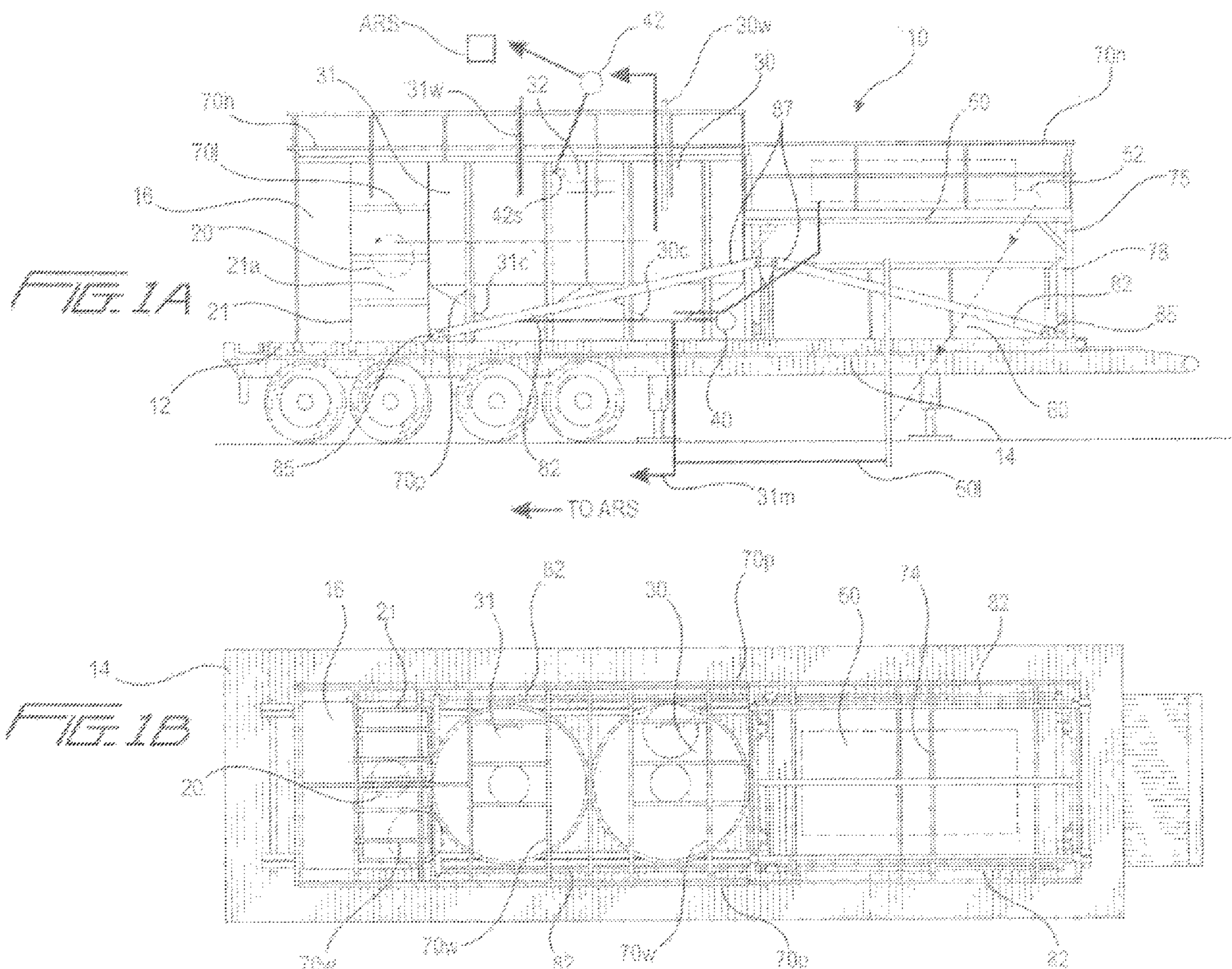




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(54) Title: APPARATUS AND METHOD FOR PROCESSING SOLIDS LADEN FLUID IN THE DRILLING AND
MAINTENANCE OF OIL AND GAS WELLS



(57) Abrégé/Abstract:

An apparatus for processing solids laden fluid used in the drilling and maintenance of oil and gas wells, the apparatus comprising a base (12), a support structure (70) on the base, a brace apparatus (80) releasably connected to the base (12) for bracing the su



(57) **Abrégé(suite)/Abstract(continued):**

port structure (70), and a holding tank apparatus (30,31) on the base for holding the solids laden fluid, a pump apparatus (16) for pumping well fluid and solids from the holding tank apparatus to a centrifuge apparatus (50), 10 said centrifuge apparatus (50) for centrifuging a mixture of the solids laden fluid to produce a reusable component of the solids laden fluid, and a centrifuge support (74) on the base (12) for supporting the centrifuge apparatus.

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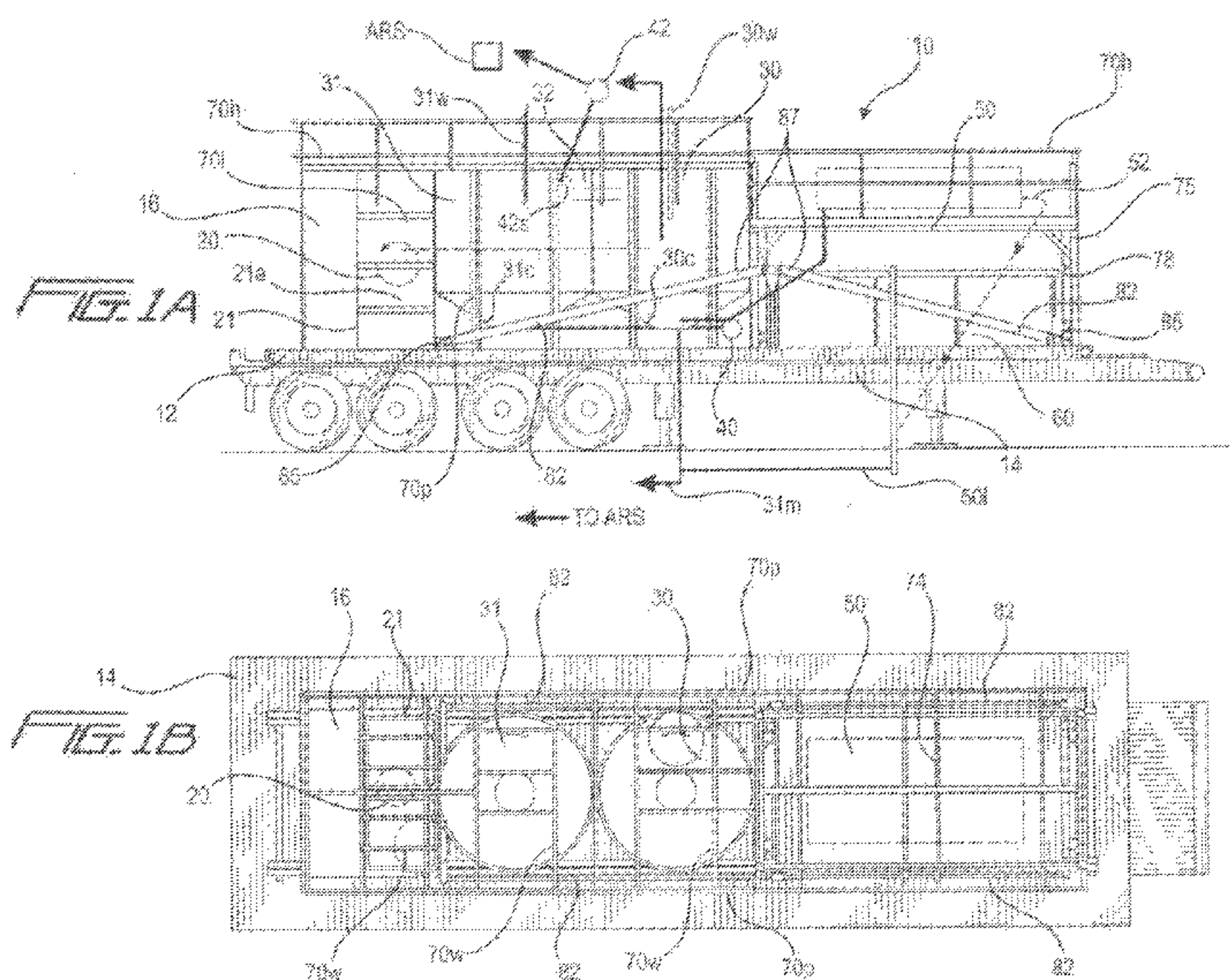
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(54) Title: APPARATUS AND METHOD FOR PROCESSING SOLIDS LADEN FLUID IN THE DRILLING AND MAINTENANCE OF OIL AND GAS WELLS



(57) Abstract: An apparatus for processing solids laden fluid used in the drilling and maintenance of oil and gas wells, the apparatus comprising a base (12), a support structure (70) on the base, a brace apparatus (80) releasably connected to the base (12) for bracing the support structure (70), and a holding tank apparatus (30,31) on the base for holding the solids laden fluid, a pump apparatus (16) for pumping well fluid and solids from the holding tank apparatus to a centrifuge apparatus (50), 10 said centrifuge apparatus (50) for centrifuging a mixture of the solids laden fluid to produce a reusable component of the solids laden fluid, and a centrifuge support (74) on the base (12) for supporting the centrifuge apparatus.

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APPARATUS AND METHOD FOR PROCESSING SOLIDS LADEN FLUID IN
THE DRILLING AND MAINTENANCE OF OIL AND GAS WELLS

The present invention relates to apparatus and
method for processing solids laden fluids in the drilling
5 and maintenance of oil and gas wells.

Oil and gas well exploration and involves the
generation of various fluids and of waste products,
including, e.g., fluid wastes, spent drilling fluids, and
fracture or return fluids from various operations.
10 Fluids, etc. have been treated and processed both on-site
and off-site.

In the drilling of a borehole in the construction of
an oil or gas well, a drill bit is arranged on the end of
a drill string and is rotated to bore the borehole. A
15 drilling fluid known as "drilling mud" is pumped through
the drill string to the drill bit to lubricate the drill
bit. The drilling mud is also used to carry the cuttings
produced by the drill bit and other solids to the surface
through an annulus formed between the drill string and
20 the borehole. The drilling mud contains expensive
synthetic oil-based lubricants and it is normal therefore
to recover and re-use the used drilling mud, but this
requires the solids to be removed from the drilling mud.
This is achieved by processing the drilling fluid. The
25 first part of the process is to separate the solids from
the solids laden drilling mud. This is at least partly
achieved with a vibratory separator, such as those shale
shakers disclosed in US 5,265,730, WO 96/33792 and WO
98/16328.

30 Shale shakers generally comprise an open bottomed
basket having one open discharge end and a solid walled
feed end. A number of rectangular screens are arranged in

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the basket held in C-channel rails located on the basket walls, such as those disclosed in GB-A-2,176,424. The basket is arranged on springs above a receptor for receiving recovered drilling mud. A skip or ditch is provided beneath the open discharge end of the basket. A motor is fixed to the basket, which has a drive rotor provided with an offset clump weight. In use, the motor rotates the rotor and the offset clump weight, which causes the basket and the screens fixed thereto to shake.

10 Solids laden mud is introduced at the feed end of the basket on to the screens. The shaking motion induces the solids to move along the screens towards the open discharge end. Drilling mud passes through the screens. The recovered drilling mud is received in the receptor

15 for further processing and the solids pass over the discharge end of the basket into the ditch or skip. In some shale shakers material flows generally horizontally or uphill from one screen to another and, in certain shale shakers, from an upper screen onto a lower screen.

20 The next stage of processing the drilling mud may comprise flowing the screened drilling mud into a centrifuge. Alternatively, a centrifuge may be used in place of the shale shakers.

25 The prior art discloses a wide variety of systems for treating drilling fluids and methods of their use; for example, and not by way of limitation, see the systems and methods in U.S. Patents 7,296,640; 7,022,240; 6,881,349; 6,863,809; 6,808,626; 6,855,261; 6,391,195; 6,193,070; 6,059,977; 5,093,008; 4,595,422; 4,536,286;

30 and 4,474,254 - all of said patents incorporated fully herein for all purposes.

U.S. Patent 4,465,598 discloses an off-site method

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for the precipitation of metals including iron, nickel, chromium, cobalt, and manganese in oil and gas well heavy brines which have been filtered initially to remove solids. U.S. Patent 4,634,533 discloses an oil and gas well brine treatment including an initial oxidizing treatment to convert iron to the ferric state. U.S. Patent 5,814,230 describes an apparatus and method for separation of solids from liquid for use with different processes and describes the separation of solids from a liquid flow using an endless conveyor carrying screen filters which dredge gravity settled solids from the bottom of a settling tank and filter solids suspended in the flowing liquid. The solids are further dewatered while on the filters using a combination of vibration and air streams. U.S. Patent 4,436,635 describes a filtering process for filtration of oil and gas well treatment fluids.

Treating fluids, etc., off-site can be uneconomic and unfriendly to the environment due to transportation. Consequently mobile systems for on-site treatment have been developed, some of which attempt to produce fluid re-usable on-site. U.S. Patent 4,895,665 discloses on-site methods for treating and reclaiming oil and gas well working fluids and the related drilling pits and methods of chemical treatment and filtration of oil and gas well working fluids within associated drilling pits. These methods include preparing a drilling pit for closure through reduction of the fluid content in sludge which is formed in the drilling pit. Treated water can be reused.

U.S. Patent 5,093,008 describes on-site processes and apparatus for recovering reusable water from waste drilling fluid. The processes involve a dewatering

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process and apparatus for concurrent reutilization of water in waste drilling fluids from an active drilling operation that includes a storage area, an intermixer for introducing treatment chemicals into the waste drilling fluids, and a centrifuge. Flocculation is chemically induced in the waste drilling fluids as they pass through the intermixing needs for introducing treatment chemicals into the waste drilling fluids. The waste drilling fluids are then transferred to a centrifuge where solid waste is separated from clear, reusable water. The water is returned to the storage area and may be chemically adjusted prior to being returned to the drilling rig.

U.S. Patent 4,536,286 describes a self contained, portable waste treatment system for hazardous and non hazardous waste with a pair of mixing tanks. Solids are removed from fluid waste streams by flocculation and related solids deposition.

