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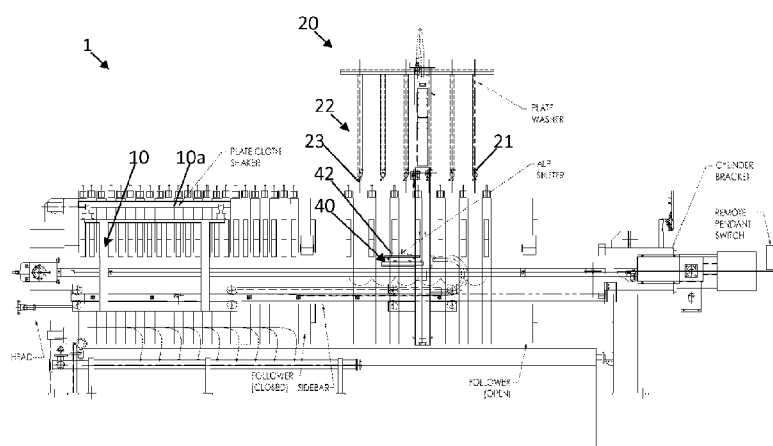


FIGURE 3

(57) **Abstract:** A filter (1) is disclosed. According to some embodiments, the filter (1) may have a frame (2) supporting a track (3), and a first carriage (10) on the track (3) which is configured to shake a plurality of filter cloths (32), for example, simultaneously shake a plurality of filter cloths (32). The first carriage may further wash the plurality of filter cloths (32) and/or a second carriage (20) may be provided to the filter (1) for performing low and/or high-pressure washing steps. Filter plate assemblies (30) may comprise a filter plate (34), a cloth bar (31) operably connected to the filter plate (34), and spring means (33) provided between the filter plate (34) and the cloth bar (31). Further disclosed are various methods of using/operating a filter (1), as well as filter plate cartridges (39) which may comprise: a plurality of filter plates (34) which are connected together with at least one link (38) which may or may not be flexible.

# FILTER PRESS FOR HIGH PERFORMANCE LIQUID/SOLID SEPARATIONS AND METHODS THEREOF

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## CROSS-REFERENCE OF RELATED APPLICATIONS

This application claims the benefit of priority document U.S. Provisional Patent Application Serial No. 61/943,249 filed on 21 February 2014, and titled "FILTER PRESS FOR HIGH PERFORMANCE LIQUID/SOLID SEPARATIONS AND METHODS  
10 THEREOF", the document of which is hereby incorporated by reference in its entirety for any and/or all purposes set forth herein.

## FIELD OF THE INVENTION

This invention relates to filtration devices such, in particular, filter presses.

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## BACKGROUND OF THE INVENTION

Typical filter presses consisting of a plurality of plates for the purpose of filtering. Plates are held together closed during a filter cycle by the use of hydraulic cylinders. The filter is opened by pulling the plates apart allowing the cake to fall from the cloth. It is  
20 beneficial after dropping the cake to clean the cloth by shaking the cloth and/or by washing the cloth.

FLSmidth has manufactured and supplied filters for over 90 years to a multitude of industries and for a multitude of applications. The company has supplied pressure filters of every size and type throughout the world and has an experience base of over 30,000 filter  
25 installations. FLSmidth is uniquely qualified to offer the highest quality and most reliable pressure filter designs available. The information found within this disclosure provides insight into the important design and manufacturing features of the new AFP IV™ LC Automated Filter Press. Features and/or combinations of the features shown and discussed herein may contribute to what makes the FLSmidth AFP IV™ LC filter press superior to  
30 other filtering machines on the market today.

The FLSmidth AFP IV™ LC builds off of prior existing AFP IV™ technology. With regard to reliability, recent reports from customers operating machines have indicated an availability of 92-98%. This metric may be obtained by the basic durability and reliability of the equipment, and the fact that cloths may be replaced on spare plates, while the filter press machine continues to run. Features and/or various combinations of the features disclosed herein may enable filter availability to be very high, and may also contribute to the ability for production to “catch-up” when or if other plant process breakdowns cause one or more filters to be shut-down for a period of time. Operating costs are a main indicator of a filter system suitability and reliability, and FLSmidth® Automatic Filter Press (AFP) systems provide some of the lowest operating costs within the industry.

On a filter press comprising a plurality of filter plates, it is typical to provide media/cloths that hang between the filter plates for use as filtration media to collect filtered solids. The cloths are often hung by means of a cloth bar. That cloth bar is typically also a manifold for spray wash water for cleaning the filter cloths. Conventional cloth bars are typically suspended above the filter plate by means of a built up metal framework (this may be appreciated from Prior Art FIG. 25). The cloth bar/spray bar and associated frameworks to hold it suspended serve the purpose of both providing wash water and suspending the cloths. These prior systems can be fairly heavy and complex, thereby necessitating a better, lighter, solution.

Still referring to prior art FIG. 25, due to the added weight above the plate and its point of suspension, additional weights are typically required below the plate to move the center of gravity down, such that the plate may move properly in its motion when the filter stack is repeatedly opened and closed. A cloth hanging hardware system that decreases the weight up high may, in turn, decrease the weight needed to be added down low (e.g., to balance). A device which may perform similar operations at a lower cost/complexity is therefore needed. There is a further need to decrease weight of the entire filter, lower costs to fabricate a filter, and/or lower costs to ship a filter and/or components thereof.

