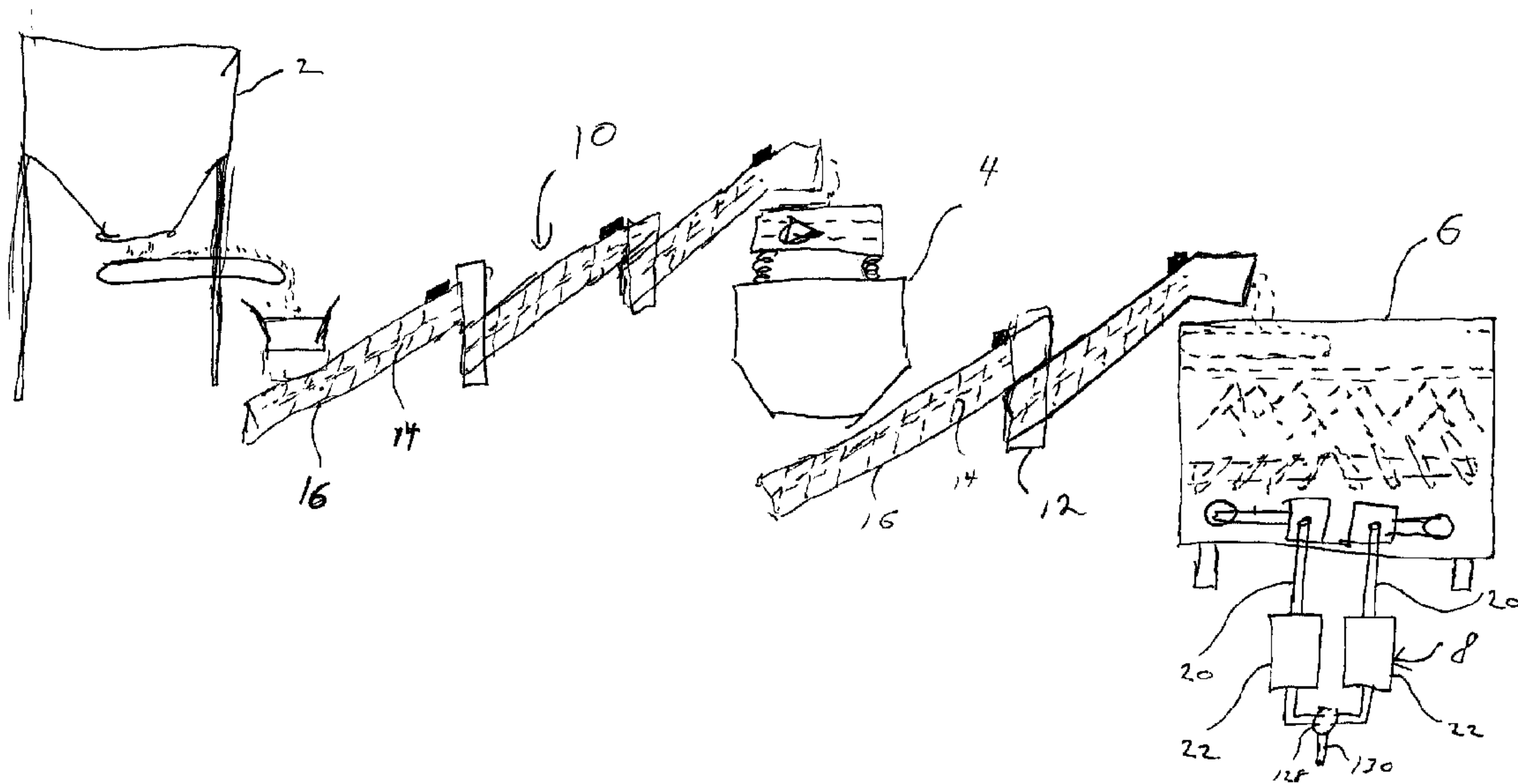




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(54) Titre : APPAREIL ET METHODE POUR LA PREPARATION DE BOUES LIQUIDE/SOLIDE
 (54) Title: APPARATUS AND METHOD FOR PREPARATION OF LIQUID/SOLID SLURRIES



(57) Abrégé/Abstract:

An apparatus and method are disclosed for the continuous formation of slurry. The apparatus includes a hopper to hold particulate material; one or more transport/mixing assemblies that mix and transport the solid material and a carrier liquid; and a mixing/averaging tank that receives the solid/liquid mixture from the transport/mixing assembly and performs a final mixing and averaging of the mixture to achieve a desired slurry consistency. An auger inside the tank continuously mixes the slurry and has one or more outlet ports to continuously discharge the slurry. The auger may be bi-directional, to direct the slurry towards dual outlets on opposing ends of the tank. Preferably, a reciprocating screen deck is provided to eliminate oversized particulates before the mixture enters the mixing/averaging tank. Carrier liquid is introduced at several points in the process, including into the transport/mixing assemblies, at the screen deck, and into the mixing/averaging tank. The transport mixing/assemblies may consist of an auger housed within a tubular housing, with rotation of the auger serving both to mix the solids and liquid and to transport the mixture through the assembly. The transport/mixing assemblies may alternatively consist of a stepwise array of auger stages with the respective auger housings interconnecting to permit material to be transported from one end of the assembly to the other. Alternatively, the assembly may employ a high-pressure jet of carrier liquid that both combines with the solid particulates and propels the mixture through a housing.

ABSTRACT OF THE DISCLOSURE

An apparatus and method are disclosed for the continuous formation of slurry.

The apparatus includes a hopper to hold particulate material; one or more transport/mixing assemblies that mix and transport the solid material and a carrier liquid; and a mixing/averaging tank that receives the solid/liquid mixture from the transport/mixing assembly and performs a final mixing and averaging of the mixture to achieve a desired slurry consistency. An auger inside the tank continuously mixes the slurry and has one or more outlet ports to continuously discharge the slurry. The auger may be bi-directional, to direct the slurry towards dual outlets on opposing ends of the tank. Preferably, a reciprocating screen deck is provided to eliminate oversized particulates before the mixture enters the mixing/averaging tank. Carrier liquid is introduced at several points in the process, including into the transport/mixing assemblies, at the screen deck, and into the mixing/averaging tank. The transport mixing/assemblies may consist of an auger housed within a tubular housing, with rotation of the auger serving both to mix the solids and liquid and to transport the mixture through the assembly. The transport/mixing assemblies may alternatively consist of a stepwise array of auger stages with the respective auger housings interconnecting to permit material to be transported from one end of the assembly to the other. Alternatively, the assembly may employ a high-pressure jet of carrier liquid that both combines with the solid particulates and propels the mixture through a housing.

APPARATUS AND METHOD FOR PREPARATION OF LIQUID/SOLID SLURRIES

FIELD OF THE INVENTION

5 The invention relates to an apparatus and method for the preparation of slurries from mixtures of liquids and solids. The invention is particularly intended for the preparation of slurries that incorporate waste materials, for injection into geological formations. The invention may also be adapted for the preparation of other types of slurries, for other uses.