U.S. Patent 7,022,240 discloses an apparatus and method for on site treatment and reclamation of oil and gas well waste water or fracturing fluids. The mobile treatment process and apparatus provide both chemical precipitation and filtration to treat the drilling fluid waste to a technically and environmentally acceptable level allowing for reuse. Alkaline treating agents are applied to the drilling waste fluids, as they are pumped through the treatment apparatus, to increase the pH of the fluid waste to a preferred pH range and to also cause selective soluble contaminants in the fluids to form a precipitate. The waste fluid is allowed to clarify as the precipitate of insoluble contaminants, through flocculation, settle and form a sludge at the bottom of the drilling pit. The clarified fluids are then filtered

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to satisfy applicable industry and environmental requirements.

Single skid mounted apparatus for providing all the components necessary to treat used drilling mud and return a clarified liquid for reuse in an active mud system are disclosed in prior references; e.g., see U.S. Patents 4,536,286; 4,474,254; 5,582,727; 6,391,195; and 6,863,809. For example, U.S. Patent 4,536,286 discloses a transportable waste treatment which is completely mobile and capable of treating high mud volumes. This system is self contained having chemical storage, chemical pumps, sludge pumps, water pumps, laboratory, centrifuge, conveyors etc. and has weight, height and width suitable for highway travel. A skid incorporates three settling tanks and two chemical tanks for flocculation. Waste liquids containing solids enter a first settling tank and are mixed with flocculation chemicals. Solids settle to the tapered bottom of the tank for collection by a suction located at the apex of the tank bottom. Partially clarified liquid from the first settling tank overflows a weir to the next adjacent settling tank and similarly for the second to the third settling tank.

U.S. Patent 5,582,727 discloses a single structural skid with four settling tanks, each equipped with a shaker and a de silter. Used drilling mud is routed sequentially from tank to tank. Partially clarified liquid is decanted over weirs to each tank in succession. Fixed suction pumps extract settled solids from the bottom of each tank and route them to the de silter of each additional and successive tank. Foster does not practice flocculation.

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U.S. Patent 6,391,195 discloses an apparatus for cleaning clearwater drilling muds and a process for treating used drilling mud, particularly that produced during clearwater drilling. A structural and highway transportable skid has two or more settling tanks connected in succession. Flocculation aids settling of solids to the bottom and clarified liquid forms at the surface. Clarified liquid flows from one tank to the next successive tank. Clarified liquid is produced from the last of the successive settling tanks. The tanks have flat bottoms. Passageways extend between each successive tank for gravity flowing liquid from one tank to successive settling tank. A solids tank or centrifuge is also mounted within the skid. The solids and settling tanks are located for weight balancing. A rotational suction is positioned in the bottom of each settling tank and having one or more radially extending conduits which rotate about an axis and have inlets at their distal ends which traverse an inscribed circular path about the periphery of the tank's bottom. Collected solids are directed to the solids tank and a drag conveyor transporting solids product outside the skid.

US Patent Application, Publication Number 2006/086676 Smith, discloses an apparatus comprising a settling tank divided into three compartments by dividers having overflow openings therein for separating solids from a solids laden drilling fluid. The solids settle in a sump from which a fraction is tapped off and pumped with a pump through a conduit to a centrifuge. The centrifuge is located above the settling tank on an erectable platform. The platform is arranged on pivotable legs and erected using telescoping cylinders. A

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flocculant is added from a flocculant store. A bin is provided to receive solids. The components are arranged on a skid to facilitate transportation on a truck trailer. An alternative settling tank is disclosed having
5 nine compartments arranged in series.

US Patent Application, Publication Number 2005/0040119 Kulbeth, discloses an apparatus for separating solids from solids laden drilling fluid, the apparatus comprising a trailer having a scalping shale
10 shaker, the overflow flowing into a bin and the underflow flowing into a settling compartment of a converging container, the settled solids slurry fraction withdrawn on an auger and flowing through a pumped conveying line to a mud cleaner comprising a hydrocyclone and a fine
15 screen shaker. The overflow from the mud cleaner flowing into the bin and the underflow flowing into a baffled compartment of the container, the solids slurry fraction withdrawn on auger to a pumped conveying line and into a further mud cleaner, the overflow flowing into bin and
20 the underflow flowing into the a baffled compartment of the container, the settled fluid pumped and jetted into a compartment which contains overflow fluid from container.

US Patent Number 4,587,024 Hayatdavoudi, discloses a
25 pair of skid mounted cyclone separators.

US Patent Number 5,303,786 Prestridge, discloses a fluid laden drill cuttings processing apparatus comprising a plurality of hoppers flowing material into a conveying auger conveying the drill cuttings to a bucket
30 elevator supplying a ball mill. The resultant cuttings flowing on to a coarse screen and into a holding tank, the settled slurry pumped on to cascading screens, the

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overflow returned to the ball mill and the underflow back into tank. Fluid in the top portion of the tank pumped on to a screen, the overflow returned to ball mill and the underflow flows out of the system.

5 There has long been a need, recognized by the present inventors, for effective and efficient systems for on-site treatment and processing of well fluids. There has long been a need, recognized by the present inventors, for effective and efficient unitized skid-
10 mounted systems for processing well fluids with centrifuge apparatus.

 U.S. Patent 6,863,809 discloses transportable drilling fluid cleaning systems for removing solids from drilling fluid at a drill site comprises a platform for
15 transporting the system. A bin region on the platform retains solids from the drilling fluid. A settling tank on the platform separates the drilling fluid into an upper fluid fraction having a reduced concentration of solids and a lower solids fraction having a higher
20 concentration of solids as the drilling fluid flows from an inlet chamber for receiving drilling fluid to at least one other chamber. A stand on the platform supports at least one centrifuge for separating the solids from the drilling fluid, the stand being movable between stored
25 and operating positions. The system provides a self contained unit that is easily transportable on a flat bed truck to provide all the ancillary equipment necessary for solids control at the drill site. In certain aspects such systems include: a platform for transporting the
30 cleaning system to a drill site; a bin region on the platform to retain solids from the drilling fluid; a settling tank on the platform having an inlet chamber to

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receive drilling fluid and at least one other chamber, the settling tank acting to separate the drilling fluids into an upper fluid fraction having a reduced concentration of solids and a lower solids fraction having a higher concentration of solids as the drilling fluid flows from the inlet chamber to at least one other chamber; and a stand on the platform to support at least one centrifuge for separating the solids from the drilling fluid, the stand being movable between a stored position during transport of the platform and an operating position. In certain of these systems, the platform is skid loadable onto a trailer towable by a vehicle to move the system as a unit.

According to the present invention, there is provided an apparatus for processing solids laden fluid used in the drilling and maintenance of oil and gas wells, the apparatus comprising a base, a support structure on the base, a brace apparatus releasably connected to the base for bracing the support structure, and a holding tank apparatus on the base for holding the solids laden fluid, a pump apparatus for pumping solids laden fluid from the holding tank apparatus to a centrifuge apparatus, the centrifuge apparatus for centrifuging a mixture of the solids laden fluid to produce a reusable component of the solids laden fluid, and a centrifuge support on the base for supporting the centrifuge apparatus characterised in that said holding tank comprises a conical bottom which reduces in cross-sectional area towards a lower point for facilitating solids concentration and movement.

Preferably, the brace apparatus braces the support structure during movement of the apparatus.

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Advantageously, the centrifuge apparatus comprises a plurality of centrifuges, preferably all arranged on the centrifuge support. Preferably, the centrifuge apparatus produces an overflow of cleaned well fluid for feed back to the active rig well fluid system, and the centrifuge apparatus produces an underflow of drilled solids. Advantageously, the base comprises a skid. Advantageously, the centrifuge is transported separately from the apparatus or within the apparatus but not on the centrifuge support or on the centrifuge support.

Preferably, the base comprises a skid and is mountable on at least one of: a truck, lorry, train carriage and barge. Preferably, the skid is of standard size and may have a foot print of a 40ft ISO container. Advantageously, the brace apparatus is also releasably connected to the support structure. Preferably, the centrifuge support is collapsible, such that during transportation of the apparatus, the centrifuge support is stored in a collapsed state and during use, the centrifuge support is used in an erected state. Advantageously, the apparatus further comprises raising apparatus for raising the centrifuge support to a desired height. Preferably, the raising apparatus raises the centrifuge support up vertically. Advantageously, the raising apparatus comprises a hydraulically powered piston apparatus. Preferably, the centrifuge is arranged on the centrifuge support above the holding tank.

Advantageously, the apparatus further comprises a mixing tank for mixing materials in aqueous solution for introduction as solids laden fluid into the holding tank apparatus. Preferably, a further pump apparatus is provided for pumping the solids laden fluid in aqueous

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solution from the mixing tank to the at least one holding tank. Advantageously, the materials in aqueous solution include flocculant and coagulant.

5 The conical bottom preferably comprises a cone or frusto-conical portion which reduces in cross-sectional area towards a lower point.

Advantageously, the holding tank apparatus comprises a first holding tank, a second holding tank adjacent the first holding tank. Each holding tank may comprise a
10 baffle to facilitate settling of solids and separation of fluid therefrom. Preferably, the apparatus further comprises water flow apparatus via which water is flowable from the second holding tank to the first holding tank. Preferably, the holding tank apparatus
15 comprises at least one settling tank, wherein at least a portion of the solids in the solids laden fluid collect at the bottom of the settling tank.

Preferably, the apparatus further comprises a pump apparatus for pumping water from the first holding tank.
20 Preferably, the pump apparatus pumps the water to one of the active rig well fluid system and storage.

Advantageously, the holding tank apparatus comprises a jet line for providing fluid under pressure. Preferably, the jet line facilitates flow of the
25 recovered barite solids to the active rig well fluid system.

Preferably, the apparatus further comprises an active rig well fluid system, the well fluid to be treated flowing from the active rig well fluid system.

30 The present invention also provides a method for processing solids laden fluid used in the drilling and maintenance of oil and gas wells using the apparatus as

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claimed in any preceding claim, the method comprising the steps of flowing waste fluids from an active rid well fluid system to the apparatus, wherein the solids laden fluid flows into a holding tank and pumped from the
5 holding tank to the centrifuge.

The present invention discloses, in certain aspects, systems for treating well fluids which are easily transportable; which include erection apparatus for raising system components to facilitate their positioning
10 and operation; and which include removable bracing structures for transport.

In certain aspects, such systems require no auger apparatus to move material. In certain aspects, such systems employ at least one or one or more cone-bottom
15 tanks with a feed well from which top fluid is skimmed to an adjacent tank via a baffle. The conical bottom converges and concentrates solids for removal or for feed to one, two, or more centrifuges for further processing. In certain particular aspects, using such cone tanks,
20 barite recovery is enhanced since there is one primary suction area or point within the tank. This is also beneficial in oil-based mud solids reduction (stripping) operations to concentrate solids. In such systems, optional agitation enhances chemical and solids/fluid
25 blending and inhibits the accumulation and the undesirable build up of solids on the tank bottoms.

In certain aspects, systems in accordance with the present invention include raising apparatus for raising a centrifuge support with one or more centrifuges thereon.
30 The centrifuge support has multi-part telescoping vertical legs and the raising apparatus raises the centrifuge support up vertically as the legs telescope

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out vertically.

In certain aspects, such systems require relatively less space than certain prior systems. In certain aspects systems in accordance with the present invention
5 weigh about 24 tonnes (53,000 pounds), including a centrifuge and can fit on a 13 metres (43 ft) long skid; whereas certain prior systems weigh about 25.9 tonnes (57,000 pounds) without a centrifuge.

Such systems and methods with erection apparatus for
10 raising system components vertically to facilitate their positioning and operation; and such systems and methods with the system parts braced with releasable bracing apparatus for stability during movement of the system, e.g. during transport to a remote site.

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For a better understanding of the present invention, reference will now be made, by way of reference to the accompanying drawings, in which:

Figure 1A is a side view of a system in accordance
5 with the present invention;

Figure 1B is a top view of the system shown in Figure 1A;

Figure 1C is a perspective view of part of the system shown in Figure 1A;

10 Figure 1D is a side view of part of the system shown in Figure 1A;

Figure 1E is a top view of part of the system shown in Figure 1A;

15 Figure 1F is a side view of part of the system shown in Figure 1A;

Figure 1G is a perspective view of part of the system shown in Figure 1A;

Figure 1H is an end view of the system shown in Figure 1A;

20 Figure 1I is an end view of the system shown in Figure 1A with part of the system raised;

Figure 1J is a perspective view of part of a centrifuge support used with the system as shown in Figure 1A, with a location of the centrifuge indicated in
25 dashed lines;

Figure 1K is a top view of the centrifuge support shown in Figure 1J;

Figure 1L is a perspective view of part of a centrifuge support;

30 Figure 1M is a top view of the centrifuge support shown in Figure 1L;

Figure 1N is a perspective view of part of a

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centrifuge support in accordance with the present invention;

Figure 10 is a top view of the support shown in Figure 1L;

5 Figure 2 is a perspective view of a tank of the system shown in Figure 1A;

Figure 3 is a perspective view of part of the system shown in Figure 1A;

10 Figure 4 is a perspective view of a shale tank of the system of Figure 1A;

Figure 5A is a side view of a power apparatus for raising a centrifuge support of the system shown in Figure 1A, shown in a first step of operation;

15 Figure 5B is a side view of the power apparatus shown in Figure 5A in a second step of operation;

Figure 5C is a side view showing the power apparatus shown in Figure 5A in the second step of operation;

Figure 6A is a schematic view of a system in accordance with the present invention;

20 Figure 6B is a schematic view of a system in accordance with the present invention;

Figure 6C is a side schematic view of the system shown in Figure 6B;

25 Figure 6D is a side view in cross-section of part of the system shown in Figure 6B; and

Figure 7 is a side schematic view of a system in accordance with the present invention.