Filter plates on a typical filter press may have (e.g., in the case of typical Shriver® filtration products) a single plate shifting mechanism. In this regard, a shifter may be free to travel down the length of the filter, and filter plates in such prior devices may have a tendency to slide, roll, or separate from connections to one another. In the case of

traditional automatic filter presses, nearly all filter plates are linked to one another, so that the filter plates may be pulled from one side or the other to open up dropping the cake from between all the plates at the same time. One issue with traditional automatic filter presses, is that the links (e.g., chains) connecting the filter plates must be strong enough to pull the accumulation of weight and added friction from *all* the plates as they spread open from one another, during each cycle.

Because of the large quantity of connections utilizing precision components, the cost of linking filter plates in traditional automatic filter presses can be quite costly. Accordingly, there is a long-felt need in the filtration arts for a lower cost horizontal filter press solution that might not require costly precision links or precision chain to hold the plates at specific predetermined spacings from one another when the filter opens. With the proposed new filter design disclosed herein, only a fraction of the entire plate stack may need to be pulled to open a first and/or a second group of filter plate assemblies adjacent the first group of filter plate assemblies. For example, a shifter may only pull open and/or close a few plates at a time (e.g., 6 filter plates at a time, without limitation). This functionality may overcome many of the aforementioned issues with conventional links which need to be precise due to tolerance stacking over an entire filter plate stack when the entire filter plate stack is opened. This functionality of certain embodiments disclosed herein may also overcome the need for links to be as strong as traditional links or chain (e.g., because only a handful of plates may be opened and/or closed at the same time, without limitation). Ideally, embodiments disclosed herein may be cheaper than conventional filter technologies practicing the use of traditional links and chain (e.g., the large number of expensive precision link components may not be entirely necessary for some embodiments disclosed herein).

With typical filter press designs, the filter opens and drops its filtered solids (i.e., filter cake). Often thereafter, a shaker may provide motion or vibration to the filter plates, in order to shake and/or detach particles, chunks of cake, or other residual solids clinging to filter cloths/filter media. Also, once a drip tray is closed, washers may be used to clean the filter cloths/filter media. Washing tends to remove residual solids particles that might damage the filter cloths/filter media, or which might prevent proper sealing between filtration cycles. The shaker and the wash water manifolds, as well as other items the filter

press requires, are typically mounted to the floor, the press frame, to the plates, or otherwise solidly mounted to a stationary object on the filter. This requires that these devices be at, or nearly the full operating length of the filter, in order to provide their intended purposeful functions to each and every one of the filter plates in the filter press plate stack.

In order to reduce the size/envelope, cost, and/or complexity, a simple and strong carriage and track system is needed such that a shaker, a shaker with integral washer, a shaker/washer combination, and/or a washer may be configured to traverse down the length of the filter and provide its operation in one or more select areas within a plate stack. As may be appreciated from the disclosed figures and descriptions herein, a select portion of the plates in the stack may be opened, shaken, and/or washed simultaneously, but independently of all plates within the stack. The proposed filter system, apparatus, and methods may satisfy some of these long-felt needs for a new filter design. The proposed system, apparatus, and methods may allow an operating filter to open and shake, and/or wash select filter cloths (e.g., six at a time as shown) independently of other filter cloths, without limitation. Moreover, the proposed system, apparatus, and methods may not necessarily require the use of costly precision guides which might increase initial expenditures (e.g., CAPEX) as well as increase costs to maintain (e.g., OPEX). Furthermore, it is needed to provide a simple track design for a filter press that may be configured to work well, even when particles, dirt, grime come into contact with the track. Additionally, it is needed to provide a simple track design for a filter press that may be configured to accommodate inaccurate tracks, excessive wheel tolerances, changing tolerances due to wear, and fit/compatibility over time.

As previously stated, it is common practice to wash filtered solids off of filter media in order to improve cloth life and/or to improve sealing between filter surfaces. Washing may help to ensure that filter cloths are relatively free of large buildups of filtered solids/filter cake. Flood wash systems usually comprise a floor-mounted manifold with nozzles and/or manifolds as part of the cloth hanging hardware (FIG. 22). Accordingly, components of prior flood wash systems move with the filter plates. Excessive movement of the nozzles during shaking operations may lead to nozzle breakage. Moreover, water weight and/or component weight attributed to the nozzles and/or manifolds provided on the plate

assemblies may cause imbalances or plate assembly top-heaviness. Additionally, such prior flood wash systems often have a high number of hoses which are necessary for allowing travel of the plates.

There also exists a need to low-pressure wash (e.g., flood wash) and/or direct  
5 high-pressure wash multiple cloths at once, particularly with the novel filter apparatus disclosed (which may shift and open a plurality of plates at a time). Positioning manifolds to wash the appropriate plates and respective filter cloths necessitates a traveling washer system not yet seen with prior filter devices.

It is common practice to shake filtered solids off of filter media, because it helps to  
10 extend cloth life and improve sealing of filter surfaces. In other words, it is relatively important that filter cloths are relatively free of large buildup of filtered solids or filter cake. Shaker systems usually comprise a frame mounted to the floor and a mechanism that induces a motion which shakes the filter plates and cloth. However, such shaker systems are not mobile as with embodiments of a filter disclosed herein. According to certain  
15 embodiments disclosed herein, a portion of the plates that have been opened in a plate stack of a filter may be simultaneously shaken (whether "collectively" shaken at the same time, or independently and "substantially simultaneously" shaken as suggested in FIGS. 46 and 47). In doing so, less cost-efficient traditional shaking means comprising a shaker frame that spans the entire length of the filter may be avoided, wherein only a select few  
20 plates may be shaken at a time (this may be readily appreciated by the appended drawings). Accordingly, there is a need for a shaker that travels to the correct position down the length of the filter press where it may then shake the filter cloths of a select few plates that are open and are in need of shaking the filter cloths. Embodiments disclosed herein may further overcome some of the technical challenges found in prior art filter  
25 presses regarding plates changing their "open" positions over time, for example, due to wear or stretch of linking mechanisms between the plates.