10

BACKGROUND OF THE INVENTION

 Slurries comprised of suspensions of solids within a liquid carrier, with or without the presence of other liquids such as waste oils, are prepared for a variety of applications that require a continuous slurry formation process. The present
15 applicant's co-pending application 2,185,259 relates to an apparatus and method for the disposal of wastes by the generally continuous preparation of a slurry comprised of waste materials suspended in a carrier liquid (typically water), with the slurry being injected into geological formations. The slurry is prepared on the surface with apparatus designed to produce a generally continuous stream of slurry. Typical wastes
20 that may be slurrified for this process include:

- oily sand from petroleum industry operations, as well as waste drilling fluids and drill chips from well drilling operations and oily slop and sand and residues from tank-

bottom clean-outs;

- soil contaminated with toxic materials such as PCB, heavy metals, cyanide compounds, hydrocarbons, naturally-occurring radioactive wastes, etc.;

- dredging wastes;

5 - municipal sewage sludge from which the organic wastes have been largely decomposed;

- waste plastics, glass, and other solid materials;

- fly ash, clinker or other residue from combustion of wood, coal or municipal wastes;

- flue gas desulphurization sludges as well as recaptured particulates from smoke or

10 emission abatement processes, whether in solid or aqueous suspension form;

- high solids content sludges and residues from petroleum refining, including high ash content coke, heavy oil residues and removed solids.

Typical existing slurry-making systems employ a batch processing method, wherein slurry is generated and discharged in a series of discrete batches. This approach is not desirable for generating the high volumes of slurry that is preferred for subterranean injection applications, nor does it permit an injection pump to operate on a continuous basis.

As well, apparatus for producing slurry for use in an injection process as described in co-pending application 2,185,259 must meet several design criteria in order to dispose of a substantial volume of wastes at a high rate:

- delivering prepared slurry on a continuous basis at a surface pressure of between 6-15 Mpa;

- disposition of slurry injected at a rate of between 1.5 and 2.0 m³/min. and 1000 m³/day;
- slurry composition with a granular solids content between 15-40% and real-time waste concentration and slurry density control to maintain density between 5 1100 and 1500 kg/m³ ;
- processing of 200-400 m³ /day of granular wastes;
- ability to accept a variety of solid materials, including slop and sand.

The operating parameters of a slurry forming apparatus for use in a waste 10 injection system require equipment capable of preparing a relatively granular, highly viscous slurry at high rates and pressures. Preferably, the slurry formation apparatus for this application should provide the following features:

- a) relative ease of handling of waste material;
- b) screening of granular waste material on a continuous basis to remove oversize 15 or undesirable material;
- c) a real-time monitoring apparatus to monitor and record injection parameters;
- d) variable speed controls linked to the monitoring apparatus to control the various slurry-forming components and maintain consistent slurry quality and delivery rate;
- e) relatively rapid set-up and disassembly of the system; 20
- f) slurry formation equipment capable of shearing highly viscous material to increase slurry mobility and injectivity, maintaining slurry consistency within a

relatively small range, and being capable of handling relatively large amounts of waste material, in the range of at least 100 m³ /day.

A further requirement of an apparatus designed to process sand or other abrasive materials is that the moving parts not be exposed to excess wear. This requirement particularly affects the material transport means within the system, which should minimize the use of moving parts in contact with each other that are also in contact with the slurry mixture. As well, where the system is intended to provide slurry to a waste injection system, it is desirable to provide a dual slurry outlet, in order to permit the use of dual injection pumps to reduce wear on the individual pumps and minimize maintenance downtime.

SUMMARY OF THE INVENTION

In light of the objectives outlined above, the present invention consists of apparatus for the formation of a slurry having a predetermined consistency, on a generally continuous basis, by combining a carrier liquid, suspended solids and optionally other liquids and solids. The apparatus achieves a continuous slurry formation by means of introducing carrier liquid into the particulate mixture and continuously performing one or more preliminary mixing operations prior to entry of the mixture into a main mixing tank. This preliminary mixing stage limits the functions of the main mixing tank to the performing of a final mixing and averaging, or adjustment, of the slurry consistency. These functions may be performed on a continuous basis within a tank that is provided with an effective shearing and mixing

means.

In its broadest aspect, the apparatus consists of:

- a) receiving means to receive solids in particulate form;
- b) an elongate first transport/mixing assembly having an opening at a first
5 end to receive material from the receiving means, at least one inlet to receive carrier liquid, and transport/mixing means to continuously combine the solid material with the carrier liquid while transporting the mixture from the first end to a second end of the assembly;
- c) a mixing/averaging tank positioned to receive the solid/liquid mixture
10 from the transport/mixing assembly and adapted to perform a final mixing and averaging of the mixture to achieve a desired slurry consistency, and to discharge the finished slurry on a continuous basis.

The mixing/averaging tank is provided with one or more inlet means to direct additional carrier liquid into the slurry mixture. The inlet means may comprise a
15 sprayer positioned to spray liquid at the surface of the slurry within the tank. The tank is provided as well with mixing means such as an auger to continuously mix the slurry, and one or more outlet ports at the base of the tank to discharge the slurry.

Preferably there is further provided particulate sizing means to eliminate oversized particulates from the particulate/liquid mixture before the mixture enters the
20 mixing/averaging tank. The sizing means may comprises a screen deck with single or multiple screen layers, with means to shake or vibrate the screen deck to perform a screening operation. A stream of carrier liquid may be directed at the screen deck to

introduce additional liquid to the mixture and assist in the screening operation. The sizing means may receive the particulate/liquid mixture from the second end of the first transport/mixing assembly, with a second transport/mixing assembly being provided to transport the screened mixture from the sizing means to the
5 mixing/averaging tank. Preferably, one or more additional carrier liquid inlets permit additional liquid to be introduced into the second transport/mixing assembly. As well, additional carrier liquid intake ports may be incorporated into the second mixing/transport assembly to permit additional liquid to enter the second assembly.

Each of the transport mixing/assemblies may comprise at least one auger
10 housed within a tubular housing, with an inlet into the housing to permit the entry of carrier liquid. Rotation of the auger serves both to mix the solids and liquid, and to transport the material from the first to the second end of the assembly. The assembly may also comprise a multiple auger assembly, consisting of a stepwise array of auger stages, each auger being housed within a tubular housing. The housings interconnect
15 to permit material to be transported from one end of the assembly to the other. An inlet for the entry of additional carrier liquid enters each auger stage. Alternatively, the assembly comprises a housing with means to transport the mixture within a jet of liquid.

The slurry output conduit or conduits leading from the mixing/averaging tank
20 may be linked to single or dual pressurizing pumps to generate a pressurized slurry stream for deep-well injection.

In another aspect of the invention, a mixing/averaging tank is provided wherein

the mixing/averaging means within the tank consists of a bi-directional auger rotatably mounted near the base of the tank. The auger flightings are angled in opposing directions on either side of the midpoint of the auger, permitting the auger when rotated to push the slurry within the tank towards opposing ends of the tank. This permits the slurry to be withdrawn from the tank through dual outlets at either side of the tank, to be pressurized within dual pressurizing pumps for subsurface injection. The pump outputs are later combined for subsurface injection within a well. The use of dual injection pumps minimizes system downtime for pump maintenance and permits the individual pumps to operate at lower rate to minimize wear.

10 The invention further comprises a method for the formation of a slurry, using the apparatus described above. In its broadest aspect, the method consists of the following steps:

- a) delivering solid material in particulate form to a first elongate mixing/transport assembly of the type described above;
- 15 b) adding a carrier liquid to the material within the assembly;
- c) performing a preliminary mixing of the solids and liquid within the assembly, while transporting the mixture to a mixing/averaging tank;
- d) delivering additional carrier liquid into the tank and mixing the materials together;
- 20 e) removing the slurry from the tank on a generally continuous basis.