30 Figures 1A and 1B show a system 10 in accordance with the present invention which has a base known as a skid 12 removably positioned on a trailer 14. Fluid to be treated (including, but not limited to, spent drilling fluid with drilled cuttings and/or solids therein) is

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pumped from an active rig system ARS to a first holding tank 30. A pump 42 pumps fluid from a tank 31 to an active rig pumping system ARS. Flocculant and coagulant is mixed in aqueous solution in the tank 21 with an
5 agitator or impeller 21a (shown schematically) in the tank. The coagulant, e.g. but not limited to calcium nitrate - CaNO_3 , makes the fluid more of a fluidic semi-solid mixture. A pump or pumps 20 (shown schematically) in a doghouse enclosure 16 pump the fluid-flocculant
10 mixture from the tank 21 to the first holding tank 30; and, optionally, to a centrifuge or centrifuges as described below in detail. The doghouse enclosure 16 may also have: pumps for the flocculant mixture 16a; impeller/agitator controls 16b; hydraulic controls 16c
15 for power apparatus 78; and/or a heater 16d. Solids that settle down in the tank 30 are pumped by the pump 40 (shown schematically) to a centrifuge 50 (shown schematically, Figures 1A, 1B). Water from the upper part of the tank 30 overflows via water flow apparatus, a
20 baffle 32, to the tank 31. Relatively clean water from a feed well 31w is pumped by the pump 42, e.g. to storage or to the active rig system ARS. Any desired number of tanks like the tanks 30 and/or 31 may be used.

A sensor system 42s signals the pump 42 to control
25 the amount of water sent to the rig system ARS. Solids with some fluid from the lower part of the tank 31 (and from lower the part of the tank 30) are pumped by the pump 40 to the centrifuge 50 (one or two or more centrifuges 50 may be used). Relatively clean water from
30 the upper part of the tank 30 flows via the baffle 32 to the tank 31 and is then pumped to the active rig system ARS by the pump 42. Fluid (including water and some

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drilling fluid) with solids in it is pumped by the pump 40 to the centrifuge 50. In one aspect the tanks 30 and 31 have conical bottoms 30c and 31c, respectively, to facilitate solids movement and flow.

5 Centrifuge underflow (drilled solids separated in the centrifuge by centrifugal force) flows from the centrifuge 50 down into a tank 60. This underflow is then transferred to a holding tank or pit for storage and/or further treatment.

10 The system 10 includes a structure 70 with a plurality of interconnected beams, members, bars, supports and pieces 70p. Some of these pieces 70p form upper walkways 70w and hand rails 70h.

 To buttress the system 10 and the structure 70 during transport and movement, a removable brace apparatus 80 is releasably connected to the structure 70 and to the skid 12. The apparatus 80 includes four beams 82 each with an end 83 releasably connected to the skid 12 and with another end 84 releasably connected to the structure 70. As shown in Figure 1D a removable pin 85 releasably secures an end 83 to the skid 12. Pins 87 releasably secure the ends 85 to an upright 89 of the structure 60. The pins are removed and the beams 82 are removed following positioning of the system at a site.
25 Four beams 82 are shown, but two, three, five, six or more can be used. The beams 82 do not prevent erection of the centrifuge support 74 described below.

 As shown in Figure 1G the structure 70 includes a centrifuge support 74 with legs 75 and 76. A power apparatus 78 (e.g. an hydraulic piston apparatus powered by an available hydraulic power unit 78h, shown schematically, Figure 1I) can raise the centrifuge

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support 74 up vertically with respect to lower legs 76 of the structure 70. Figure 1I shows the legs 75 raised with respect to the legs 76. The legs 75 telescope out of and up from the legs 76.

5 Figure 1H shows the centrifuge support 74 in a lowered position and Figure 1I shows it in a raised position. An extension ladder 77 extends upwardly as the centrifuge support 74 is raised.

10 The centrifuge 50 produces the underflow described above and a stream 52 of clean drilling fluid which can be fed into a line 501 by gravity flow to the line 31m for return to the active rig system ARS.

15 The tanks 30, 31 are shown as "cone" tanks with a bottom shaped to converge solids; but it is within the scope of other aspects of the present invention to use other tanks, e.g. with non-conical bottoms or with flat bottoms.

20 Figures 1J - 1O illustrate various possibilities in accordance with the present invention for solids discharge from one or two centrifuges on a support 74. Figures 1J and 1K show a support 74a for one centrifuge 74k (shown schematically in dotted lines) with a single solids discharge channel 74b. Figures 1L and 1M show a support 74c with a single solids discharge channel 74d. 25 Figures 1N and 1O show a support 74e with two solids discharge channels 74f, 74g for centrifuges 74m, 74n (in dotted lines) (or alternatively, 74h, 74i - shown in dotted lines). Any two discharges shown in Figure 1O may be used.

30 In certain particular aspects the overall footprint of a system in accordance with the present invention is 12.8m (42ft) by 2.4m (8ft) and the footprint of one

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particular old system is 12.2m (40ft) by 9.75m (32ft).

Figures 5A to 5C illustrate various positions for the hydraulic ram apparatus 78.

Figure 6A shows schematically a system 100 like the
5 system shown in Figure 1A. Two centrifuges 101, 102 are
like the centrifuge 50; and tanks 130, 131 correspond,
respectively, to the tanks 30, 31. A tank 160
corresponds to the tank 60; a pump 142 corresponds to the
pump 42; and an active rig system ART corresponds to the
10 active rig system ARS.

As shown in Figure 6A the system 100 is useful, e.g.
in typical drilling operations. A slurry from the active
rig system ART fed to the tank 130 with solids material
therein is pumped by a pump 151 to the centrifuge 101 in
15 a feed line 137. The underflow (with solids and drilled
solids) from the centrifuge 101 is gravity fed to the
tank 160. The overflow from the centrifuge 101 is
gravity fed to the tank 130 or back to the system ART.
From the tank 130, a pump 152 pumps fluid with solids in
20 a feed line 135 to the centrifuge 102. Overflow from the
centrifuge 102 flows by gravity to the active rig system
ART or to the tank 130. Underflow from the centrifuge
102 flows to the tank 160.

The tank 130 can overflow to the tank 131 via a
25 baffle 132.

The centrifuge overflows of centrifuges 101 and 102
are primarily cleaned fluid and the underflows contain
drill solids for return to the tank 160. Pump suction
from the pump 151 and/or the pump 152 is applied to the
30 line 133 to pump from both tanks 130 and 131.

Relatively clean fluid is pumped by the pump 142 in
a line 144 to the active rig system ART.

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In one particular aspect the system 100 is used for barite recovery, as shown in Figures 6B and 6C. A slurry from the active rig system ART with barite material therein is pumped from a line 138 by the pump 151 in the line 137 to the centrifuge 101. The underflow (primarily barite and/or drilled solids) is jetted by a line 137 and is gravity fed to the system ART in a line 139. The overflow from the centrifuge 101 is gravity fed in the line 134 to the tank 130. Material from the tank 130 is pumped by the pump 152 in the line 135 to the centrifuge 102. Overflow from the centrifuge 102 flows by gravity to the system ART. Underflow from the centrifuge 102 flows to the tank 160.

Centrifuge 101 underflow contains recoverable barite which is returnable to the active rig system ART. The jet line 107 is fed by the line 137. The jet line 107 is a line with pressurized fluid for inhibiting plugging by barite and for moving the barite to the system ART. In one aspect fluid from the line 137 is oil based fluid at about 1.7 bars (25 psi). Figure 6D illustrates the exit of barite solid particles from the centrifuge 101. This barite flows by gravity or is pumped.

Figure 7 shows one particular embodiment for the tanks 30, 31 and associated pumps 40 and 42. Slurry from the active rig system is introduced into the tank 30 via an inlet 30r. The slurry contains drilling fluid, drill solids or drilling solids (desirable solids added to drilling fluid), drilled solids (e.g. drilled cuttings) and debris. The mixture from the tank 21 is fed to the tanks 30, 31 ("FLOC MIX ENTRY"). The pump 40 pumps a mixture of solids and some other components to the

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centrifuge(s) 50. The pump 42 pumps water from the tank 31 back to the active rig system ARS. The pump 42 is connected to, and in fluid communication with, the feed well of the tank 31. Water pumped by the pump 42 comes
5 to it directly from the feed well of the tank 31.

Optionally, agitators ADJ with impellers L agitate the fluid in the tanks.

The present invention, therefore, provides in at
10 least certain embodiments, a system for well fluid treatment, the system being transportable, the system including: a base; a support structure on the base; a brace apparatus connected to the base and to the support structure for bracing the support structure during
15 movement of the system, the brace apparatus releasably secured to the support structure and releasably secured to the base; at least one holding tank on the base for holding well fluid to be treated, the well fluid to be treated from an active rig well fluid system and the well
20 fluid to be treated including solids; centrifuge apparatus for centrifuging a mixture of well fluid and solids from the at least one holding tank, producing a reusable component of the well fluid; a first pump apparatus for pumping well fluid and solids from the at
25 least one holding tank to the centrifuge apparatus; and a centrifuge support on the base for supporting the centrifuge apparatus. Such a system may have one or some, in any possible combination, of the following: a mixing tank for mixing materials in aqueous solution for
30 introduction to well fluid in the at least one holding tank, and a second pump apparatus for pumping materials in aqueous solution from the mixing tank to the at least

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one holding tank; wherein the materials in aqueous solution include flocculant and coagulant; raising apparatus connected to the centrifuge support for raising the centrifuge support and the centrifuge apparatus to a
5 desired height; wherein the raising apparatus raises the centrifuge support up vertically; wherein the raising apparatus includes hydraulically powered piston apparatus for raising the centrifuge support; wherein the at least one holding tank has a conical bottom for facilitating
10 solids concentration and movement; the at least one holding tank is two holding tanks including a first holding tank, a second holding tank adjacent the first holding tank, the second pump apparatus pumping the materials in aqueous solution into the first holding
15 tank, and the first holding tank receiving the well fluid to be treated; water flow apparatus via which water is flowable from the second holding tank to the first holding tank; a third pump apparatus for pumping water from the first holding tank; wherein the third pump
20 apparatus pumps the water to one of the active rig well fluid system and storage; wherein the well fluid to be treated includes drilled solids and the centrifuge apparatus produces an overflow of cleaned well fluid for feed back to the active rig well fluid system, and the
25 centrifuge apparatus produces an underflow of drilled solids; the centrifuge apparatus includes a plurality of centrifuges for processing fluid with solids from the at least one holding tank; wherein the well fluid to be treated contains recoverable barite solids and the
30 centrifuge apparatus produces an underflow with recovered barite solids for feed to the active rig well fluid system, and the centrifuge apparatus produces an overflow

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for feed to the at least one holding tank; and/or a jet line for providing fluid under pressure to the recovered barite solids to facilitate flow of the recovered barite solids to the active rig well fluid system.

5 The present invention, therefore, provides in at least certain embodiments, a system for well fluid treatment, the system being transportable, the system including: a base; a support structure on the base; a
10 brace apparatus connected to the base and to the support structure for bracing the support structure during movement of the system, the brace apparatus releasably secured to the support structure and releasably secured to the base; at least one holding tank on the base for holding well fluid to be treated, from an active rig well
15 fluid system and the well fluid to be treated including drilling solids and drilled solids; centrifuge apparatus for centrifuging a mixture of well fluid and solids from the at least one holding tank, producing reusable drilling solids; a first pump apparatus for pumping well
20 fluid and drilling solids from the at least one holding tank to the centrifuge apparatus; a centrifuge support on the base for supporting the centrifuge apparatus; a mixing tank for mixing materials in aqueous solution for introduction to well fluid in the at least one holding
25 tank; a second pump apparatus for pumping materials in aqueous solution from the mixing tank to the at least one holding tank; and wherein the materials in aqueous solution include flocculant and coagulant.

30 The present invention, therefore, provides in at least certain embodiments, a method for treating well fluid with drilling fluid, drilled solids, and drilling solids therein, the well fluid from an active rig well

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fluid system, the method including providing well fluid to a well fluid treatment system from an active rig well fluid system, the well fluid treatment system as any described or claim herein in accordance with the present invention, and producing reusable material with the centrifuge apparatus of the well treatment system. Such a method may have one or some, in any possible combination, of the following: the centrifuge apparatus producing a stream of reusable drilling solids, and returning the stream of reusable drilling solids to the active rig well fluid system; and/or the centrifuge apparatus producing a stream of reusable fluid, and returning the stream of reusable fluid to the active rig well fluid system.

15 The present invention, therefore, provides in at least certain embodiments, a method for transporting a well fluid treatment system, the well fluid treatment system including well fluid treatment apparatuses secured to a support structure, the support structure secured to a base, the method including connecting bracing apparatus releasably to the base and to the support structure to brace the well fluid treatment system during movement of the well fluid treatment system.

25 The present invention, therefore, provides in at least certain embodiments, a method for moving a centrifuge support with centrifuge apparatus thereon of a well fluid treatment system, the method including raising with raising apparatus the centrifuge support with centrifuge apparatus thereon, said raising being raising the centrifuge support up vertically.

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CLAIMS:

1. An apparatus for processing solids laden fluid used in the drilling and maintenance of oil and gas wells, the apparatus comprising a base (12), a support structure
5 (70) on the base (12), a brace apparatus (80) releasably connected to the base (12) for bracing the support structure (70), and a holding tank apparatus (30,31) on the base for holding the solids laden fluid, a pump apparatus (16) for pumping solids laden fluid from the
10 holding tank apparatus to a centrifuge apparatus (50), said centrifuge apparatus (50) for centrifuging a mixture of the solids laden fluid to produce a reusable component of the solids laden fluid, and a centrifuge support (74) on the skid (12) for supporting the centrifuge apparatus
15 characterised in that said holding tank comprises a conical bottom (30c,31c) which reduces in cross-sectional area towards a lower point for facilitating solids concentration and movement.
2. An apparatus as claimed in Claim 1, wherein said
20 base comprises a skid mountable on at least one of: a truck, lorry, train carriage and barge.
3. An apparatus as claimed in Claim 1 or 2, wherein said brace apparatus (80) is also releasably connected to the support structure (70).
- 25 4. An apparatus as claimed in Claim 1, 2 or 3, wherein said centrifuge support (74) is collapsible, such that during transportation of said apparatus, said centrifuge support (74) is stored in a collapsed state and during use, said centrifuge support (74) is used in an erected
30 state.
5. An apparatus as claimed in Claim 4, further comprising raising apparatus (75,76) for raising said

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centrifuge support (74) to a desired height.

6. An apparatus as claimed in Claim 5, wherein the raising apparatus (75,76) comprises a hydraulically powered piston apparatus.

5 7. An apparatus as claimed in any preceding claim, wherein said centrifuge (50) is arranged on said centrifuge support (74) above said holding tank (30,31).

8. An apparatus as claimed in any preceding claim, further comprising a mixing tank (21) for mixing
10 materials in aqueous solution for introduction as solids laden fluid into the holding tank apparatus (30,31).

9. An apparatus as claimed in any preceding claim, wherein the holding tank apparatus (30,31) comprises a first holding tank (30), a second holding tank (31)
15 adjacent the first holding tank (30).