Filter presses have a plurality of plates that must be separated in order for the filtered solids to drop off of the filter cloth. To date, conventional filter presses have either shifted a single filter plate (i.e., "one at a time"), or filter presses have pulled open the entire  
30 stack or plates in one single motion. A benefit of opening all plates at once is that the opening process is faster than opening one single plate at a time; however, in this regard,

the filter must be built to be very long. A benefit of opening one plate at a time, is that the filter may be made to be a shorter overall length, however, the opening process is much slower than opening all plates at once. Accordingly, there is an unmet need for a filter that is configured to open *some*, but not *all* of the plates in a filter plate stack at once, so that the filter may operate fairly fast but does not have to be built too long. For example, in some preferred embodiments disclosed, a filter may open six plates at once, thereby reducing cycle times while providing the ability to reduce filter footprint, without limitation.

### OBJECTS OF THE INVENTION

It is, therefore, an object of certain embodiments of the invention, to provide an improved filter press which may require reduced capital expenditure (CAPEX) costs, which may reduce the necessary footprint area for a filtration process, and/or which may increase filtration area per footprint ratio, etc.

It is also an object of certain embodiments of the invention, to improve upon existing FLSmidth® AFP IV™ filter technology by providing an AFP IV™ LC filter press which overcomes the above problems.

These and other objects of the invention will be apparent from the drawings and description herein. Although every object of the invention is believed to be attained by at least one embodiment of the invention, there is not necessarily any one embodiment of the invention that achieves all of the objects of the invention.

### SUMMARY OF THE INVENTION

A filter having a frame supporting a track is disclosed. The filter may comprise a first carriage on the track which is configured to shake a plurality of filter cloths simultaneously. The filter cloths may be attached to respective filter plate assemblies supported by the frame. Each of the filter plate assemblies may comprise a filter plate, a cloth bar operably connected to the filter plate, and spring means provided between the filter plate and the cloth bar, without limitation. According to some embodiments, the first carriage may further comprise first washing means.

According to some embodiments, the first washing means may be configured to wash the plurality of filter cloths simultaneously. According to some embodiments, the first

washing means may comprise upper and/or lower washing nozzles. According to some embodiments, the upper and/or lower washing nozzles may be fixed to the first carriage. According to some embodiments, the first washing means may comprise a flood wash. According to some embodiments, the flood wash may be configured to remove cake from the plurality of filter cloths, simultaneously. According to some embodiments, the flood wash may comprise a low pressure wash. According to some embodiments, the flood wash may comprise a high pressure wash. According to some embodiments, the filter may further comprise a second carriage on the track. According to some embodiments, the second carriage may be independently movable on the track with respect to the first carriage. According to some embodiments, the second carriage may move less frequently than the first carriage, relative to the track. According to some embodiments, at a point in operation, the second carriage may move relative to the track, while the first carriage may remain stationary, relative to the track. According to some embodiments, the first carriage may move relative to the track, while the second carriage may remain stationary, relative to the track. According to some embodiments, the second carriage may move relative to the track via a shifter comprising a dog, wherein the first carriage may move relative to the track via the same shifter. According to some embodiments, the filter plate assemblies may also move relative to the track via the same shifter. According to some embodiments, the second carriage may comprise second washing means.

According to some embodiments, the second washing means may be configured to wash the plurality of filter cloths, simultaneously. According to some embodiments, the second washing means may comprise upper and/or lower washing nozzles. According to some embodiments, the second washing means may comprise a high pressure wash. According to some embodiments, the high pressure wash may be configured to penetrate the plurality of filter cloths, simultaneously. According to some embodiments, the upper and/or lower washing nozzles may be movable with respect to the second carriage. For example, in some embodiments, upper and/or lower washing nozzles may be movable via a lowering mechanism comprising a first portion which is fixed to a frame of the second carriage, and a second moving portion which moves relative to the first portion .

According to some embodiments, the upper and/or lower washing nozzles may be fixed to the second moving portion of the lowering mechanism, without limitation.

Also disclosed, is a filter having a frame supporting a track, and a second carriage provided on the track which is configured to wash a plurality of filter cloths simultaneously. The filter cloths may be attached to respective filter plate assemblies supported by the frame, without limitation. Each of the filter plate assemblies of the filter may comprise a filter plate, a cloth bar operably connected to the filter plate, and spring means provided between the filter plate and the cloth bar. According to some embodiments, the second carriage may comprise second washing means. According to some embodiments, the second washing means may be configured to wash the plurality of filter cloths simultaneously. According to some embodiments, the second washing means may comprise upper and/or lower washing nozzles.

According to some embodiments, the second washing means may comprise a high pressure wash. According to some embodiments, the high pressure wash may be configured to penetrate the plurality of filter cloths. According to some embodiments, the upper and/or lower washing nozzles may be movable with respect to the second carriage. According to some embodiments, the upper and/or lower washing nozzles may be movable via a lowering mechanism. According to some embodiments, the upper and/or lower washing nozzles may be movable via a lowering mechanism comprising a first portion which may be fixed to a frame of the second carriage, and a second moving portion which may move relative to the first portion. According to some embodiments, the upper and/or lower washing nozzles may be fixed to the second moving portion of the lowering mechanism. According to some embodiments, the filter may further comprise a first carriage on the track. According to some embodiments, the first carriage may further comprise first washing means.