The method may include the further steps of delivering the mixture from a first

mixing/transport assembly to a particle sizing means comprising a screen deck engaged
to a motor-driven shaker to shake the screen deck; shaking the mixture through the
screen deck to remove oversized particles; delivering additional carrier liquid to the
mixture at the screen deck; and delivering the mixture from the particle sizing means
5 to the mixing/averaging tank through a second mixing/transport assembly.
Additional carrier liquid may be added to the mixture within the mixing/averaging
tank. This may be accomplished by spraying additional liquid onto the surface of the
slurry within the tank.

10 **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a schematic view of the slurry-forming apparatus according to the
present invention, with internal components being shown by broken lines;

Figure 2 is a sectional view of the particulate-receiving hopper;

15

Figure 3 is a sectional view of a transport/mixing assembly;

Figure 4 is a schematic side sectional view of a second embodiment of the
transport/mixing assembly;

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Figure 5 is a side elevational view, partly cut-away, of the sizing means;

Figure 6 is a sectional view of the mixing/averaging tank showing the bi-directional mixing auger within the base of the tank.

Figure 7 is a schematic view of the control system of the present invention.

5

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1, the slurry formation apparatus comprises in general terms a hopper 2, a particle sizing apparatus 4 and a mixing-averaging apparatus 6. The slurry output from the apparatus may lead to an injection pump apparatus 8 for injection of the slurry into a well (not shown). A first elongate mixing/transport assembly 10 transports particulate material from the hopper to the sizing apparatus, and a second mixing/transport assembly 12 transports the mixture to the mixing-averaging apparatus. Both mixing/transport assemblies comprise multi-staged auger assemblies that comprise multiple auger assemblies 14, each comprising an auger housed within a corresponding tubular housing 16. The housings are arranged in an interconnecting stepwise array. A water source (not shown) delivers a steady high-pressure (approx. 200 psi) source of water. From the mixing-averaging tank, dual pipes 20 transport the slurry to corresponding dual slurry pressurizing pumps 22. The water supply tank is linked by hoses (not shown) to the various liquid inlet ports in the apparatus.

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Referring to Figure 2, the hopper 2 has an open top to receive solid material in particulate form. Various particulate materials, including sand, may be deposited in

the hopper, as well as combinations of particulates and viscous liquids such as sludge-bearing sand or the like. The hopper of the preferred embodiment is designed to receive a load of between 8 and 20 cubic meters of sand. Material exits the hopper at a controlled rate through a variable-sized aperture 24 at the base of the hopper. A
5 conveyor 26 transports the particulates from the hopper to a receiving cone 30 that funnels the particulates into a mouth 32 at a first end of the first mixing/transport means. A grating 34 over the receiving cone screens oversized material.

Turning to Figure 3, the first mixing/transport assembly consists of a three-stage auger assembly, comprising a series of three individual auger stages 14 (a), (b)
10 and (c), respectively that angle upwardly in a stepwise arrangement from the receiving end to the discharge end. The use of a multi-stage auger assembly provides the assembly with a relatively long reach without requiring any of the augers to be rotatably supported within bushings at their midpoint; this achieves better wear characteristics when sand or other abrasive material is transported. An auger
15 supported only at its ends may reasonably be achieved only if the auger is kept relatively short. Each auger stage comprises an auger 36(a)-(c) housed within a corresponding tubular auger housing 16(a)-(c). The auger is journalled at either end within a bushing. One end of the auger has a shaft 40 extending from the end of the housing, rotatably linked to and driven by a hydraulic motor 42. The auger housings
20 16 each have a mouth 32 within the upper face of their first ends to receive material, and a second opening 48 within the lower face of their second ends to discharge the material.

Each auger housing 38 has a water inlet 49 to permit carrier liquid to be introduced into each auger stage. The first auger stage 14(a) has an inlet port 50 to receive additional non-solid material for incorporation into the slurry, such as viscous oils and the like.

5 The second mixing/transport assembly is similar to the first assembly, except that it comprises only a two stage auger assembly.

An alternative embodiment of the mixing/transport assemblies is illustrated in Figure 4. In this version, the motive power for transporting particulates through the assembly comprises a carrier fluid, consisting of a jet of water or air. The assembly
10 comprises an elongate tubular conduit, with means to deliver a high-pressure mixture of carrier fluid and particulates with sufficient velocity to carry the mixture the length of the conduit. The tubular conduit 56 angles upwardly from its base to its discharge end, which terminates at the sizing apparatus 4 (not shown in this drawing). A pressurized carrier fluid stream is delivered to the assembly via a conduit 58, and is
15 pressurized before delivery by means of a compressor 60. The carrier fluid enters the compressor through inlet 59. The conduit 58 has a narrowed region 61, with a secondary inlet 62 entering the conduit 58 at the narrowed portion. The narrowing of the channel results in a Bernoulli effect that draws particulate material from the hopper 2, through a secondary inlet 62, into the narrowed portion, where the particulates
20 become entrained within the carrier fluid. The pressurized stream, bearing the entrained particulates, enters a preliminary mixing chamber 64, which also receives a secondary high-pressure fluid stream from the compressor 60 through a secondary

conduit 65. The preliminary mixing chamber combines the particulates and the secondary carrier fluid into a generally uniform mixture and discharges the mixture into the conduit 56 with sufficient velocity to carry the mixture up the length of the conduit.

5 The sizing apparatus 4, seen in detail in Figure 5, comprises a screening means to screen out oversized particles. The apparatus consists of a rectangular screen housing 70 having an open top and bottom, mounted on coil springs 72 over a hopper 74. A hydraulic motor 76 mounted to the housing drives an eccentric cam 78, which when rotated causes the screen housing to vibrate and shake. Upper and lower screen
10 decks 80 and 82 extend across the housing, with the particulates being deposited from the first transport/ mixing apparatus onto the upper screen deck 80. The individual screens within the deck are adjustable and removable to optimize slurry composition for particular injection conditions. Typically, the upper deck has a courser mesh than the lower deck. A water sprayer 84 is positioned to direct a high-pressure stream of
15 water at the particulate mixture as it is deposited on the screen decks. The action of the spray jet and the shaking of the screens serves to remove particles having a size greater than about 0.25 to 1 cm. from the waste stream. The screens are replaceable in order to change slurry composition through the use of different mesh sizes in the screens. The oversized particles are either crushed by a stand-alone crusher (not
20 shown), to be fed back into the waste stream, or are collected and disposed of by other means.

The screened wastes fall from the screen deck into the hopper 74. An opening

92 at the base of the hopper 74 funnels the slurry into the second mixing/transport assembly. The slurry is then transported to the slurry mixing/averaging tank 6, seen in detail in Figure 5. The tank has an open top to receive the particulate/liquid mixture. A short horizontal conveyor or auger 96 receives the mixture from the second
5 mixing/transport assembly and transports it partway across the tank 6. The tank has generally straight sides and a trough-shaped bottom, with a mixing auger 100 rotatably mounted within the trough 102. An auger shaft 104 extends through the wall of the tank and is rotatably driven by a hydraulic motor 106. The mixing auger is bidirectional, with the flightings on either side of the midpoint of the mixing auger
10 being canted in opposing directions to push the slurry towards opposing sides of the tank. A water spray bar surrounds at least part of the upper rim of the tank and sprays additional carrier liquid onto the slurry. Additional liquid may be added to the tank to adjust the slurry consistency through an inlet port 108. Other additives may also be added directly into the tank 6 through the inlet port, if required.

15 Dual outlets 120 lead from of the base of the slurry averaging tank adjacent each end thereof. As seen in Figures 1 and 6, from each outlet a conduit 122 directs the slurry through a booster pump 124 into one of two injection pumps 22 (seen in Figure 1), each of which pressurizes the slurry sufficiently to permit the slurry to be injected into a well (not shown) extending deep into a geological formation. The
20 injection pumps separately discharge into a combiner 128 that combines the streams from the two pumps into a single discharge pipe 130 into the well.