10. An apparatus as claimed in Claim 9, further comprising water flow apparatus (32) via which water is flowable from the second holding tank (31) to the first holding tank (30).

20 11. An apparatus as claimed in Claim 9 or 10, comprising a pump apparatus (42) for pumping water from said first holding tank (30).

12. An apparatus as claimed in any preceding claim, wherein said holding tank apparatus comprises a jet line
25 (107) for providing fluid under pressure.

13. An apparatus as claimed in any preceding claim, further comprising an active rig well fluid system, the well fluid to be treated flowing from said active rig well fluid system.

30 14. An apparatus as claimed in any preceding claim, wherein the holding tank apparatus (30,31) comprises at least one settling tank, wherein at least a portion of

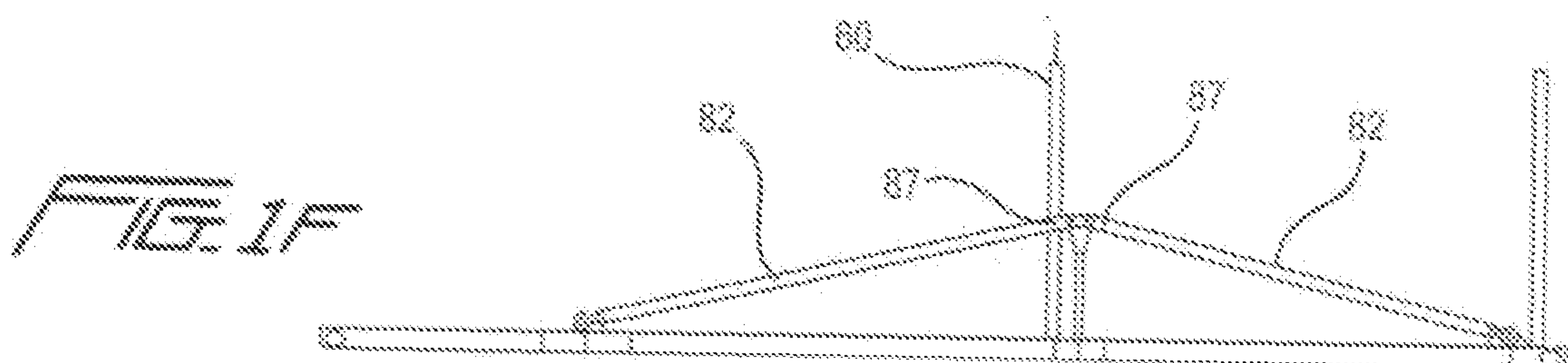
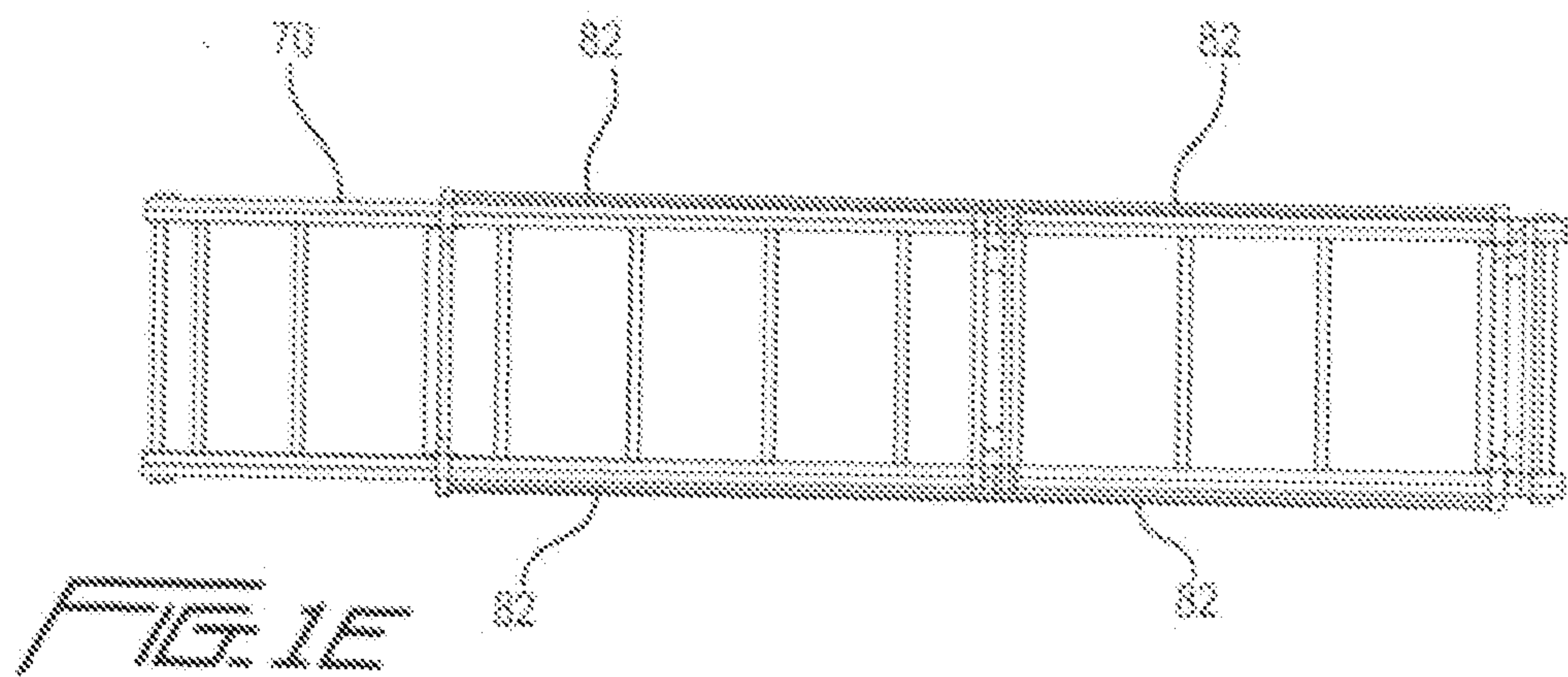
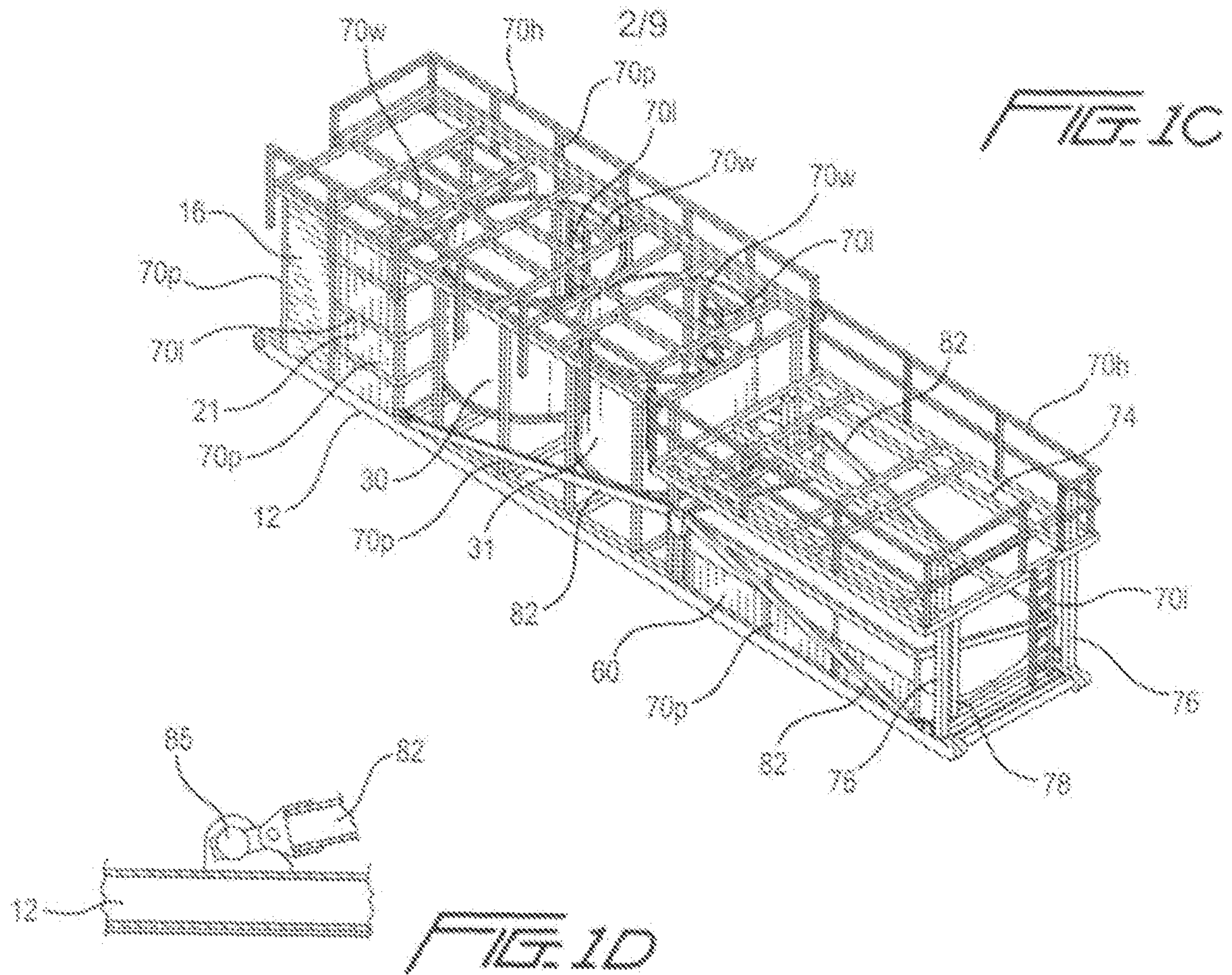
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the solids in the solids laden fluid collect at the bottom of the settling tank.

15. A method for processing solids laden fluid used in the drilling and maintenance of oil and gas wells using
5 the apparatus as claimed in any preceding claim, the method comprising the steps of flowing waste fluids from an active rid well fluid system to said apparatus, wherein said solids laden fluid flows into a holding tank (30,31) and pumped from said holding tank (30,31)
10 comprising a conical bottom to said centrifuge (50).

16. A method in accordance with Claim 15, wherein the method further comprises the steps of mixing materials in aqueous solution to said solids laden fluid for introduction into the holding tank apparatus.

15 17. A method in accordance with Claim 16, wherein the materials in aqueous solution comprise a flocculant and coagulant.



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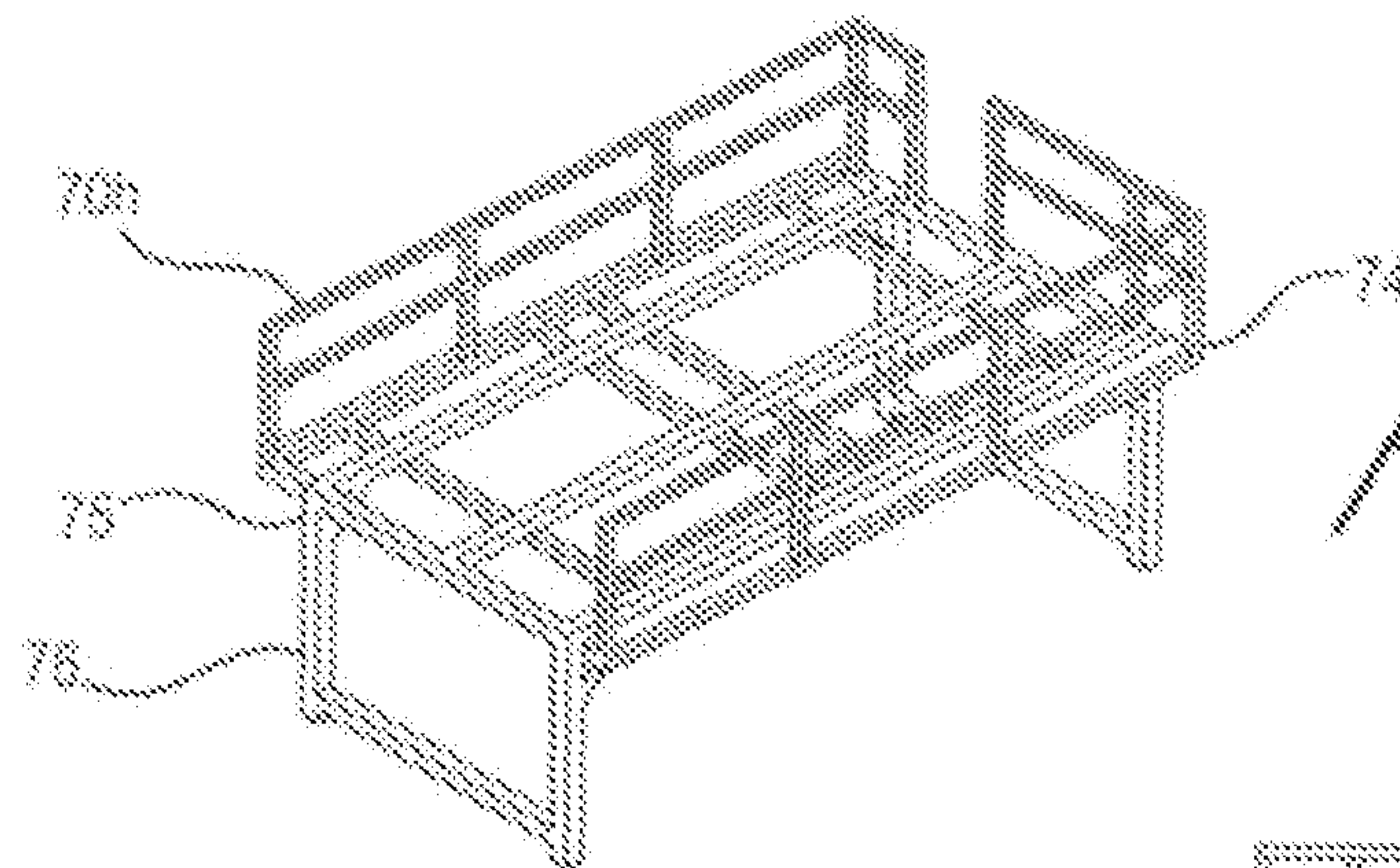


