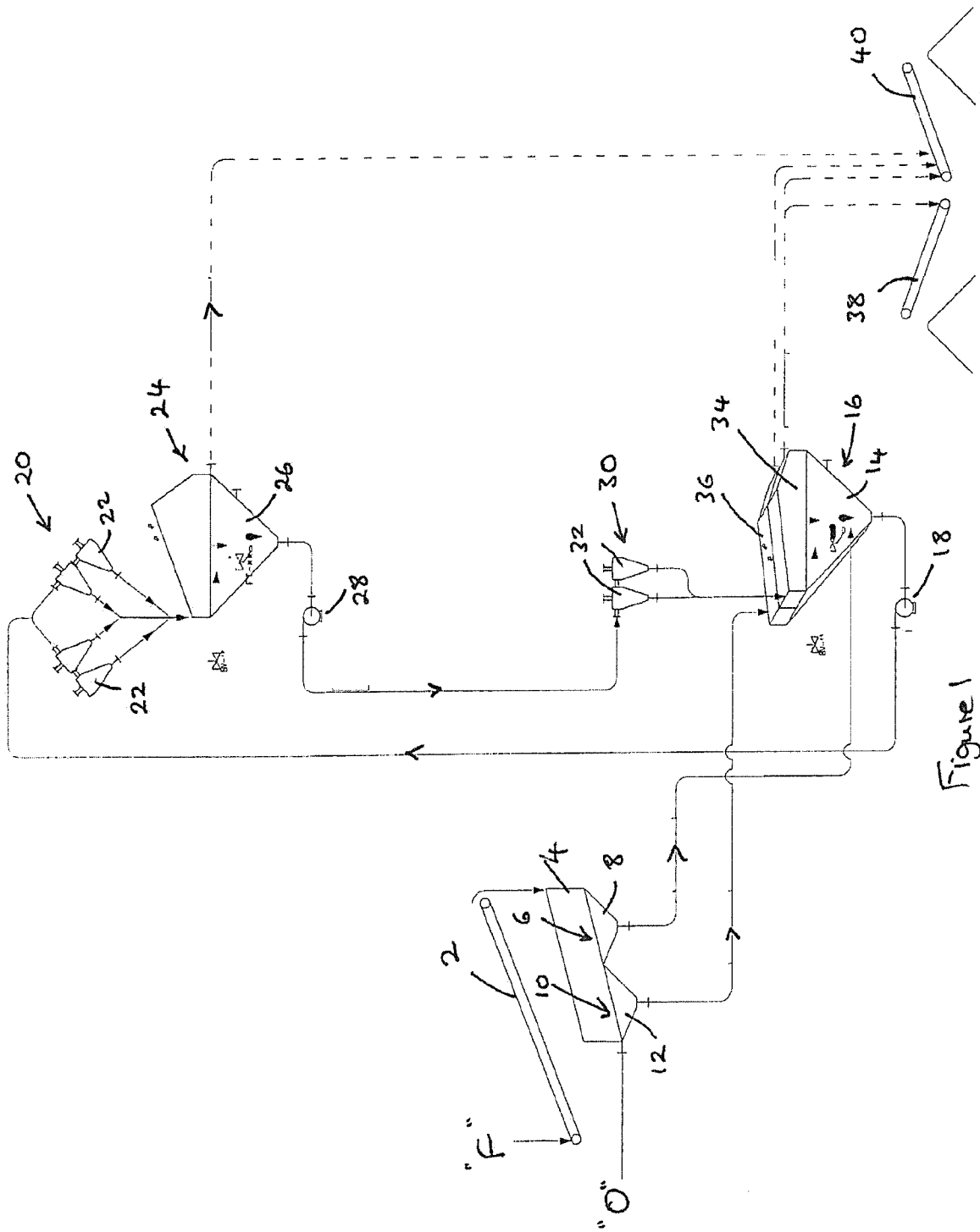
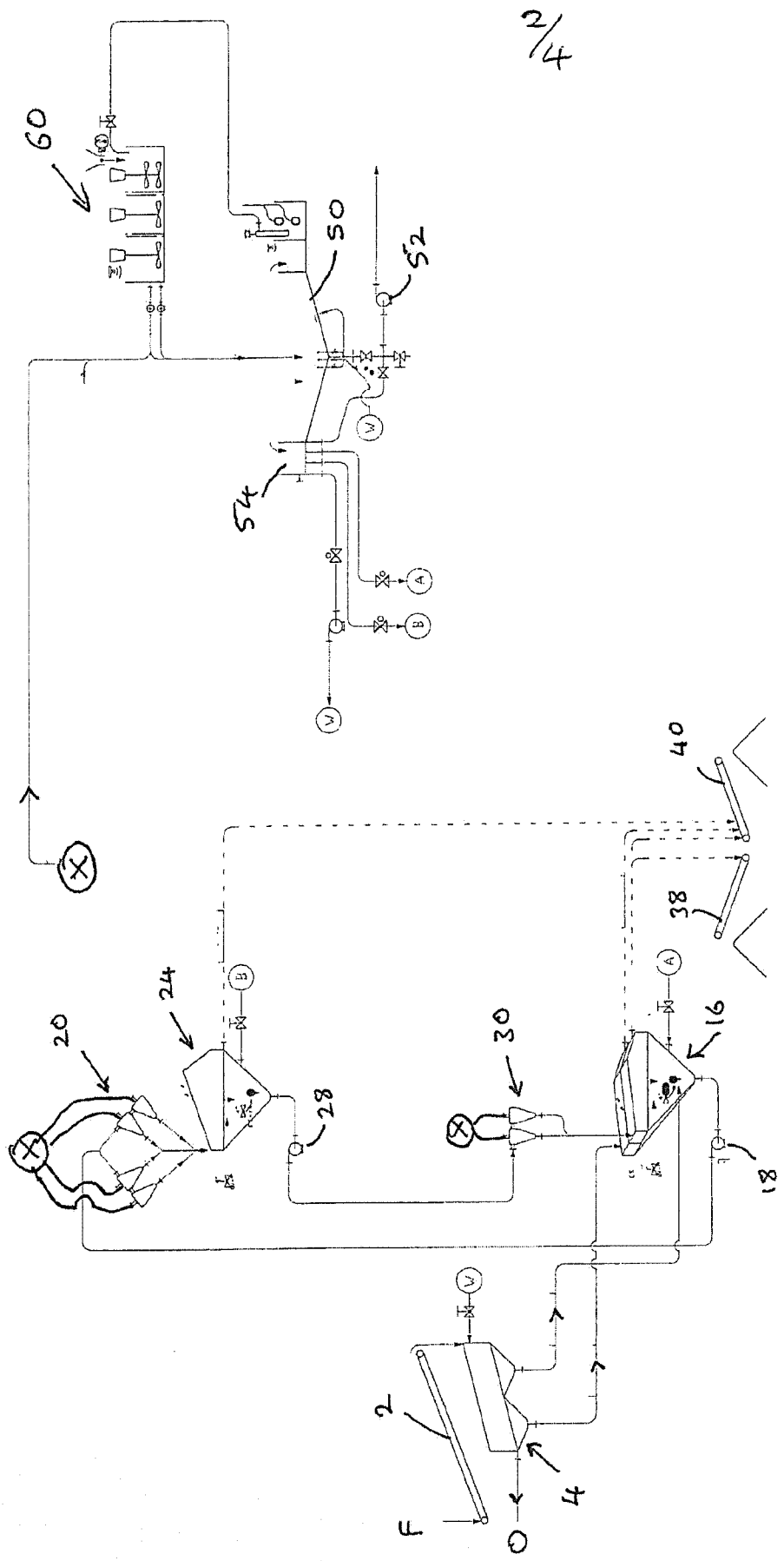