According to some embodiments, the first washing means may be configured to wash the plurality of filter cloths simultaneously. According to some embodiments, the first washing means may comprise upper and/or lower washing nozzles. According to some embodiments, the upper and/or lower washing nozzles may be fixed to the first carriage. According to some embodiments, the first washing means may comprise a flood wash. According to some embodiments, the flood wash may be configured to remove cake from the plurality of filter cloths. According to some embodiments, the flood wash may comprise a low pressure wash. According to some embodiments, the flood wash comprises a high

pressure wash. According to some embodiments, the second carriage may be independently movable on the track with respect to the first carriage. According to some embodiments, the second carriage may move less frequently than the first carriage, relative to a track provided to the filter frame. According to some embodiments, the second carriage may move relative to the track, via a shifter comprising a dog, wherein the first carriage may also move relative to the track via the same shifter. According to some embodiments, filter plate assemblies may also move relative to the track via the same shifter, without limitation.

A method of using/operating a filter is also disclosed. According to some embodiments, the method may comprise one or more of the steps of: separating a first group of filter plate assemblies, moving the first carriage adjacent the separated first group of filter plate assemblies, shaking the plurality of filter cloths of the separated first group of filter plate assemblies simultaneously, and, flood washing the separated first group of filter plate assemblies simultaneously. According to some embodiments, the first group of filter plate assemblies may comprise a filter plate cartridge of multiple filter plate assemblies connected by links which may or may not be flexible. According to some embodiments, the method may further comprise the steps of: closing the separated first group of filter plate assemblies, separating a second group of filter plate assemblies, moving the first carriage adjacent the separated second group of filter plate assemblies, shaking the plurality of filter cloths of the separated second group of filter plate assemblies, and, flood washing the plurality of filter cloths of the separated second group of filter plate assemblies, without limitation. According to some embodiments, the method may further comprise the steps of: moving the first carriage away from the separated first group of filter plate assemblies, moving a second carriage adjacent the separated first group of filter plate assemblies, and cloth washing the plurality of filter cloths of the separated first group of filter plate assemblies. According to some embodiments, the method may further comprise the step of moving the second carriage adjacent the separated second group of filter plate assemblies, and cloth-washing the plurality of filter cloths of the separated second group of filter plate assemblies. According to some embodiments, a method of using/operating a filter may comprise: separating a first group of filter plate assemblies, moving the second carriage adjacent to the separated first group of filter plate assemblies, and cloth

washing the plurality of filter cloths of the separated first group of filter plate assemblies simultaneously, without limitation.

Moreover, a filter plate cartridge is disclosed. According to some preferred embodiments, the filter plate cartridge may comprise, without limitation: a plurality of filter  
5 plates which may each be configured to receive a filter cloth; wherein the plurality of filter plates may be connected together with at least one link (which may or may not be flexible); wherein the at least one link may be configured to allow each plate within the plurality of filter plates to be moved against an adjacent plate within the plurality of filter plates; and wherein the at least one link may be configured to allow each plate within the plurality of  
10 filter plates to be moved away from an adjacent plate, without limitation. In some embodiments, each of the filter plates may comprise a handle having a hook, the hook comprising a receiving portion configured to receive a hoist bar of a hoist, without limitation. In some embodiments, the filter plate cartridge may be engaged by a hoist, to remove the plurality of filter plates from a filter, simultaneously. In some embodiments, at least one of  
15 the filter plates may comprise a plate tab which is configured to engage a dog of a shifter. In some embodiments, only one of the plurality of filter plates may comprise the plate tab.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a spray bar cloth wash concept according to some embodiments.

20 FIGS. 2-5 are detailed views of a filter press according to some embodiments.

FIGS. 6 and 10 are isometric views of a filter press having a shaker (e.g., "first carriage") being located adjacent to a start point, and a washer (e.g., "second carriage") being in an up position and standby status, according to some embodiments.

FIGS. 7-9 are isometric views of a filter press having a shaker (e.g., "first carriage")  
25 being located adjacent to an end point, and a washer (e.g., "second carriage") being in a down position and washing-in-process status, according to some embodiments.

FIG. 11 suggests a non-limiting embodiment of a shaker (e.g., "first carriage") having a shaker bar configured for downward activation.

FIG. 12 suggests a non-limiting embodiment of a washer (e.g., "second carriage")  
30 configured in an upward standby position.

FIG. 13 suggests a non-limiting embodiment of a washer (e.g., "second carriage") configured in a downward washing position.

FIG. 14 suggests a shifter having a dog that is engaging a plate tab (e.g., a tang or pawl) on a first filter plate of a first filter plate cartridge.

5 FIGS. 15, 16, and 59-62 show encoders, shifter drive mechanisms, and closure cylinders which may be employed by a filter according to some embodiments.

FIG. 17 suggests a shaker mechanism just prior to or just after a downward application of force to a first group of filter plate assemblies, via one or more shaker bars, according to some embodiments.

10 FIGS. 18 and 19 suggest one non-limiting embodiment of a wheel assembly of a shaker carriage (e.g., a first carriage) which may also be employed on a washer carriage (e.g., a second carriage). It should be understood that while not shown, the wheel assembly may comprise internal or external springs, damping mechanisms, and/or tolerance compensation mechanisms, without limitation.

15 FIG. 20 suggests one embodiment of a spray bar of a washer which may be movable via a lowering mechanism, without limitation. While shown on a washer (e.g., "second carriage"), it should be understood that such a spray bar may be employed to a shaker (e.g., "first carriage"), without limitation.

20 FIGS. 21-24 show connection means between a plate and a cloth bar, according to some non-limiting embodiments, wherein spring means and filter cloth attachment means are shown.

FIG. 25 shows a filter plate assembly of the prior art which comprises spray nozzles on an integral cloth bar.

25 FIGS. 26-37 show connection means between a plate and a cloth bar, according to some non-limiting embodiments, wherein spring means and filter cloth attachment means are shown.