FIG. 1G

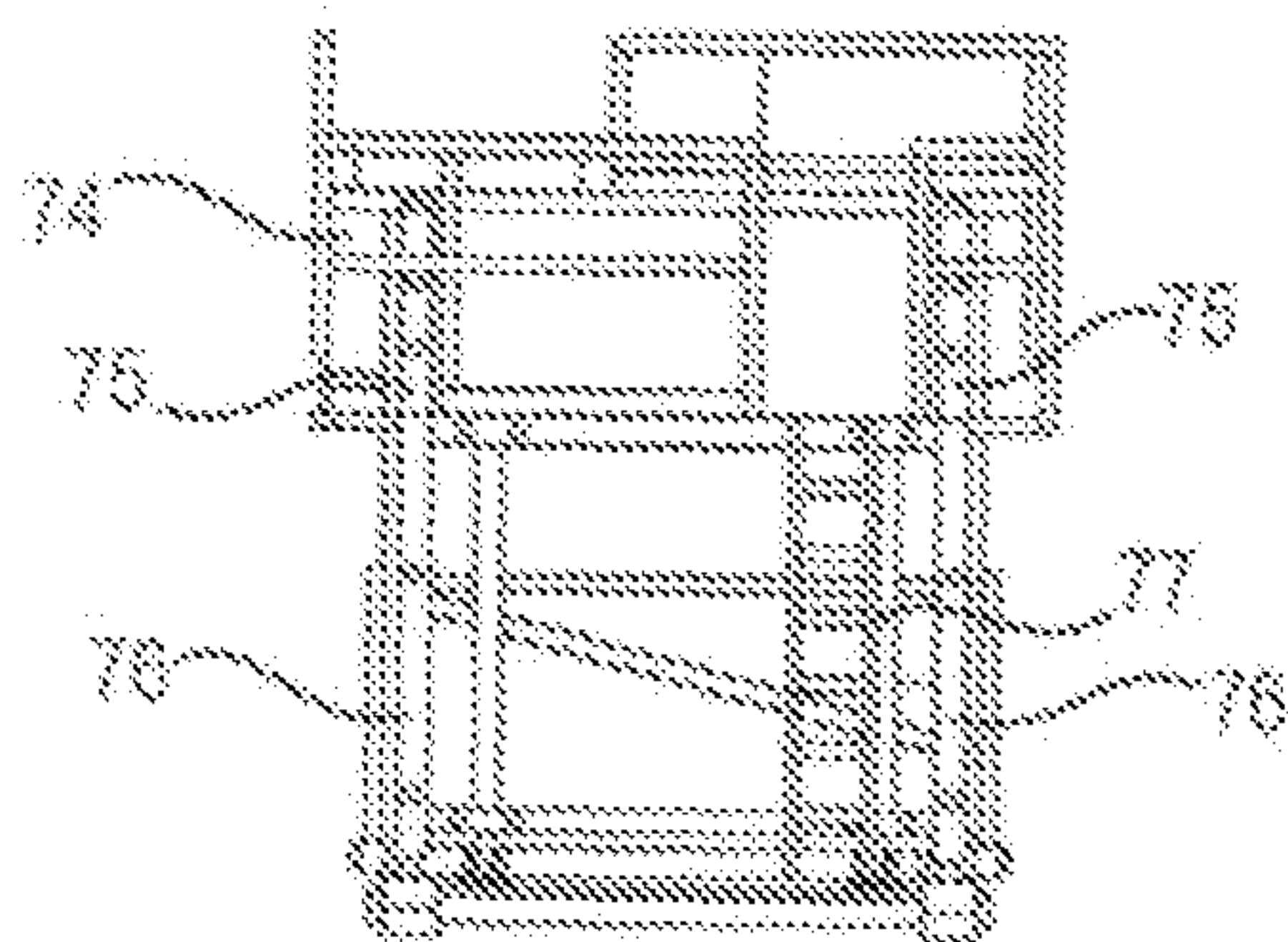


FIG. 1H

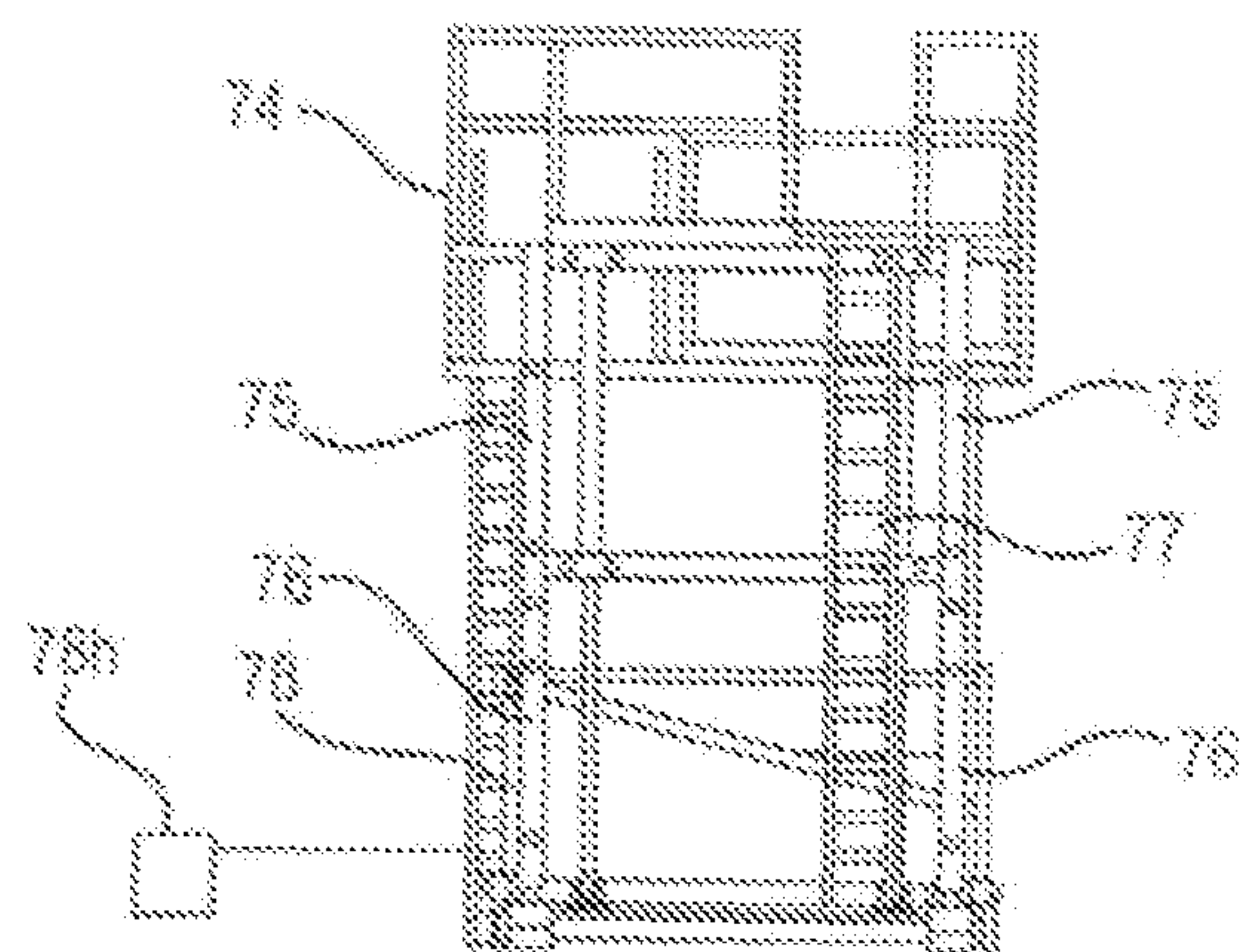


FIG. 1I

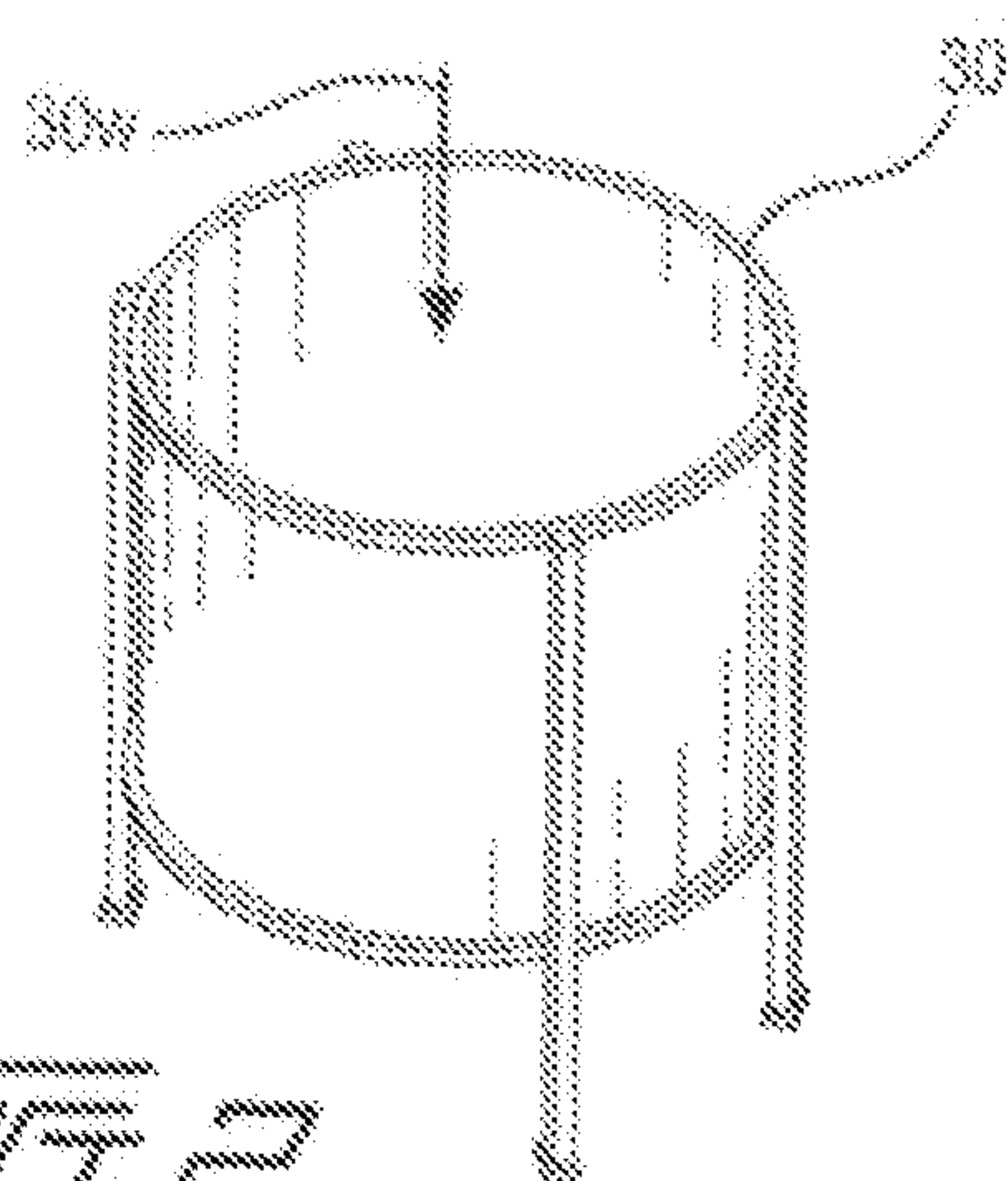


FIG. 2