The various hoses, pipes, conduits and pumps that deliver carrier liquid and

hydraulic fluid to the apparatus are not shown.

The various components of the system are driven by conventional variable speed hydraulic motors 139 (various of which are shown schematically in Figure 7). These pumps in turn are linked to a control system 140, which permits control over the
5 inputs into the slurry-production means and over the slurry design. Where the apparatus is used in association with a waste-injection system, the control system, shown schematically in Figure 7, receives input from a real-time monitoring system that monitors, records and visually displays the parameters of slurry density, injection rate, surface injection and well-bottom pressures, injected volumes and slurry solids
10 concentration. The monitoring system consists of :

- slurry density measuring means 142;
- pump pressure measuring means 144;
- means 146 to measure water input into the system;
- means 148 to measure slurry uptake rates, such as injection rates into a well;
- 15 - means 149 to measure slurry volumes being injected;
- a control data logger 150 linked to all of the measuring means to record and store the data in real time. A digital display 152 is provided in the data logger.

The control means is adapted to maintain a consistent slurry density and delivery rate and pressure, through conventional feedback means.

20

The present invention has been described by way of a specific embodiment

thereof. It will, however, be understood by those skilled in the art to which this invention pertains that numerous departures from and variations to this invention may be made, while remaining within the spirit and scope of the invention as defined in the appended claims.

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WE CLAIM:

1. **Apparatus for the generally continuous formation of a slurry from a particulate substrate and carrier liquid, said apparatus comprising:**
 - a) **receiving means to receive solid material in particulate form;**
 - b) **a transport assembly having first and second ends, said first end having an opening to receive said particulate substrate from said receiving means, said assembly having at least one liquid inlet to introduce a carrier liquid into said assembly separately from said particulates; and first mixing means to mix together said liquid and particulate substrate into a mixture and transport said mixture to a second end of said assembly for discharge therefrom;**
 - c) **a mixing tank adapted to receive said mixture, said tank having at least one liquid intake to introduce additional carrier liquid into said tank, and second mixing means for forming a slurry from said carrier liquid and said additional carrier liquid on a continuous basis with a selected slurry consistency and at least one outlet to discharge said slurry on a continuous basis.**

2. **Apparatus as defined in claim 1, wherein said first mixing means comprises an auger housed within an auger housing, and means to rotatably drive said auger within said housing.**

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3. Apparatus as defined in claim 2, wherein said at least one transport assembly comprises an array of multiple rotatable augers each housed within a corresponding housing, said housings being arranged in a stepwise interconnected array.
4. Apparatus as defined in claim 1, wherein said at least one transport assembly is provided with a second inlet to admit additional carrier liquid into said assembly for incorporation within said mixture.
5. Apparatus as defined in claim 1, further comprising a particle sizing means for the removal of particles having a size exceeding a pre-selected size from said mixture, said particle sizing means comprising a screen deck and means to shake or vibrate said screen, and carrying means to transport said mixture from said particle sizing means to said mixing tank.
6. Apparatus as defined in claim 5, wherein a first of said transport assemblies is for carrying said mixture from said receiving means to said particle sizing means.
7. Apparatus as defined in claim 5, wherein said carrying means comprises a housing having an opening to receive said mixture from said sizing means, a discharge outlet, an inlet to receive additional carrier liquid and a mixer to mix said mixture with said carrier liquid while conveying said mixture and liquid to said discharge outlet.
8. Apparatus as defined in either of claims 6 or 7 wherein at least one of said first or second transport assemblies comprises an auger housed within an auger housing, and means to rotatably drive said auger within said housing.

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9. Apparatus as defined in either of claims 6, 7 or 8, wherein at least one of said transport assemblies comprises an array of multiple rotatable augers each housed within a corresponding housing, said housings being arranged in a stepwise interconnected array.
10. Apparatus as defined in claim 5 further comprising a spray means to spray additional carrier liquid onto said mixture on said screen deck.
11. Apparatus as defined in claim 10, wherein said screen deck comprises a plurality of spaced apart screens each having a generally horizontal upper surface and retained within a housing, and said spray means comprises a spray outlet adapted to spray carrier liquid onto said screen deck.
12. Apparatus as defined in claim 5, wherein said screen deck is housed within a housing, and said means to shake or vibrate said screen deck comprises a motor-driven eccentric cam mounted to said housing for shaking or vibrating said housing upon rotation of said cam.
13. Apparatus as defined in claim 12, wherein said housing is supported by one or more springs.
14. Apparatus as defined in claim 1, wherein said transport assembly comprises means to transport said solid material by entraining said material within a pressurized stream of carrier fluid and discharging said material and fluid through an elongate tube, said assembly comprising:
 - a) an elongate tube having first and second ends, said first end comprising an inlet and said second end comprising an outlet;
 - b) a chamber having an inlet to receive said carrier fluid and said solid material and an outlet to deliver said carrier liquid and said solid material to said first end of said tube in the form of a carrier fluid/solid

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mixture; and

- c) pressurizing means to pressurize said carrier fluid sufficient to drive said carrier fluid/solid mixture the length of said tube.
15. Apparatus as defined in claim 14, wherein said inlet incorporates a narrowed section and a second opening entering said inlet at said narrowed section for the introduction of said solid material into said carrier fluid, said narrowed section configured to generate a Bernoulli effect within said carrier fluid to draw said solid material into said carrier fluid.
16. Apparatus as defined in claim 1, wherein said second mixing means comprises an auger rotatably disposed within said mixing tank, and drive means to rotate said auger.
17. Apparatus as defined in claim 16, wherein said auger comprises first and second flightings on opposing ends of said auger, said first and second flightings being canted in opposing directions so as to push said slurry towards opposing sides of said tank when said auger is rotated.
18. Apparatus as defined in claim 17, wherein said tank is provided with dual slurry discharge outlets at opposing ends of said tank.
19. Apparatus as defined in claim 1, wherein said mixing tank is provided with a spray outlet at an upper rim of said tank for the admission of additional carrier liquid into said tank.
20. A method for the generally continuous creation of a particulate/liquid slurry, comprising the steps of:
- a) delivering solid material in particulate form to a transport assembly, said assembly comprising: receiving means to receive solid material in

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particulate form; at least one liquid intake means separate from said receiving means to introduce a carrier liquid into said transport assembly and first mixing means to mix together said liquid and solid material into a mixture and transport said mixture to a second end of said transport assembly;

- b) adding a carrier liquid to the solid material within the transport assembly;
 - c) performing a preliminary mixing of the solids and liquid within the transport assembly, while transporting the mixture through the transport assembly to a mixing tank;
 - d) delivering said mixture to said mixing tank, said tank incorporating second mixing means;
 - e) delivering a controlled amount of additional carrier liquid into said tank and combining said additional liquid with said mixture within said tank to form a slurry having a predetermined solids concentration and density;
 - f) removing said slurry from said tank on a generally continuous basis.
21. A method as defined in claim 20, characterized by the further steps of delivering said mixture to a particle sizing means comprising a screen deck engaged to a motion-generator means; shaking or vibrating said screen deck to remove oversized particles from said mixture; delivering additional carrier liquid to said mixture at said screen deck; and delivering said mixture from said particle sizing means to said mixing tank.
22. A method as defined in claim 21, wherein said screen deck is comprised of multiple spaced apart screens each having a generally horizontal upper surface.