FIG. 38 suggests a non-limiting embodiment of a shaker carriage (e.g., "first carriage") which may have one or more shaker bars configured for upward activation which may shake a plurality of plate assemblies having hooks, simultaneously, without limitation.

30 FIGS. 39-41 suggest a non-limiting embodiment of a shaker carriage (e.g., "first carriage") having a shaker bar configured for upward activation.

FIG. 42 suggests on non-limiting embodiment of a shifter having a dog which engages a plate tab of a filter plate within a filter plate assembly cartridge.

FIG. 42 is a broader view of FIG. 41 showing a first group of filter plates being separated and shaken simultaneously, by a shaker.

5        FIGS. 44 and 45 show a stack of six filter plate assemblies being separated by an indexing plate shifter, wherein a shaker mechanism provided to a shaker carriage moves a shaker bar upward to engage all cloth bars of the six filter plate assemblies, simultaneously, wherein other plates in the filter plate stack remain unmoved.

10        FIG. 46 shows a stack of six filter plate assemblies having been separated by an indexing plate shifter, wherein a shaker mechanism provided to a shaker carriage moves cloth bars of the six filter plate assemblies, individually, but substantially simultaneously, wherein other plates in the filter plate stack remain unmoved. The indexing plate shifter may move the shaker carriage to facilitate individual movement of the cloth bars of the six filter plate assemblies.

15        FIG. 47 shows an embodiment similar to the one suggested in FIG. 46 which uses a rounded plate (e.g., cam and follower mechanism), rather than a roller mechanism.

20        FIG. 48 suggests a step of advancing a shifter to a second group of filter plate assemblies associated with a second cartridge of filter plate assemblies, wherein the second group of filter plate assemblies within the second cartridge are linked together with links, but not linked to filter plate assemblies of other filter plate cartridges.

25        FIG. 49 suggests a step of reversing/retreating a shifter, for example, once a dog of the shifter operatively engages a filter plate tab provided to one of the plates in the second cartridge of filter plates; thereby closing a first group of filter plate assemblies associated with a first cartridge of filter plate assemblies, and opening a second group of filter plate assemblies associated with the second cartridge of filter plate assemblies.

FIGS. 50 and 51 suggest another embodiment of an elongated shifter which may comprise more than one dog member to allow opening and/or closing of individual filter plate assemblies in both directions, without limitation, wherein one dog may comprise a longer length, spring activation, and cam surface for accommodating plate tabs.

30        FIG. 52 suggests a shifter having two dogs moving along a first opened group of filter plate assemblies.

FIG. 53 suggests a shifter having two dogs pulling closed, a first group of filter plate assemblies and opening a second group of filter plate assemblies.

FIGS. 54 and 55 suggest yet another embodiment of a plate closure cycle, without limitation.

5 FIG. 56 suggests a shifter operatively engaging a limit switch and returning to a home position, without limitation.

FIG. 57 suggests non-limiting embodiments of covers for shaker and washer carriages.

10 FIG. 58 suggests rollers which may be used for supporting a movable feed pipe, according to some embodiments.

FIG. 63 suggests a washer carriage in a down/wash position, wherein a lowering mechanism comprises one or more cylinders (e.g., hydraulic or pneumatic cylinder, solenoid, linear motor, etc).

15 FIG. 64 suggests a washer carriage in a down/wash position, wherein a lowering mechanism comprises one or more gear motors provided with a rack-and pinion mechanism.

FIG. 65 suggests the washer carriage of FIG. 64 in an up/standby position.

FIGS. 66 and 67 are detailed views of the lowering mechanism shown and described for FIGS. 64 and 65.

20 FIG. 70 suggests two cartridges of filter plate assemblies, wherein each cartridge comprises a predetermined number of filter plates joined by links.

FIGS. 68 and 69 suggest handles which may comprise hooks and receiving portions for a hoist 200 to lift the entire cartridge at once as shown in FIG. 71.

25 FIG. 71 further suggests a saddle frame having side rails and legs, the saddle frame being configured to temporarily house and/or support a number of filter plate cartridges for maintenance or temporary storage purposes.

FIGS. 72 and 73 suggest a non-limiting embodiment wherein a shaker carriage (e.g., "first carriage"), may comprise washing means, for example, washing means comprising one or more upper nozzles, one or more lower nozzles, and/or one or more midway nozzles (not shown), without limitation.

FIG. 74 suggests a shaker carriage (e.g., "first carriage"), comprising washing means, wherein the shaker carriage is performing a low pressure wash (e.g., a "flood wash"), without limitation.

FIG. 75 suggests a filter wherein only a first carriage is provided, the first carriage performing both shaking and washing functions, wherein one or more shaker mechanisms and one or more wash mechanisms may be employed to the frame or chassis of the first carriage.

FIG. 76 suggests a filter wherein a first carriage and a second carriage is provided, the first carriage performing both shaking and washing functions, wherein one or more shaker mechanisms and one or more wash mechanisms may be employed to the frame or chassis of the first carriage, and wherein one or more wash mechanisms may be employed to the frame or chassis of the second carriage. For example, the first carriage may comprise a lower pressure flood wash, and the second carriage may comprise a low and/or high-pressure cloth wash, without limitation.

FIG. 77 suggests a filter such as the one shown in FIG. 76, provided with one or more covers for the carriages (e.g., as previously suggested for FIG. 57).

FIG. 78 is a non-limiting embodiment suggesting encoder functionality and/or suggesting a number of process steps which may occur during various filtration operations of a filter.