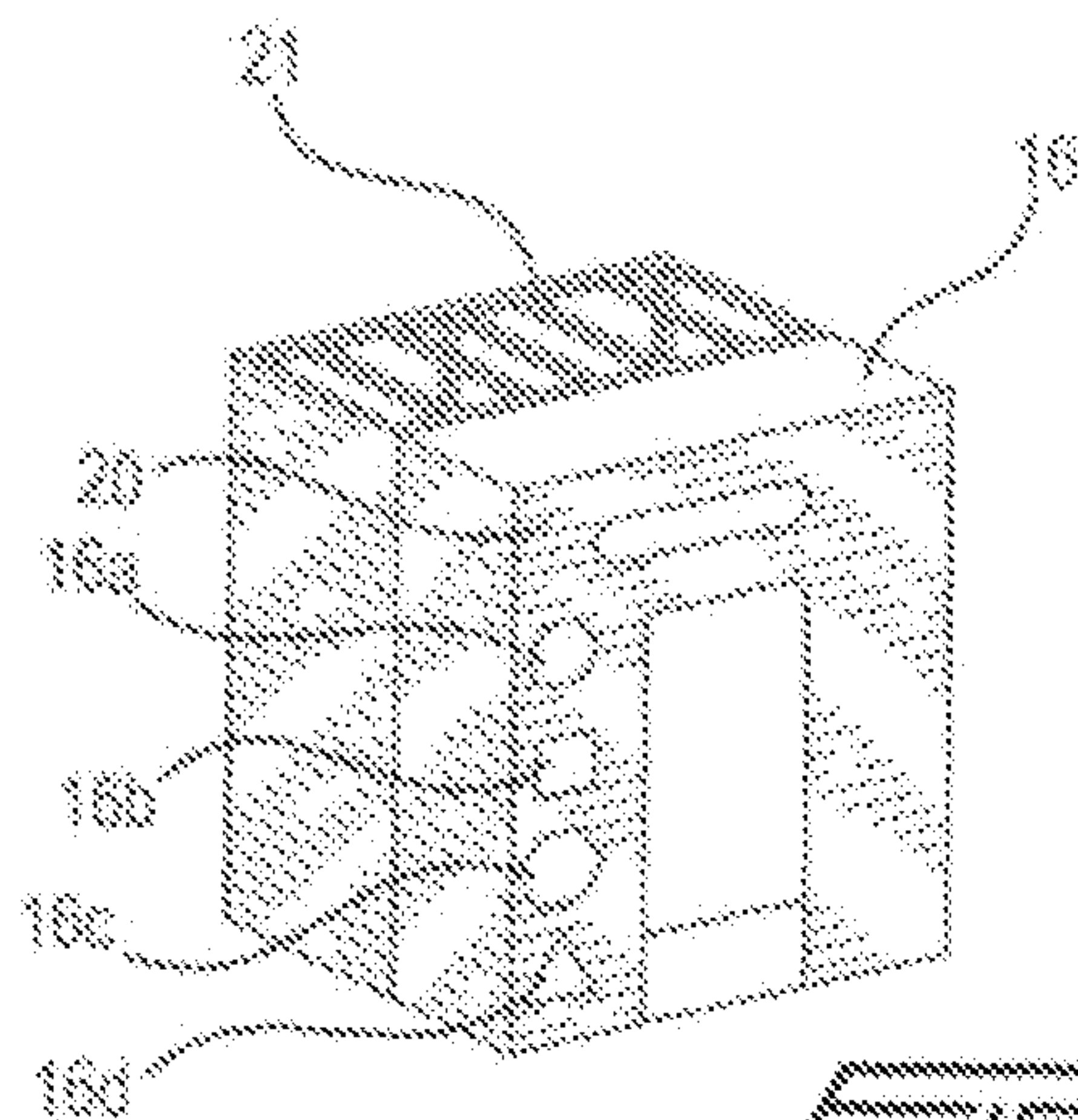


FIG. 3

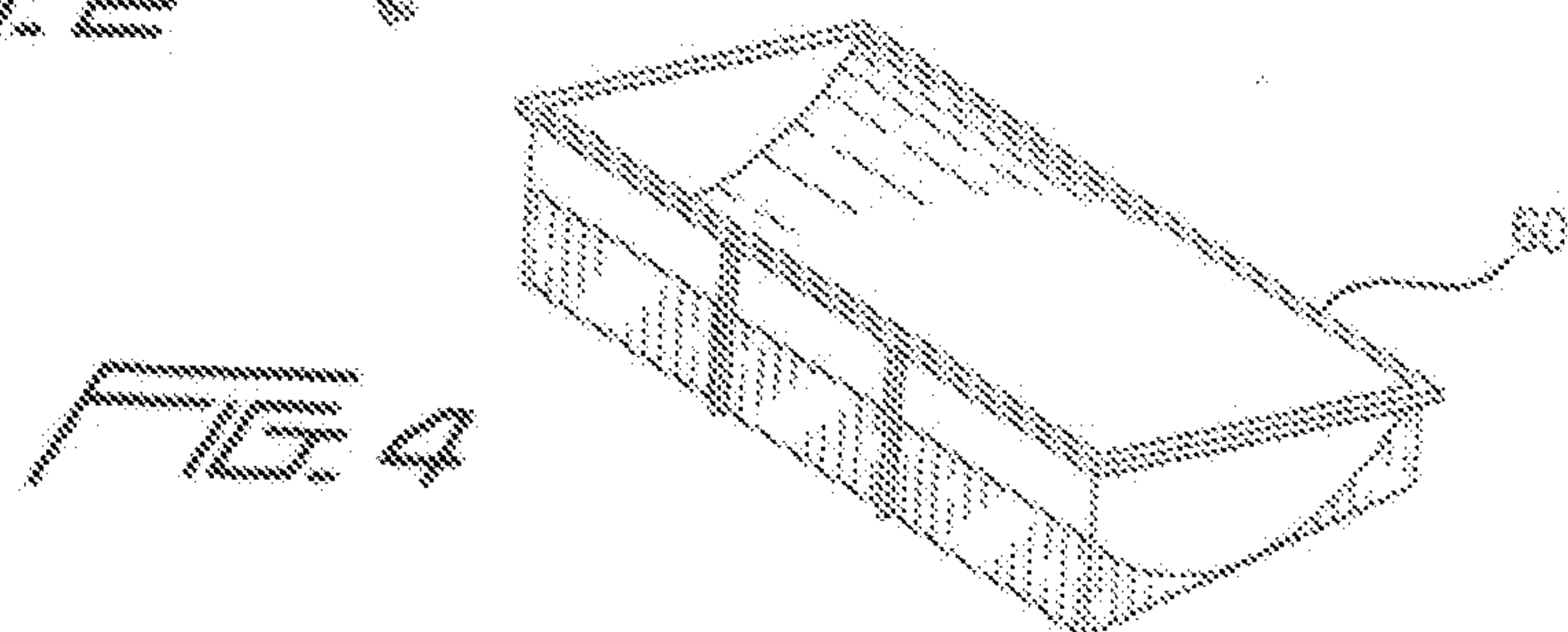


FIG. 4

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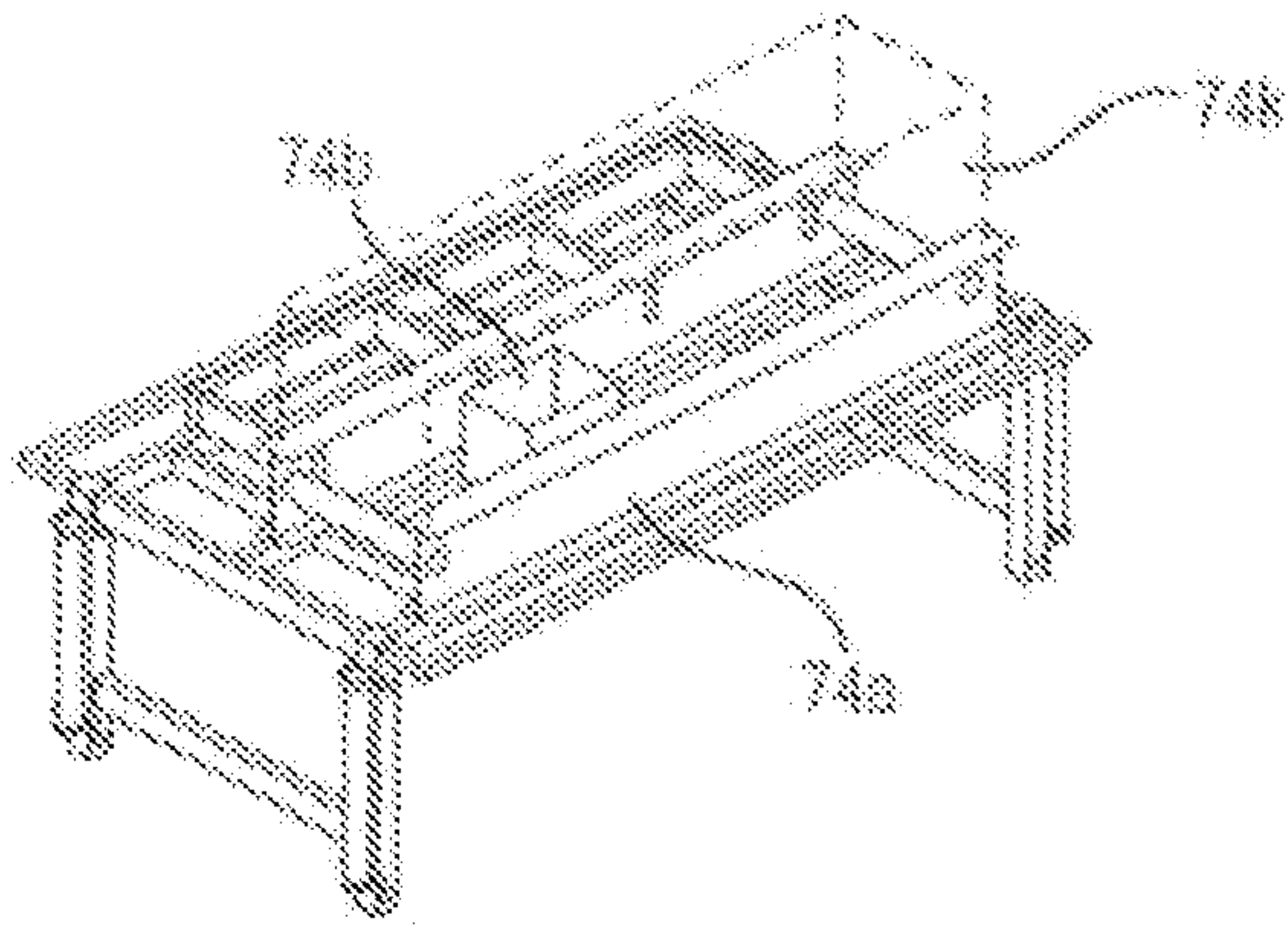