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23. A method as defined in claim 21, comprising the further steps of carrying said mixture to said particle sizing means by means of a first of said transport assemblies; carrying said mixture from said sizing means to said tank by a second of said transport assemblies introducing carrier liquid into said first and second transport assemblies; and performing mixing operations within said first and second transport assembly wherein said mixture is mixed with said carrier liquid as said mixture is transported from a first end of each of said transport assemblies to a second end thereof.
24. A method as defined in claim 20, wherein said first mixing means comprises an auger rotatably housed within an elongate tubular housing, said housing having an opening adjacent to either end thereof for the introduction and discharge, respectively, of material at first and second ends respectively of said housing and said step of mixing and transporting said material and carrier liquid is performed by rotation of said auger.
25. A method as defined in claim 20, comprising the further step of mixing and transporting said carrier liquid and solid material within said transport assembly by entraining said solid material within a pressurized stream of carrier fluid and discharging said fluid and solid material through an elongate tube, said transport assembly comprising:
- a) an elongate tube having first and second ends, said first end comprising an inlet and said second end comprising an outlet;
 - b) a chamber having an inlet to receive said carrier fluid and said solid material and an outlet to deliver said carrier liquid and said solid material to said first end of said tube in the form of a carrier fluid//solid mixture;
- and

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- c) pressurizing means to pressurize said carrier fluid with sufficient pressure to propel said mixture the length of said tube.
26. A method as defined in claim 25, wherein said solid material is drawn into said carrier liquid by generating a Bernoulli effect, by generating a stream of carrier liquid within a narrowed section of said inlet and providing a second opening into said inlet at said narrowed section, and introducing said solid material into said carrier fluid through said second opening, said liquid being driven through said narrowed section with sufficient speed to draw said solid material into said carrier fluid.
27. A method as defined in claim 20, wherein said transport assembly comprises a multistage auger assembly, said assembly comprising two or more auger stages arranged in an elongate interconnecting stepwise arrangement, each of said stages comprising an auger housed within an auger housing, and said step of mixing and transporting said mixture and carrier liquid is performed serially within said auger stages.
28. A method as defined in claim 23, wherein said second transport assembly comprises a multistage auger assembly, said assembly comprising two or more auger stages arranged in an elongate interconnecting stepwise arrangement, each of said stages comprising an auger housed within an auger housing, and said step of mixing and a transporting said mixture and carrier liquid is performed serially within said auger stages.
29. A method as defined in claim 20 wherein said second mixing means comprises an auger rotatably disposed within said mixing tank adjacent the base thereof.
30. A method as defined in claim 29, wherein said mixture is directed towards opposing

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ends of said tank by means of rotating said auger, said auger comprising a bi-directional auger characterized by first and second auger flightings on opposing ends of said auger and being canted in opposing directions, said first and second flightings adapted to propel said mixture to opposite sides of said tank as said auger is rotated.

31. A method as defined in claim 29, comprising the additional step of introducing additional carrier liquid into said mixing tank by means of spraying said additional carrier liquid onto the slurry surface within said tank.