## DETAILED DESCRIPTION OF THE INVENTION

A filter 1 may comprise a frame 2 supporting a track 3. The track 3 may support a first carriage 10 (e.g., a "shaker" carriage) which is movable relative to the track 3. The first carriage may comprise a frame 10d having a wheel assembly 10c which may be optionally damped with springs and/or dampers (e.g., pistons or shock absorbing apparatus), without limitation. The first carriage 10 may comprise one or more shaker cylinders 10b operably connected to the frame 10d of the first carriage 10. One or more shaker bars 10a may be operably connected to the one or more shaker cylinders 10b. A first carriage cover 10e may protect the shaker and/or an operator from moving components within the shaker and/or may act as a "splash guard", without limitation. In some embodiments, the first carriage (e.g., "shaker"), may comprise first washing means 12, for example, a manifold,

one or more upper washing nozzles 11, and/or one or more lower washing nozzles 13. Additional washing nozzles (not shown) may be provided between the upper 11 and lower 13 washing nozzles, without limitation.

According to some embodiments, the track 3 may support a second carriage 20 (e.g., a "washer" carriage) which is movable relative to the track 3. The second carriage may comprise a frame 20d having a wheel assembly 20c which may be optionally damped with springs and/or dampers (e.g., pistons or shock absorbing apparatus), without limitation. The second carriage 20 may comprise one or more spray bars such as the one shown in FIG. 20. The spray bars may be operably connected to a manifold that is configured to raise and/or lower relative to the frame 20d, for example, via a lowering mechanism 25. Components of the lowering mechanism 25 may be operably connected to the frame 20d of the second carriage 20. A second carriage cover 20e may protect the washer and/or an operator from moving components within the washer and/or may act as a "splash guard", without limitation. In some embodiments, the second carriage (e.g., "washer"), may comprise second washing means 22, for example, a manifold, one or more upper washing nozzles 21, and/or one or more lower washing nozzles 23. Additional washing nozzles (not shown) may be provided between the upper 21 and lower 23 washing nozzles, without limitation. A first fixed portion 27 of lowering mechanism 25 may be affixed to the frame 20d of the second carriage 20. A second moving portion 29 of lowering mechanism 25 may be configured to move relative to the first fixed portion 27 and/or relative to the frame 20d of the second carriage 20 as shown. A number of conceivable mechanisms may be utilized, including linkages, rack and pinions, linear motors, linear actuators, pistons, cylinders, combinations thereof, and/or the like, without limitation.

In some embodiments, a filter 1 may comprise a first carriage 10 that shakes and washes. In some embodiments, a filter 1 may comprise a second carriage 20 that shakes and washes. In some embodiments, a filter 1 may comprise a second carriage 20 that washes. In some embodiments, a filter 1 may comprise a first carriage 10 that shakes and may further comprise a second carriage 20 that washes (e.g., low-pressure wash, flood wash, and/or high pressure cloth wash, without limitation). In some embodiments, a filter 1 may comprise a first carriage 10 that shakes and washes (e.g., low-pressure wash, flood wash, and/or high pressure cloth wash, without limitation) and may further comprise a

second carriage 20 that washes (e.g., low-pressure wash, flood wash, and/or high pressure cloth wash, without limitation). In some non-limiting preferred embodiments, a filter 1 may comprise a first carriage 10 that shakes groupings or "cartridges" 39 of linked filter plate assemblies 30 and subsequently performs frequent low-pressure (e.g., "flood") washes and  
5 may also comprise a second carriage 20 that infrequently performs high-pressure (e.g., "filter cloth") washes, without limitation.

Turning now to FIGS. 21-37, a filter plate assembly 30 may comprise a cloth bar 31, one or more washer fasteners 31a, one or more grommets 31b (e.g., provided below the one or more washer fasteners 31a), spring means 33 disposed between the cloth bar 31  
10 and a filter plate 34, a bracket 35 attached to the filter plate 34, a cup 35a provided to the bracket 35, and a boss 35b having a threaded surface 35c also being provided to the bracket 35, wherein one or more cloth bar to bracket fasteners 35d may be used to secure the spring means 33 between the cloth bar 31 and filter plate 34; and wherein one or more  
15 bracket to filter plate fasteners 35e may be used to secure the bracket 35 to the filter plate 34, without limitation. Filter cloth 32 may be draped over the cloth bar 31 and filter plate 34, and in some instances, filter cloth 32 may be secured with the one or more cloth bar to bracket fasteners 35d, without limitation. In addition to the aforementioned, a filter plate assembly 30 may comprise one or more handles 36. In some embodiments, one or more  
20 of the handles 36 may comprise one or more hooks 36c having at least one receiving portion 36d which may be configured to receive a hoist bar 204 of a hoist 200 (as suggested in FIG. 71).

Furthermore, as suggested in FIGS. 70 and 71, multiple filter plate assemblies 30 may be joined together in a predetermined number (e.g., six in number as shown, without limitation) and connected via one or more links 38, to form a filter plate "cartridge" 39. The  
25 links 38 may be flexible as shown (e.g., provided as riveted Nylon straps, chains, or the like), or the links 38 may be rigid (e.g., provided as rigid plates each having a slot therein which receives a pin follower from an adjacent plate), without limitation. One of the multiple filter plate assemblies 30 within the cartridge 39 may comprise a plate tab 37 which may be configured to operatively engage a shifter dog 42 provided to a moving shifter 40. The  
30 moving shifter 40 may be driven by a chain or belt drive equipped with an encoder to determine a position of and maintain position awareness of the shifter 40 and dog 42. As

shown in at least FIGS. 50-52, in some embodiments, a shifter 40 may comprise multiple dogs 42, for example, which may face and/or pivot in opposing directions as shown (e.g., for pulling and/or pushing plates open and closed), without limitation. In some embodiments, a single dog 42 provided to a shifter may serve a dual purpose (e.g., pulling and/or pushing plates open and closed), without limitation. In some instances, one dog 42 may be longer than the other dog 42. In some embodiments, a longer dog may have a more graduated cam surface, without limitation.