FIG. 9

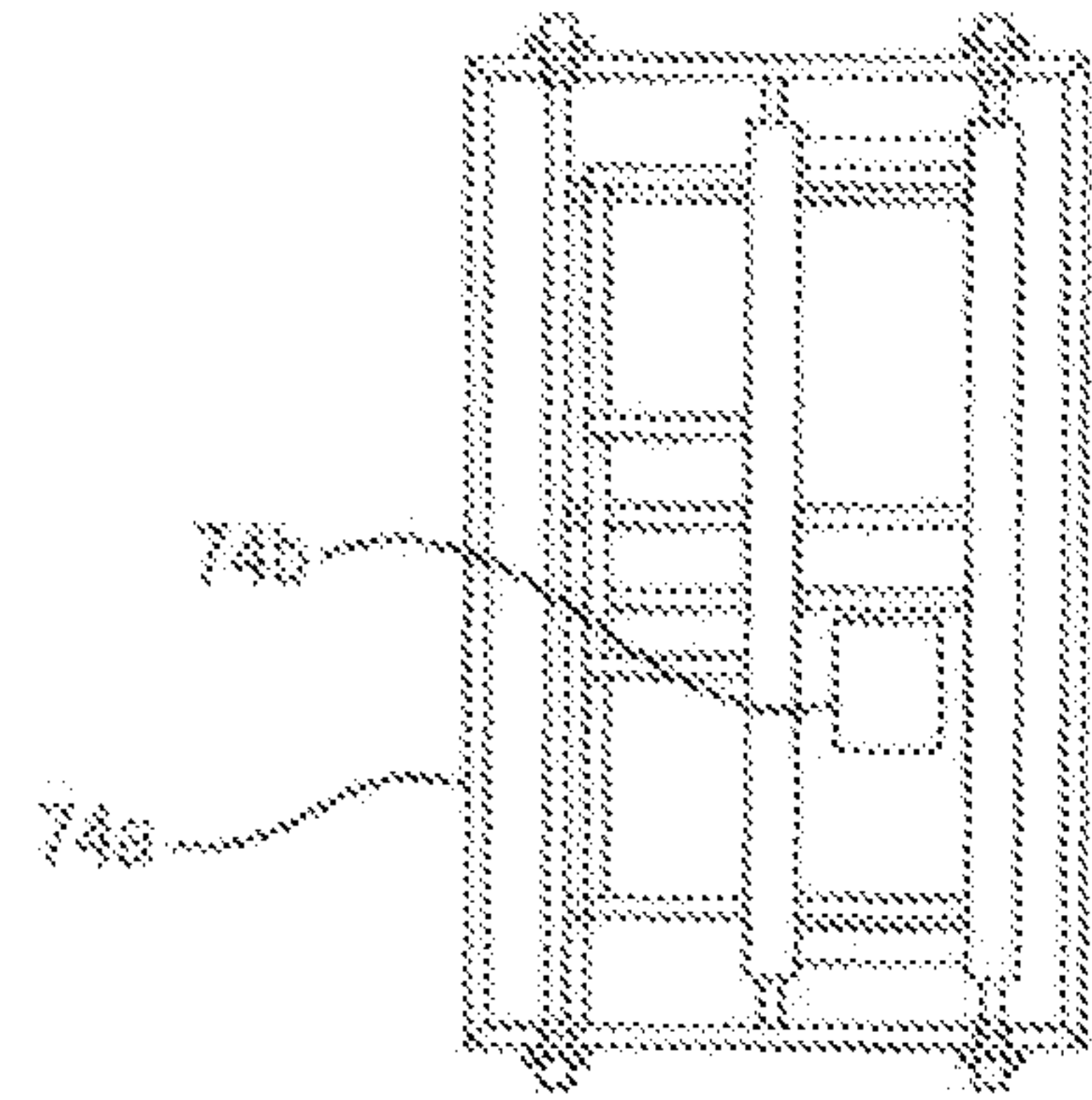


FIG. 1K

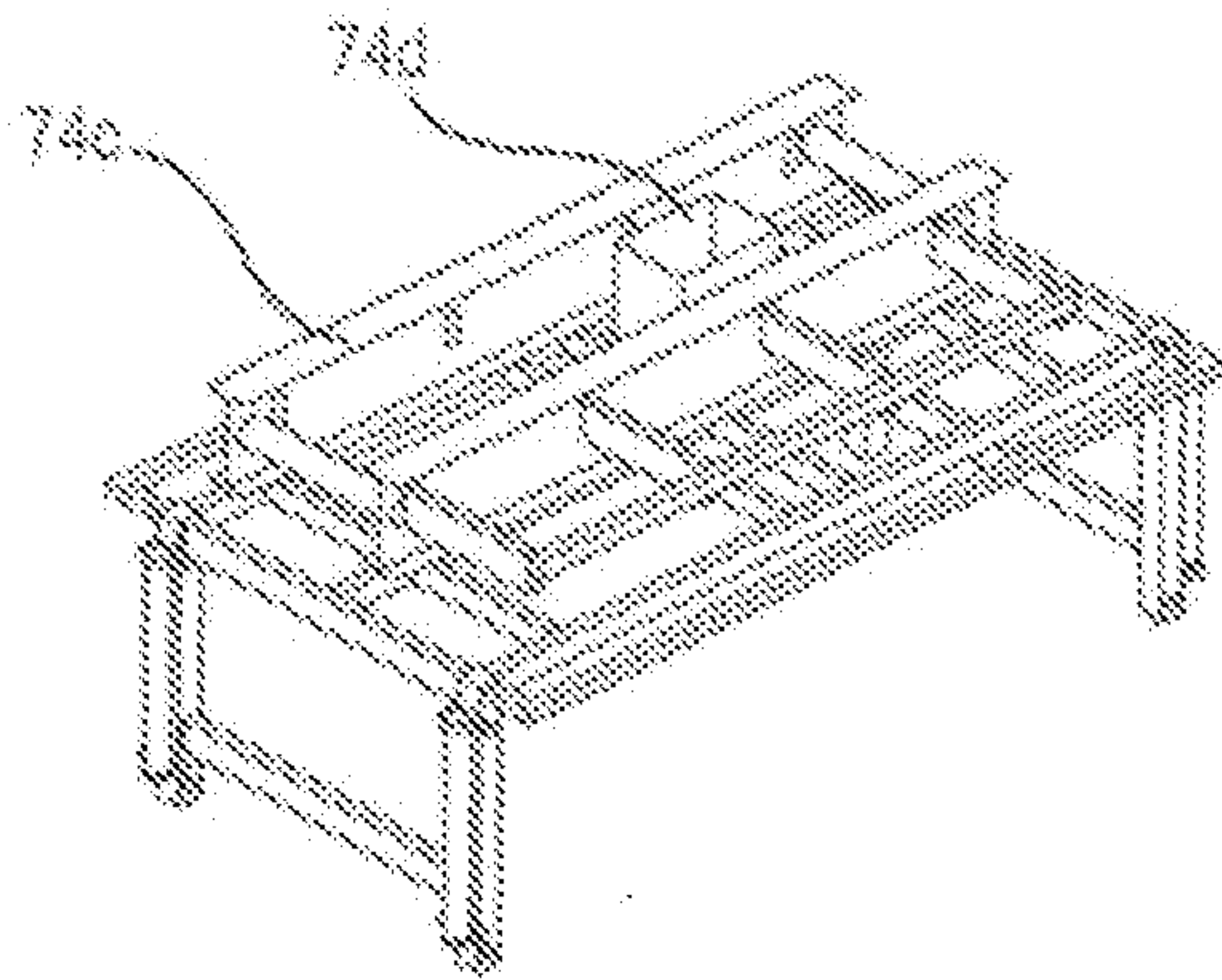


FIG. 1L

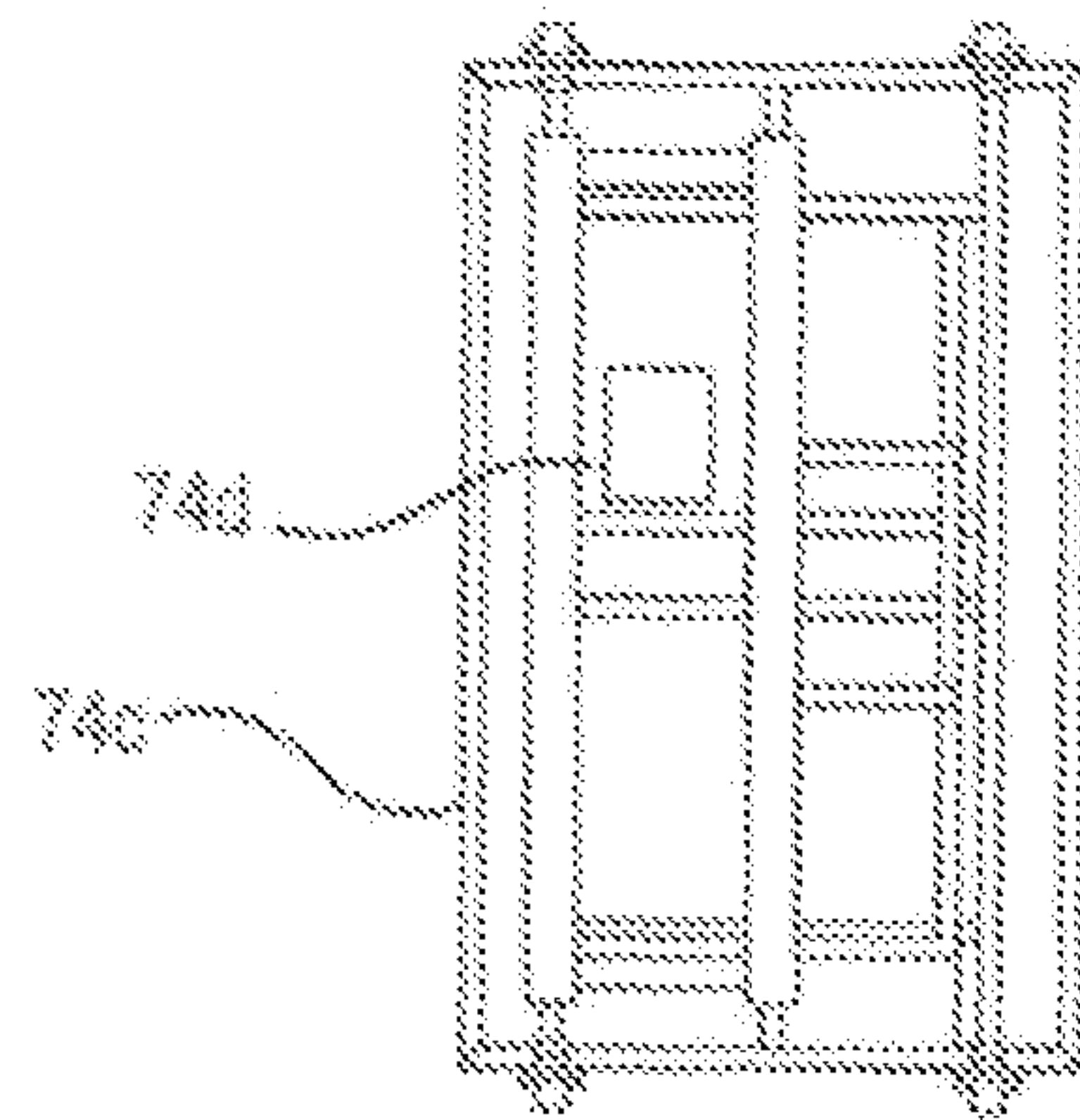


FIG. 1M

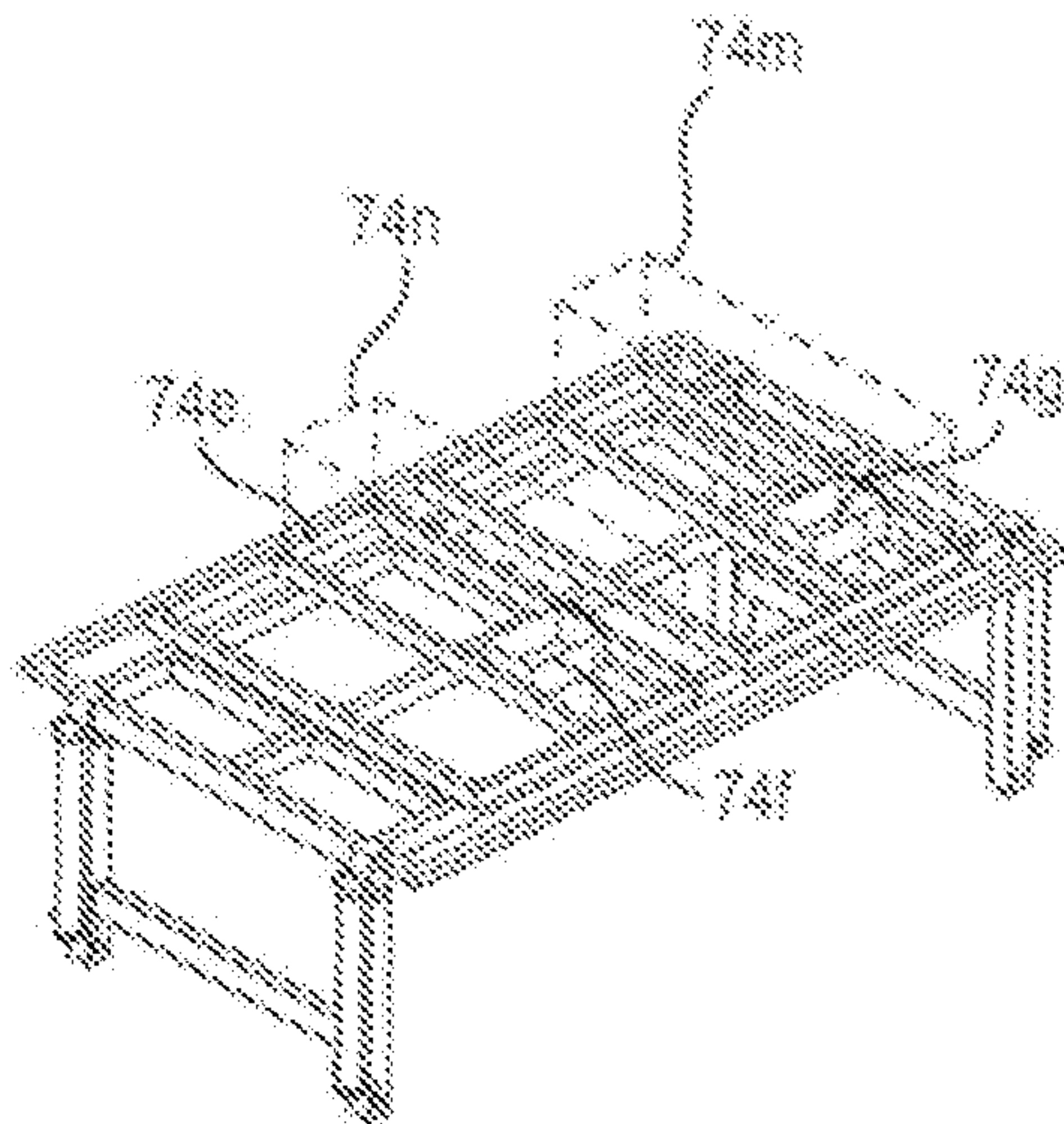


FIG. 1N

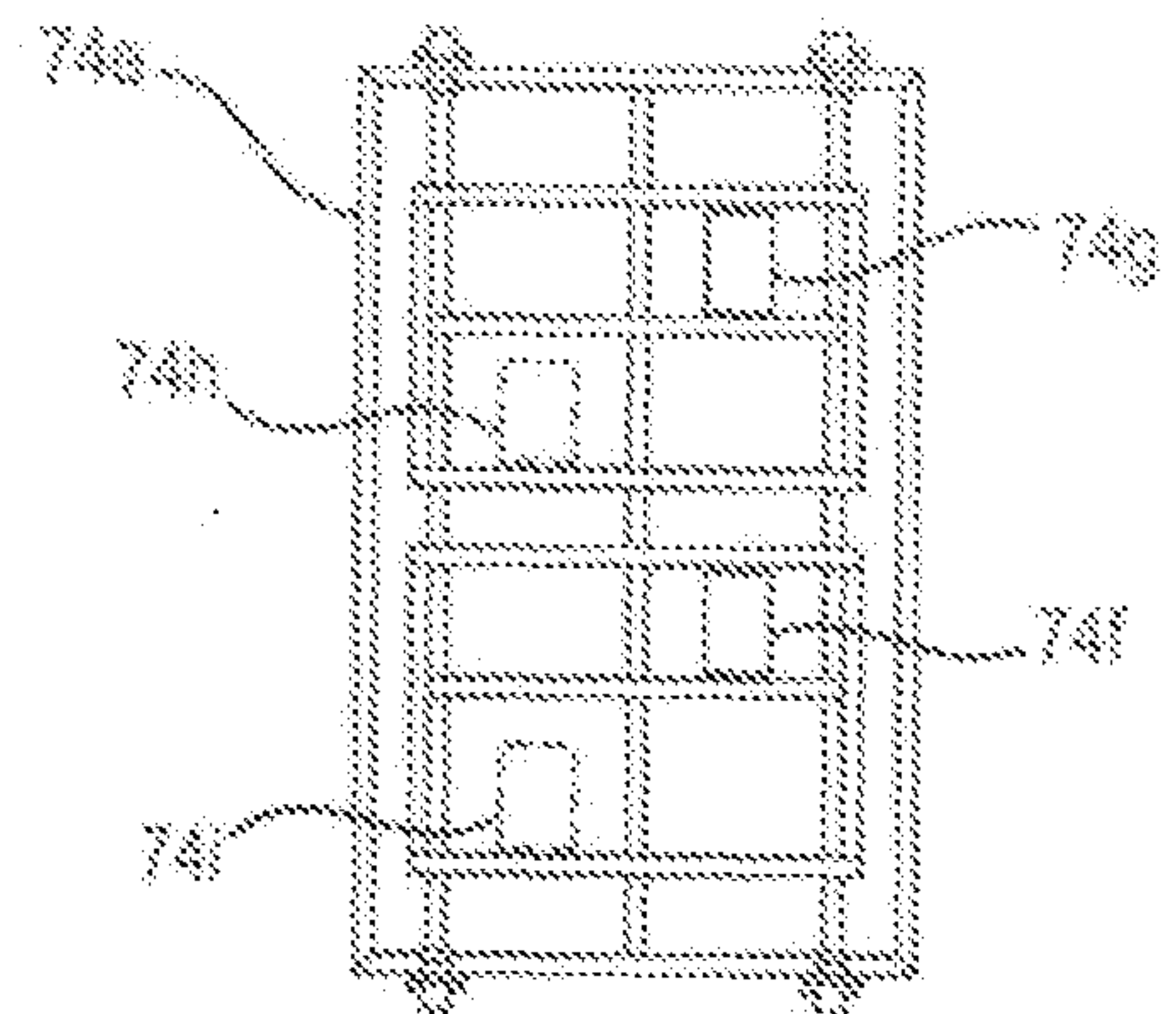


FIG. 1O

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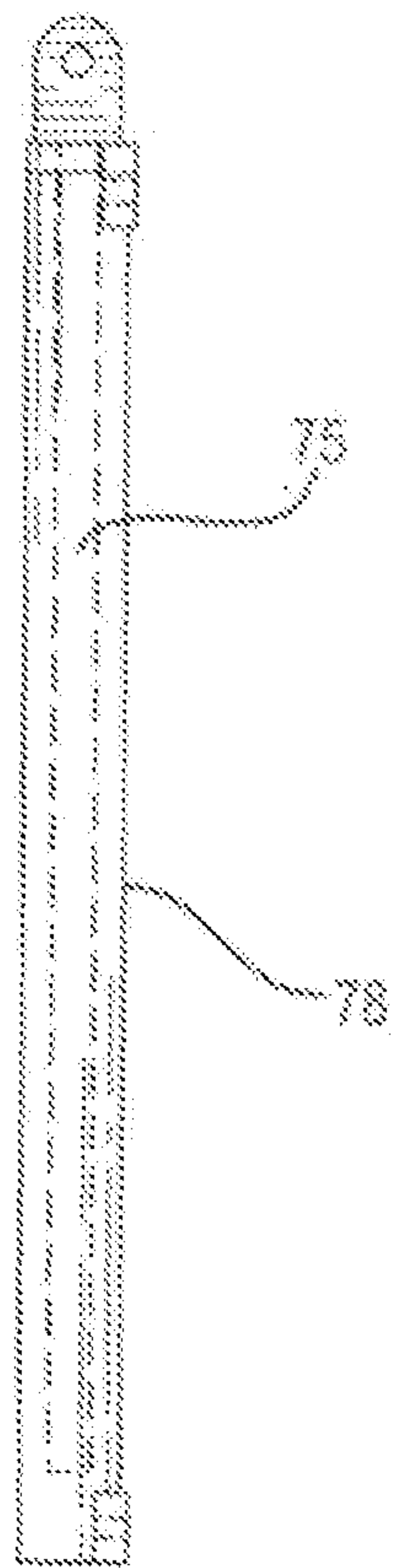