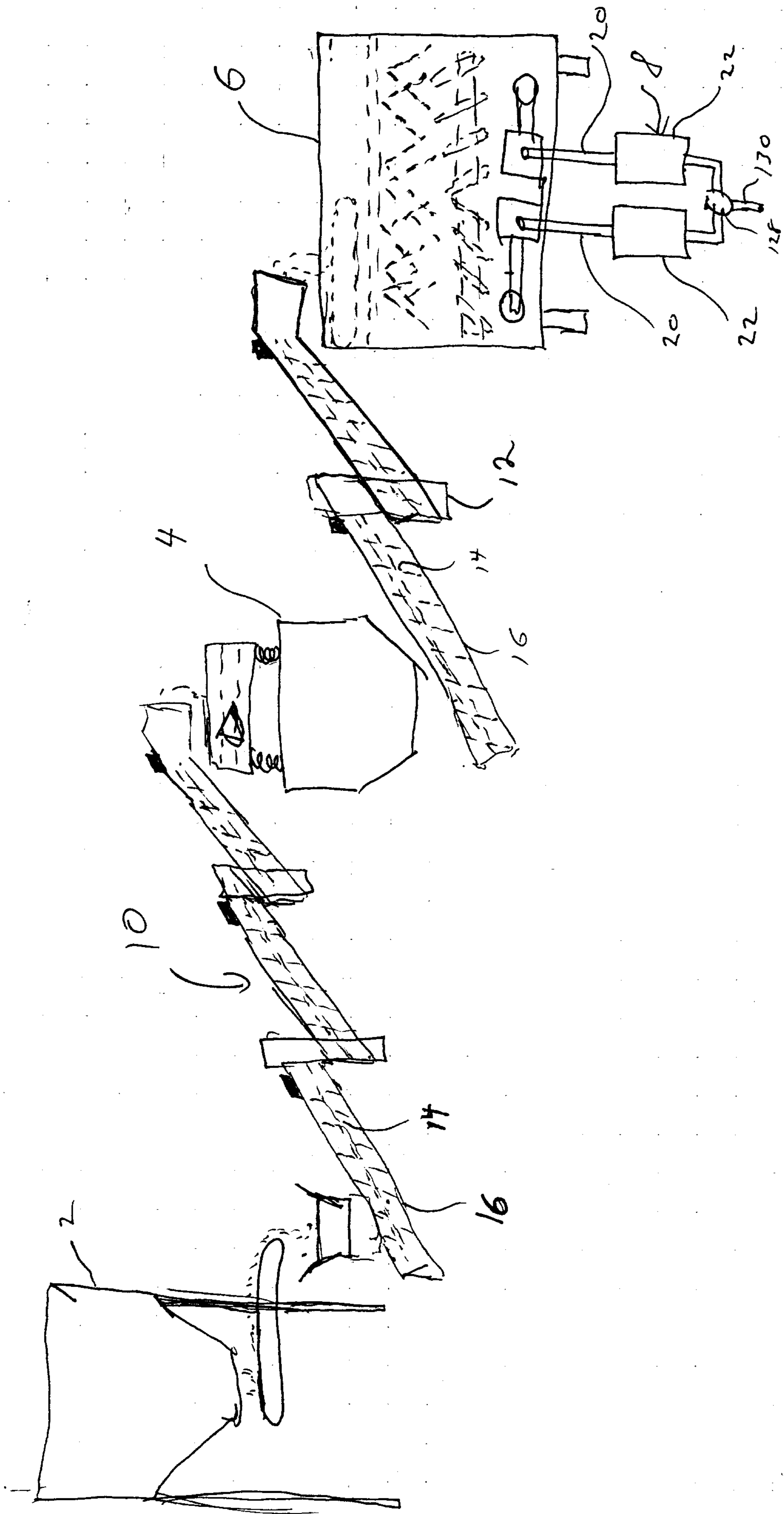


Fig. 1

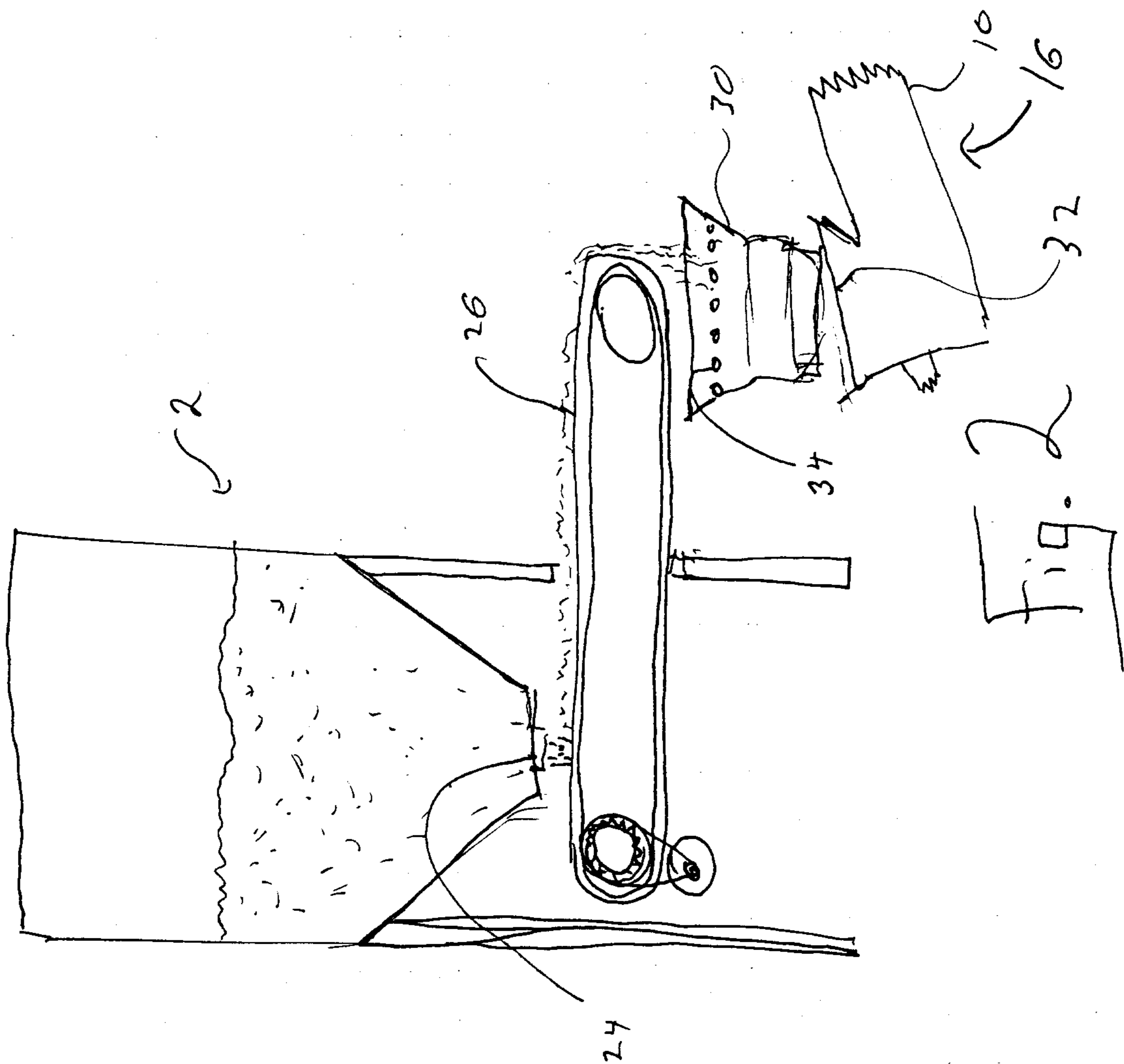


Fig. 2