Figure 1



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Figure 2

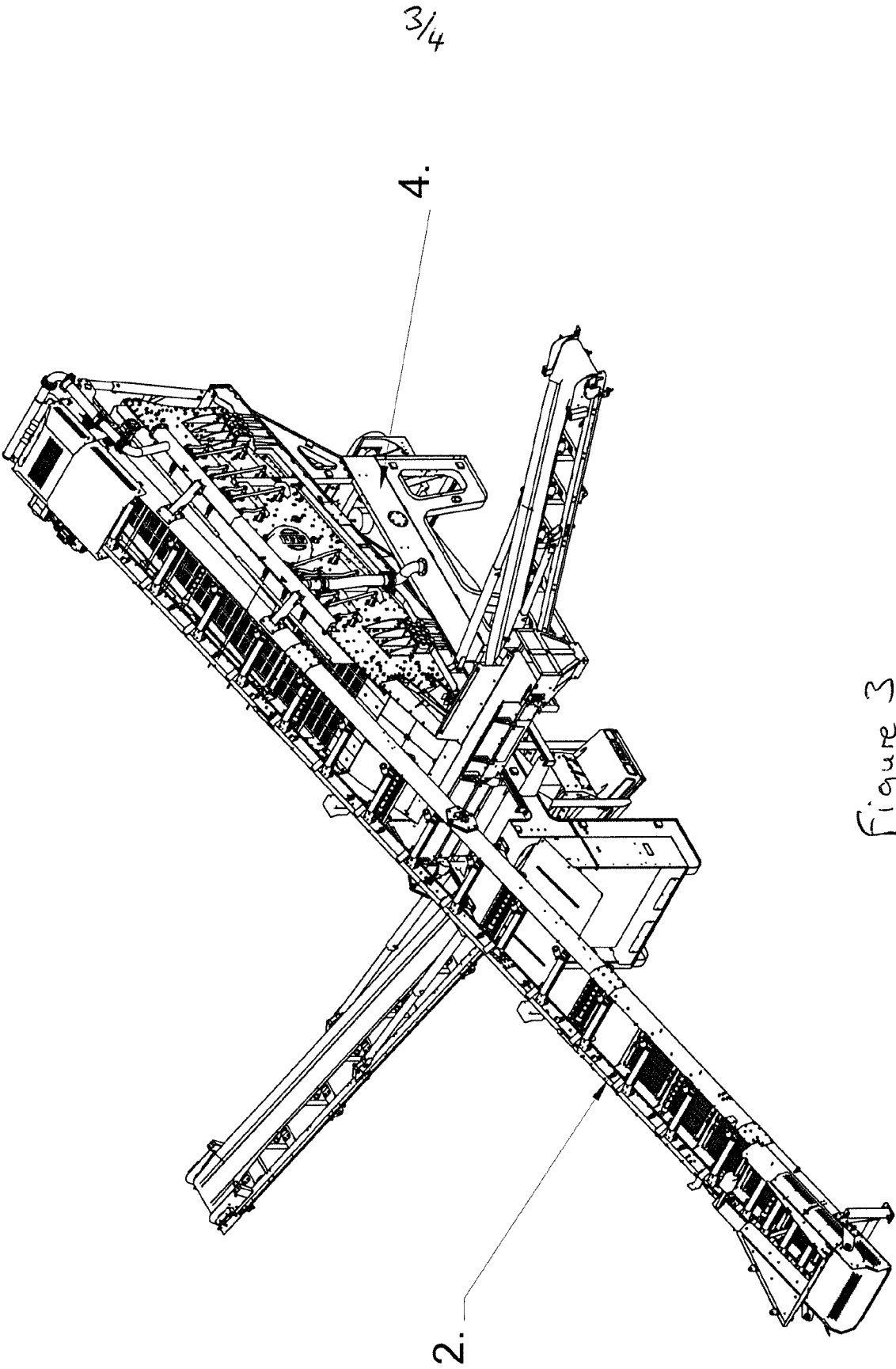


Figure 3