If maintenance is required, a new cartridge 39 may be taken from a saddle frame 210. The saddle frame 210 may comprise one or more side rails 212 and one or more legs 214 for supporting the side rails 212. For example, a new cartridge 39 may be taken from a saddle frame 210 via a hoist 200, the hoist 200 having a lift point 202 which may be operatively connected to a crane system, forklift, or the like, without limitation. One or more hoist bars 204 may be connected to the hoist 200, for example, connected via one or more chains 206 or equivalent (e.g., cabling, wire, solid tubing with hinges, rods with joints, etc.). The one or more hoist bars 204 may be slid into multiple receiving portions 36d provided to hooks 36c or handles 36 of the plates 34, and lifted, so as to remove the new cartridge 39 from the saddle frame 210. The new cartridge 39 may be lowered into a filter 1, for example, by placing the handles 36 of the plates 34 of the new cartridge 39 onto the track 3 of the filter. A used cartridge 39 may be removed from the filter 1 and placed into the saddle frame 210 in a similar fashion. In this regard, a filter 1 may maintain operation while filter plate cartridges 39 and/or individual components thereof are repaired and/or replaced.

In some embodiments, as shown in FIG. 1, a separate overhead spray bar for cleaning a filter cloth of a filter chamber defined between two plates may be provided. The separate overhead spray bar may be provided with water via a single manifold per spray bar. Or, a single manifold may be operably connected to multiple spray bars and may feed multiple spray bars simultaneously, or individually, for example, as suggested in FIGS 63-65, a single manifold may supply low pressure or "flood" wash water to multiple plates simultaneously. For infrequent "deep cleaning" of filter cloths, valves for all but one spray bar may be turned off, thereby greatly increasing water pressure in the one spray bar, wherein the one spray bar may cloth wash at a much higher pressure, and may possibly

even penetrate the filter cloth without limitation. This process may continue wherein the one spray bar may be cycled.

For example, the following steps may occur: 1) open first through sixth filter chambers, 2) move washer over the first through sixth filter chambers, 3) first spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean a first filter chamber, 4) second spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean a second filter chamber, 5) third spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean a third filter chamber, 6) fourth spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean a fourth filter chamber, 7) fifth spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean a fifth filter chamber, 8) sixth spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean a sixth filter chamber, 9) close first through sixth filter chambers, 10) open seventh through twelfth filter chambers, 11) move washer over the seventh through twelfth filter chambers, 12) first spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean a seventh filter chamber, 13) second spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean an eighth filter chamber, 14) third spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean a ninth filter chamber, 15) fourth spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean a tenth filter chamber, 16) fifth spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean an eleventh filter chamber, 17) sixth spray bar valve on, all other spray bar valves off, washer moves downward then upward to clean a twelfth filter chamber, 18) close seventh through twelfth filter chambers, 19) open thirteenth through eighteenth filter chambers, 20) move washer over the seventh through twelfth filter chambers, etc..., without limitation.

Turning now to FIGS. 44-56, methods of operation of a filter press according to some embodiments are shown. What may be appreciated from these figures is that a shifter 40 may be configured to pull a select few plates apart (e.g., plates 34 within a particular filter cartridge 39) in the stack at one time; wherein a typical FLSmidth® Shriver® filter merely pulls one individual plate at a time, and wherein a typical FLSmidth® AFP

automatic filter press pulls the entire filter plate 34 stack apart in one stroke. In preferred embodiments, as may be appreciated from FIGS. 21-37, filter cloth 32 may be held to a filter plate 34 using minimal hardware, and may be ideally held in tension, for example, via spring means 33, without limitation. Depending on how the spring means 33 is arranged, a shaker bar 10a and cylinder 10b arrangement may be configured to push up, or push down against the spring means 33. This may be appreciated from at least FIGS. 8, 11, 17, and 38-41. Note that in some preferred embodiments, a spring may be used and the shaker cylinders 10b may be configured to push a shaker bar 10a down from above, without limitation. In some embodiments, a filter cloth 32 may be stretched during shaking without need for a spring. In some embodiments, a spring 33 may be used to tension the cloth 32 and improve shaking results. In some embodiments, the shaker may travel on a carriage 10, 20, such as a first carriage 10, thereby allowing for shaking a select few filter cloths 32 at the same time, or substantially at the same time. In some embodiments, the washer may travel on a carriage 10, 20 (e.g., on second carriage 20), and may wash a plurality of filter cloths 32 with multiple spray bars or spray nozzles 11, 13, 21, 23, without limitation. It is acknowledged that there are obviously further details which cannot be adequately described herein to one-hundred percent completeness; however, further details and inventive features and concepts may be readily appreciated from the appended drawings.

## EXAMPLE 1

### Multi Shift Plate Shifter

The filter may adapt and employ inventive variations of EIMCO™ Multi-Shift plate shifter technology and/or FLSmidth® ALP plate shifter technology, in order to open multiple chambers (e.g., six chambers) in one movement, as shown, without limitation. For example, a plate shifting mechanism (e.g., "shifter" 40) may move forward to capture a first filter plate of each group of filter plates (e.g., within a filter plate cartridge 39), engage a plate tab 37 of the first filter plate, and then may then reverse, thereby pulling the first plate towards the tail end of the filter. The following six chambers may be opened at this time, also, as multiple plates 34 may be connected to the first plate via a number of links 38, without limitation. In some embodiments, an end user of the filter 1 may be able to discharge all filter cakes from the filter 1 in less than three minutes, without limitation.