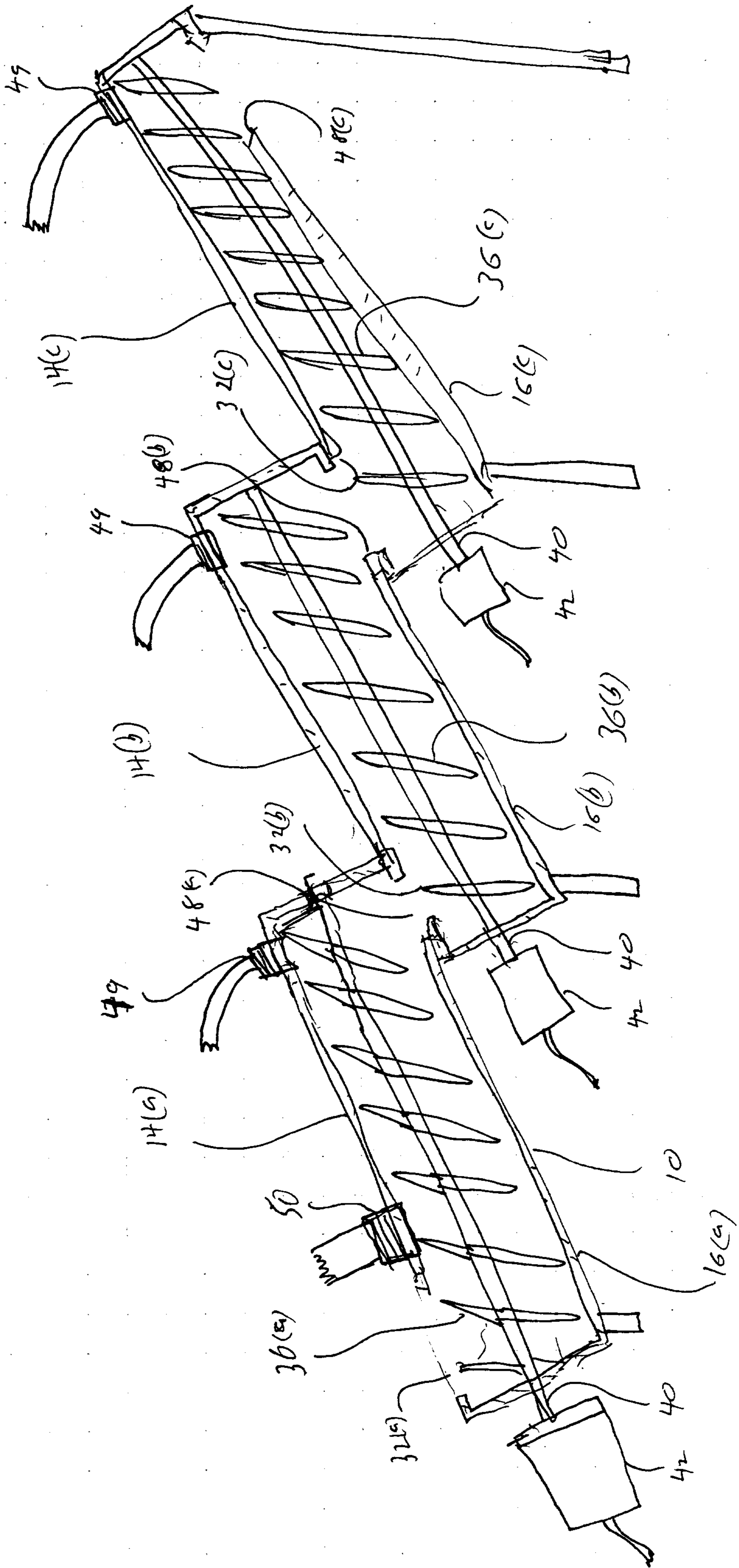


Fig. 3

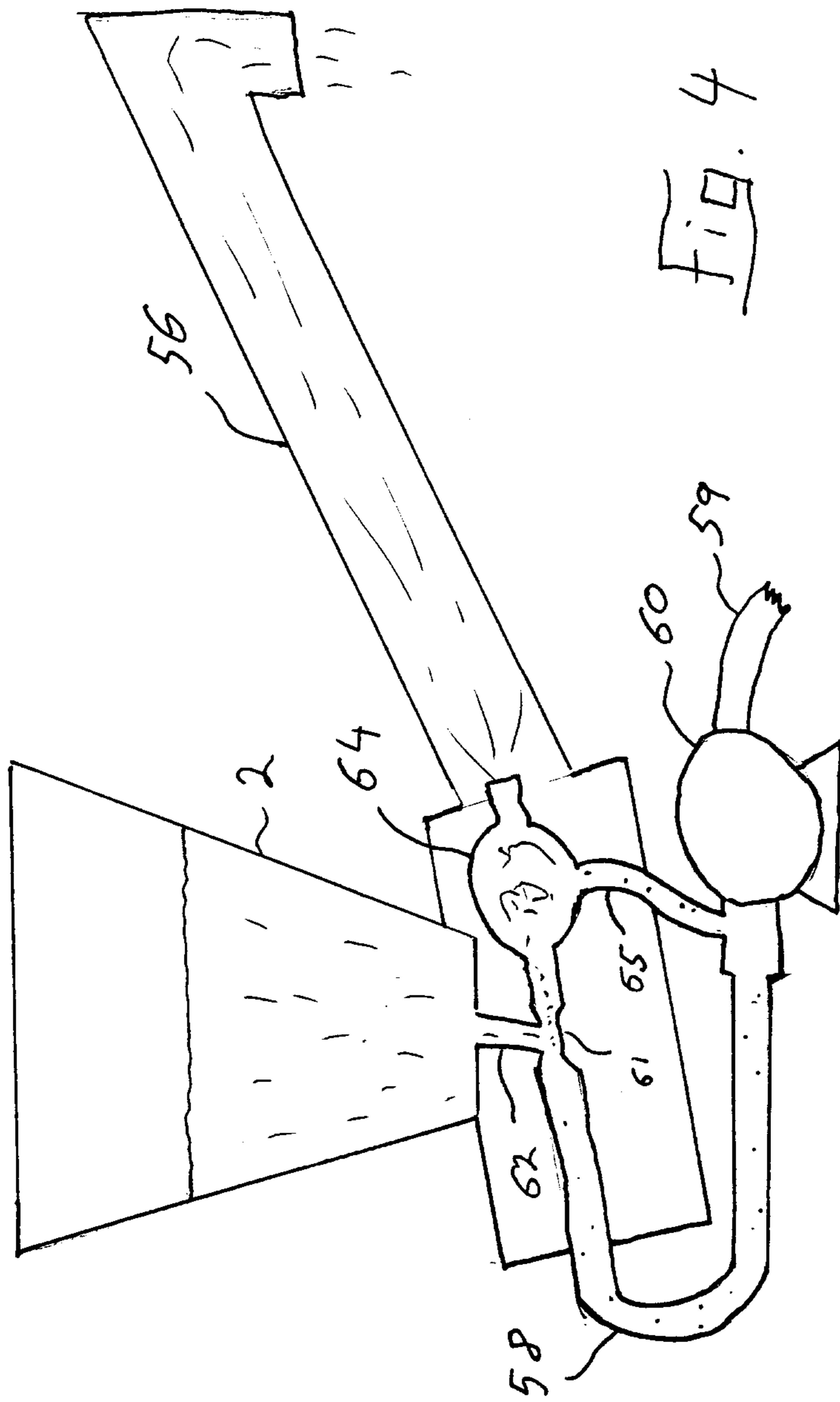
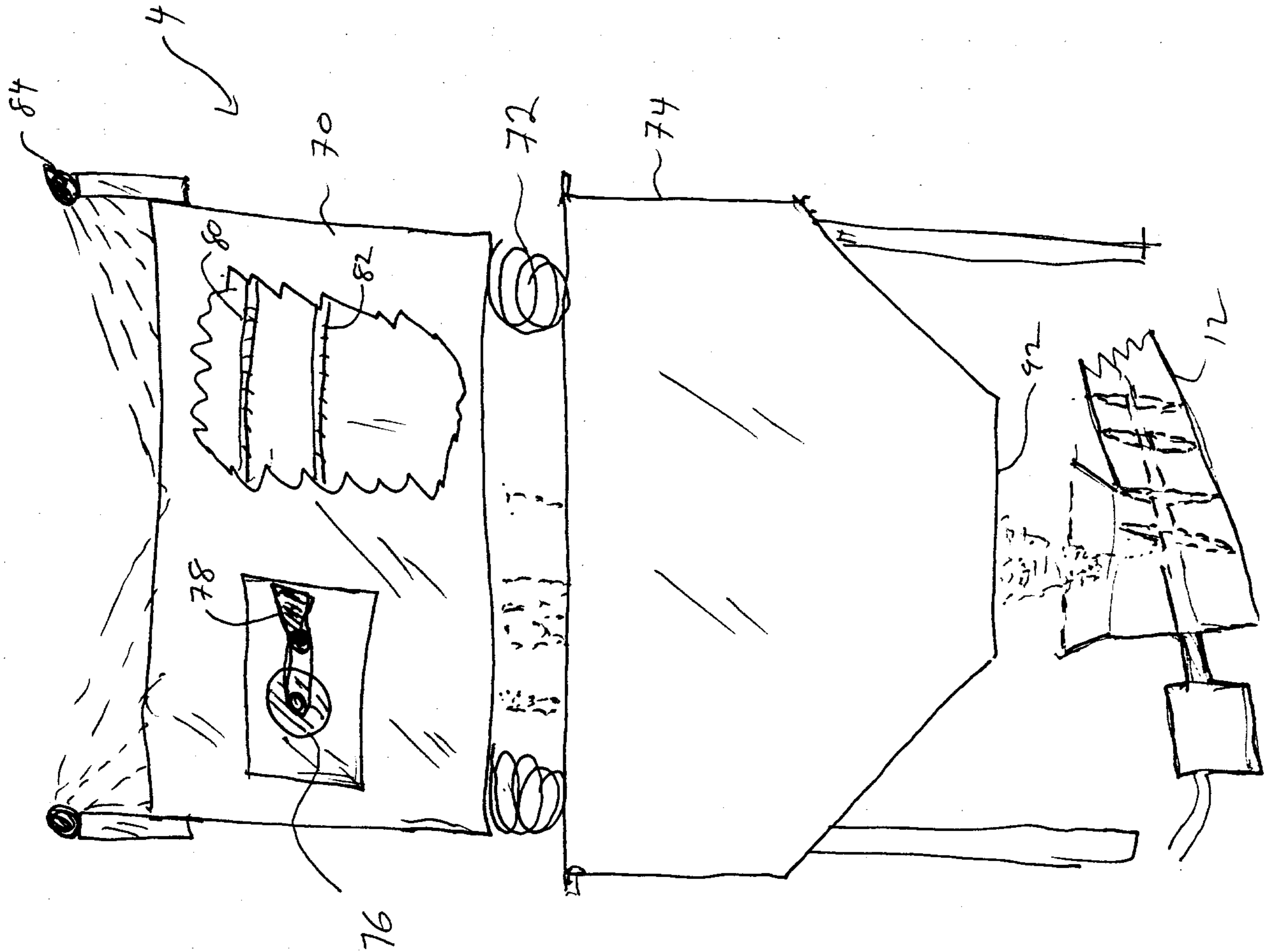