FIG. 5A

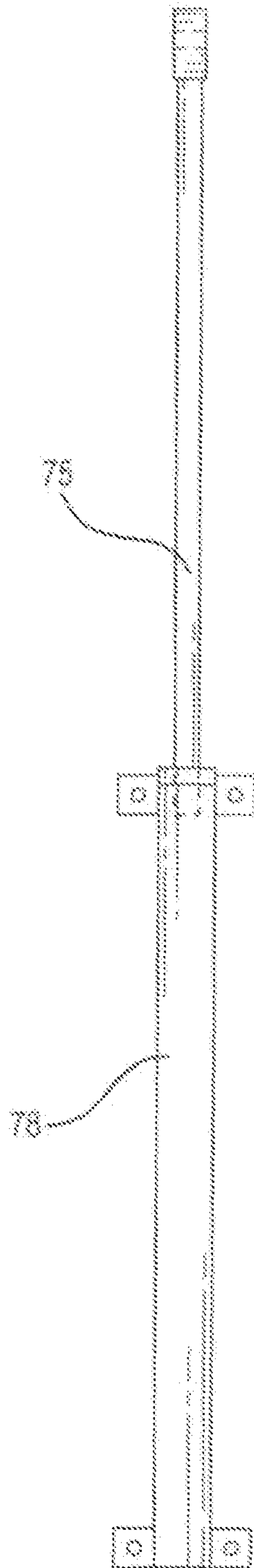


FIG. 5B

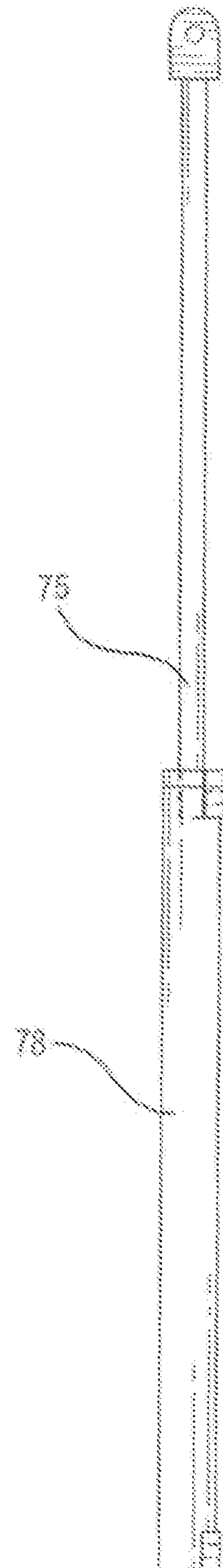
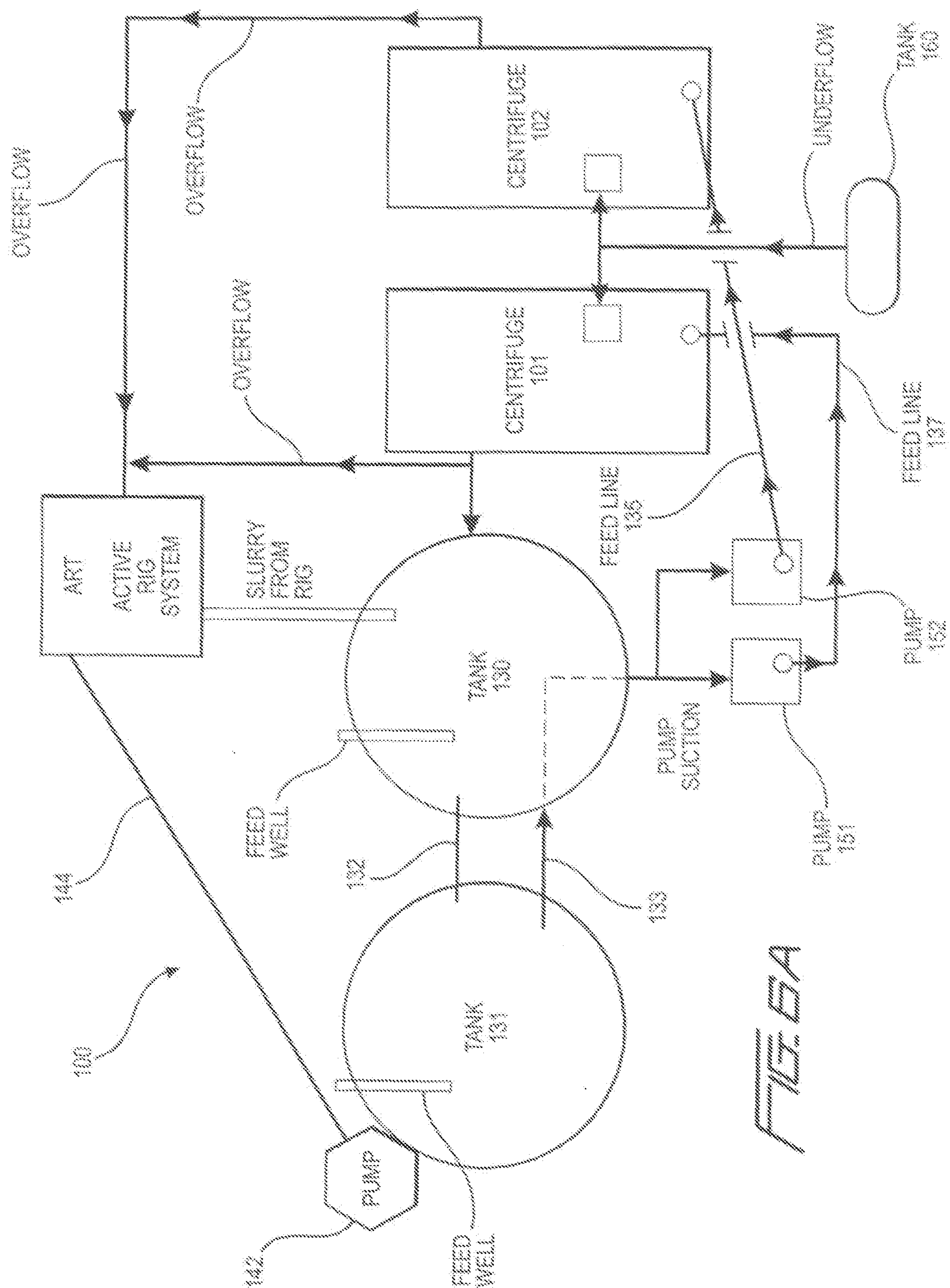


FIG. 5C

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*FIG. 6A*

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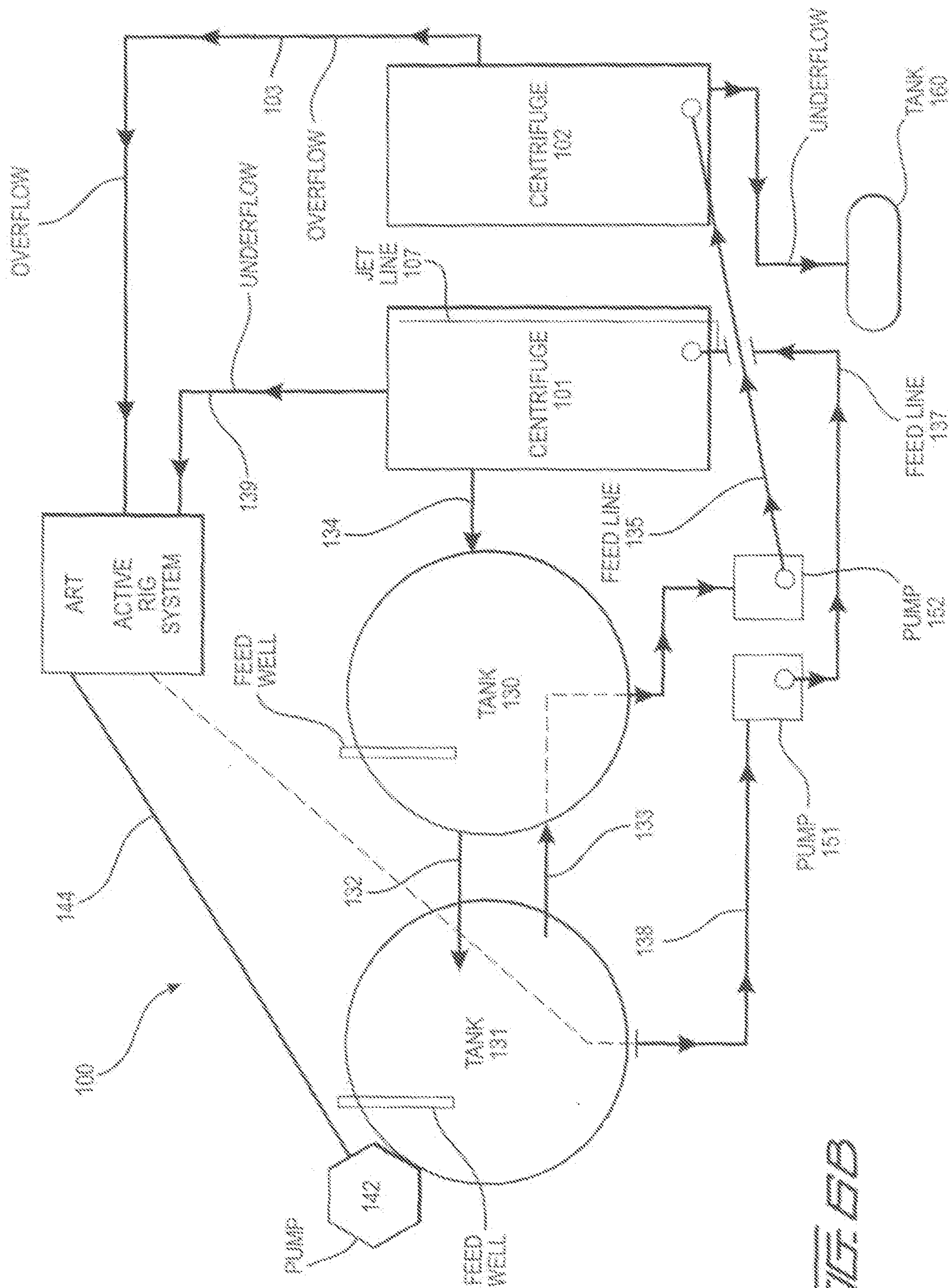
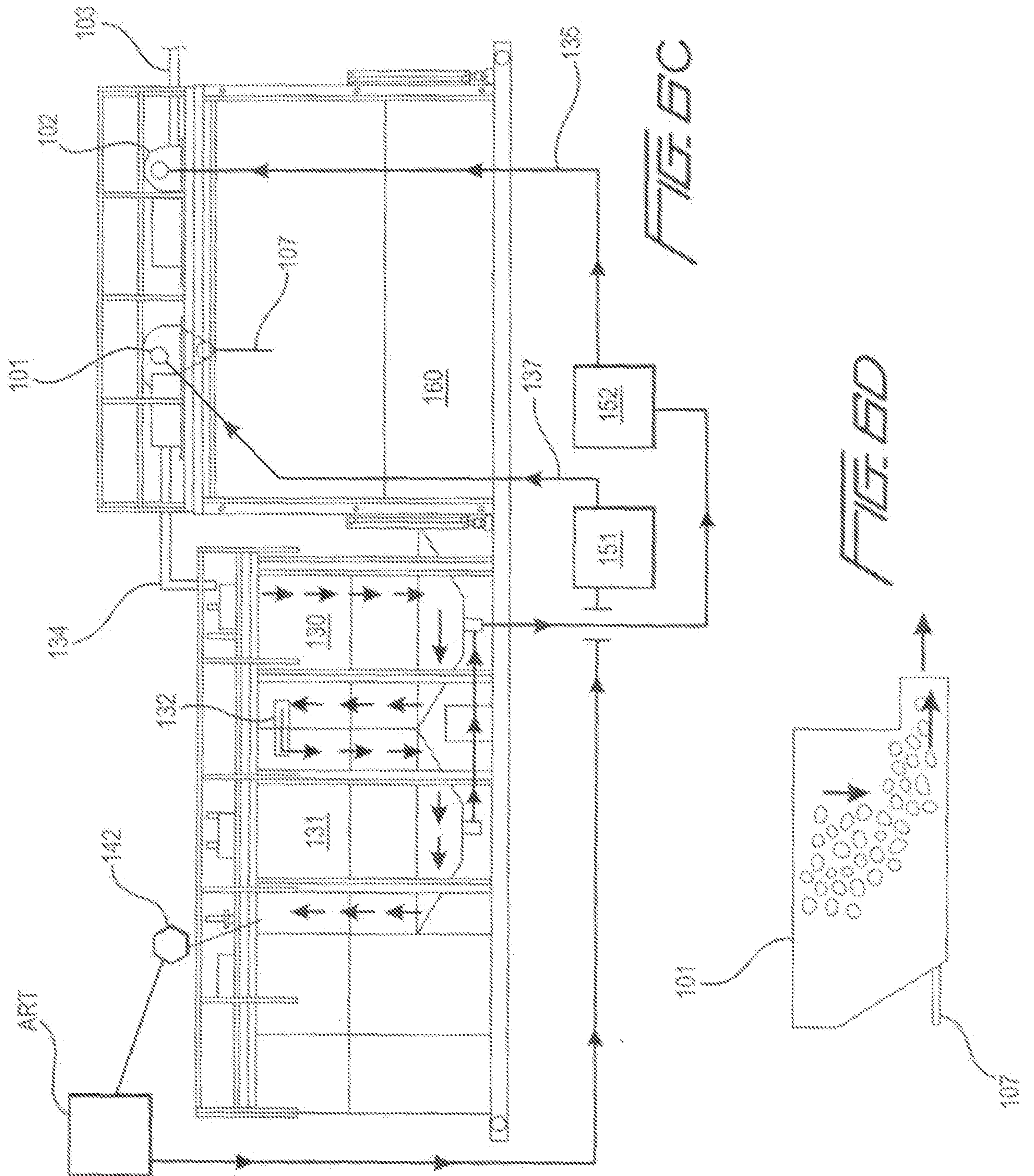


FIG. 7B

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