FIG. 4

Fig. 5



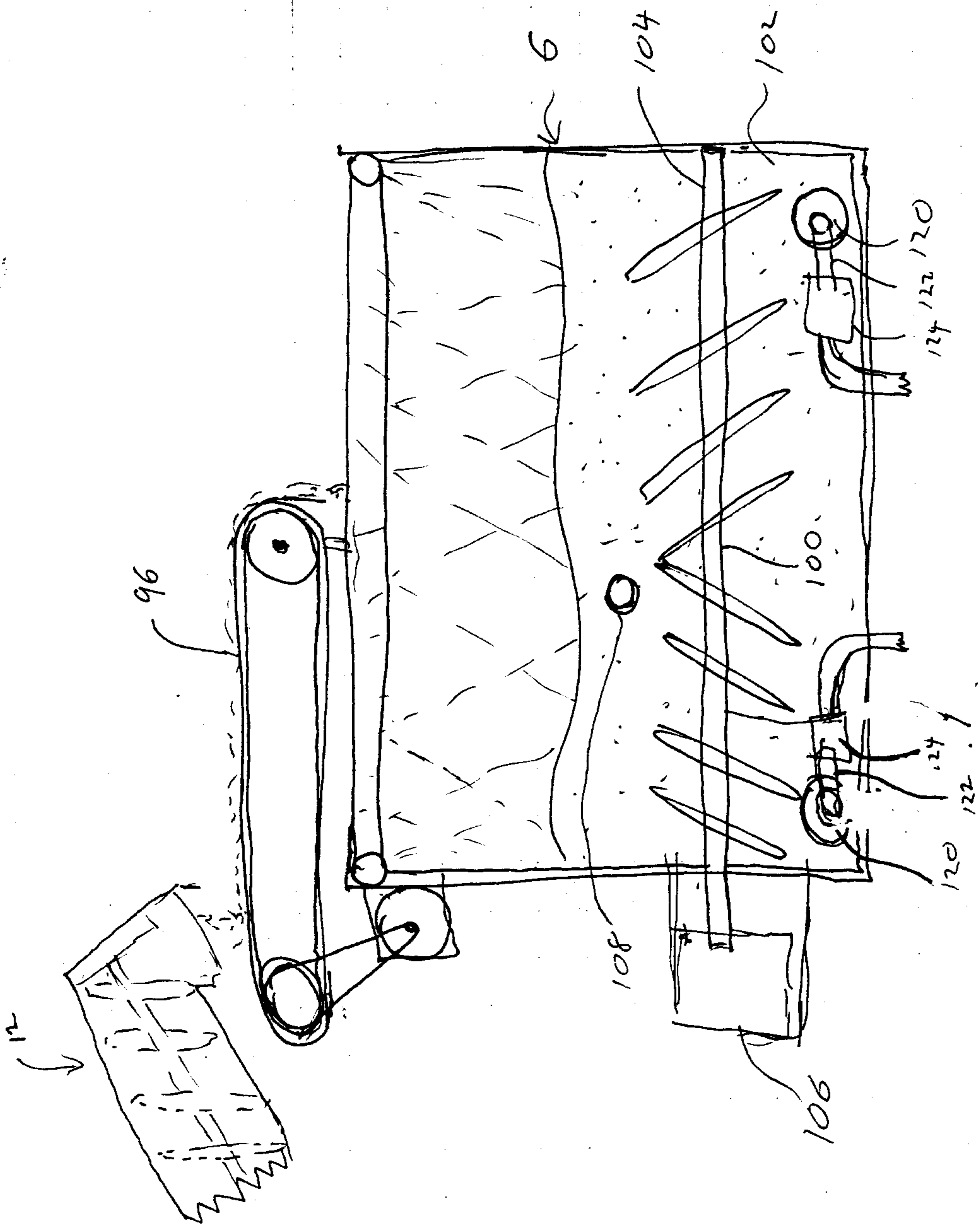


FIG. 5

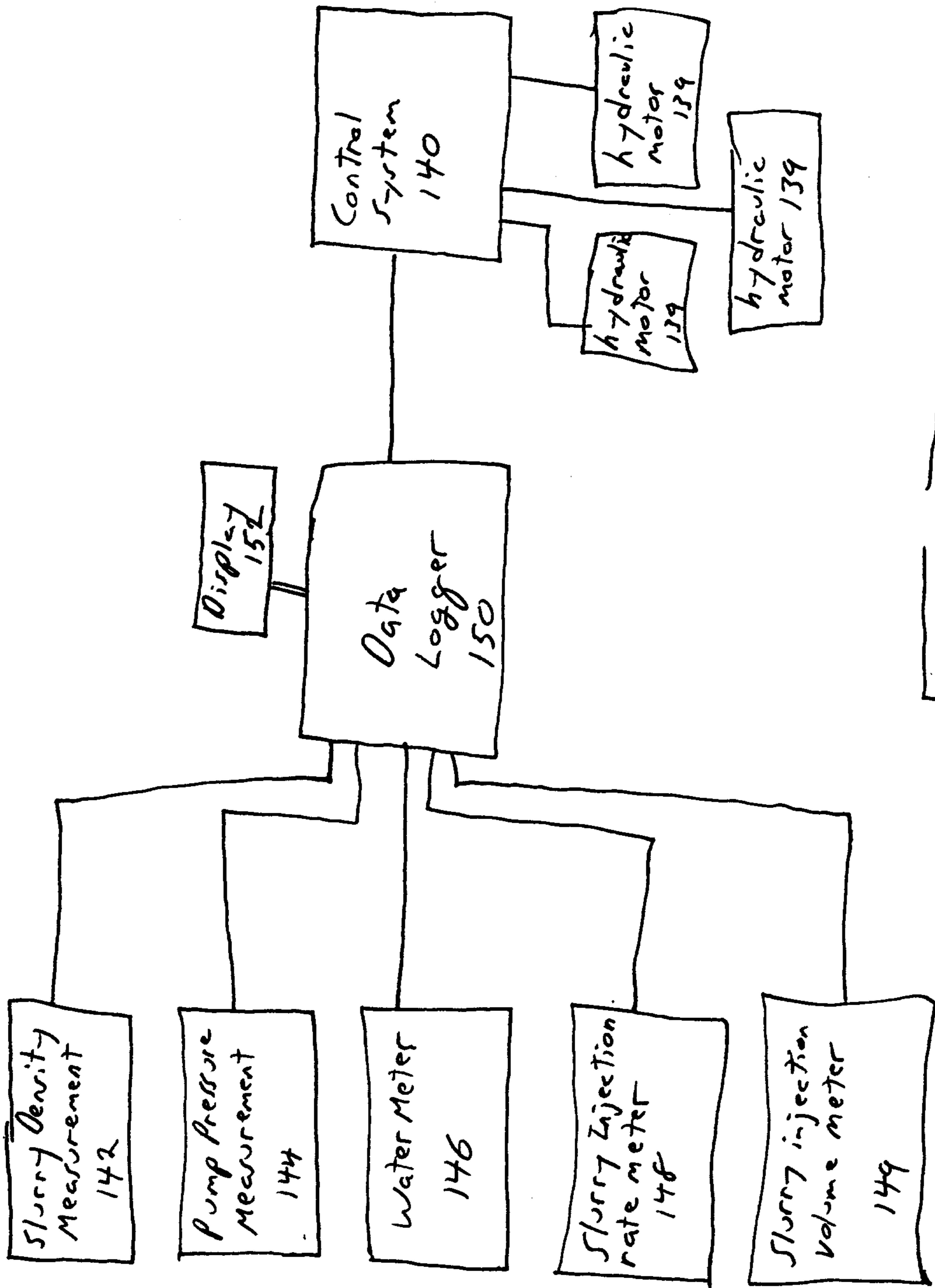


FIG. 7