### Skeleton/Frame

The filter skeleton (e.g., "frame" 2) may comprise a side bar configuration. In this configuration, the head and tail frame portions may be connected by side-bars. The side-bars may be manufactured to a length corresponding to a predetermined of filtration chambers or plates 34. The end connections may be between the side-bars and the head and cylinder (e.g., "tail") bracket. Intermediate supports may be utilized to provide sufficient rigidity to the frame. The design characteristics of certain embodiments may be rated up to mechanical properties of the side-bars that run along the sides of the plate length. It is foreseeable that some preferred embodiments may comprise side-bars which may be configured to hold a required load distribution (e.g., a 16 bar or a 225 psig stack), without limitation.

### Polypropylene Filter Plate Design

The FLSmidth® filter plates may be designed to be compatible with the shaker mechanisms shown and may be configured with a lower, center feed port location. The lower feed port may optimize the slurry distribution and minimizes stratification in each chamber while filling the filter. With the particles remaining highly energized in the lower feed eye, the cake may be able to form in even layers on the media, thereby producing an even, dry cake within each chamber. FLSmidth® has test data which indicates that feed ports located above the centerline of the plate may result in uneven chamber filling and cracked filter plates. Another benefit of the lower feed eye may be that the cloth shaking action may be enhanced, thereby maximizing cake discharge.

### Polypropylene Recessed Membrane Mixed-Pack Plate Stack

The FLSmidth® filter plates may be molded from high-grade polypropylene and may be sourced from a variety of reputable manufacturers. The plates may be equipped with molded-in stay bosses, for example, bosses specifically designed to support deflection loads between the individual plates. The filter plates may be dimensioned on DIN standards to allow for increased availability and lower replacement costs. A highly chemical and temperature resistant grade of polypropylene resin may be supplied and utilized in the

manufacture of the filter plates. Alternating plates may have a flexible diaphragm that may be inflated with water to extend into the chamber to squeeze the filter cake, according to some embodiments. For example, membrane "squeeze water" may enter through a port in each plate, connected to a manifold with flexible hoses. The hoses may have quick disconnect fittings to allow for quick plate removal and installation. Companion plates with compatible mating surfaces may alternate with the membrane plates to provide a fixed-volume cavity on the opposite side of each chamber. Plates may be specially ported for thorough cake washing and/or air blowing from one plate to the next for maximum efficiency and/or to minimize resistance to flow at high filtration and air blowing rates.

#### Feed & Filtrate Liner Pipe Connections

Liner pipes may be included with the filter and may be manufactured from 316 stainless steel. The lower center feed pipe and corner pipes may be supplied with male flanged ends for connection to customer/end user piping. One (1) pipe may be provided for each feed port and each of the four (4) filtrate discharge ports.

#### Optional Turbidity Sensors for Filter Plates

Turbidity sensors, such as the ones described in WO/2013/173847, may be fitted to each plate. Turbidity sensors may be provided as an available option for a filter, in order to allow an operator of a filter to quickly identify a hole in the filter media of each plate.

#### Filter Cloth

One (1) set of polypropylene filter cloths per filter (e.g., with edge grommets) may be provided with or for the filter. Cloth may be selected for the particular filtration application and/or contractor or supplier experience.

#### Filter Plate & Cloth Servicing

The filter cloths may be replaced in groups of 10, 20 or 30. The operator may use a lifting apparatus (e.g., "hoist" 200) to remove the group of plates (e.g., "cartridge" 39) from the filter and place them in a ready rack (e.g., "saddle frame" 210). A set of pre-serviced

filter plates (e.g., a new cartridge) may then be lifted and dropped into the filter (e.g., onto rails 3), so that the filter may be put back into service. Soiled cloths may be replaced using the ready rack while the filter is online and processing material, to minimize downtime.

5

### Hydraulic Power System

None, some, or all mechanical systems on the filter may be operated hydraulically. In some preferred embodiments, some or all of the mechanical systems on the filter may be operated hydraulically. A hydraulic power unit (HPU) may be provided, which may be  
10 designed with sufficient flow capacity to retract and close the follower in under one minute for each direction, without limitation. The hydraulic power unit may be powered by a 3 phase, TEFC, electric motor. The HPU may also be fitted with an oil/air heat exchanger, without limitation. Such a cooling unit may be fitted with a hydraulic fan. In some  
15 embodiments, the oil tank may be fitted with an oil heater to heat the oil when operating temperatures become too low.

### Cloth Shaking System

Cake discharge may be considered to be one of the most important aspects of any unattended and fully automated pressure filter. In order to eliminate operator involvement  
20 during cake discharge, the filter system may be designed to remove as close to 100% removal of the cake on every cycle as possible. The FLSmith® automated cake release system (ACS) may utilize a high-amplitude, low frequency cloth shaking protocol to remove the cakes from each chamber, and this may differ from prior designs which typically rely on low amplitude, high frequency vibration of the cloth.

25

### Automatic Cloth Washer

The automatic cloth washing system may comprise, for instance and without limitation, a 15 bar discharge nozzle pressure, for periodic cleaning of the filter media. The wash system may be supported by the filter press frame (for example via rails 3). The cloth  
30 washing mechanism, when engaged to the shifter, may provide automatic filter cloth washing. Filter cloth washing may be performed on a second carriage with high pressure

spray bars. Wash sequence may be controlled from a local PLC panel and may automatically wash the filter press cloths of the entire plate stack upon user input or after a predetermined time or number of filtration cycles. The washer may consist of a spray manifold attached to a guide mount and a plate alignment mechanism. The washer may incorporate a manual locking mechanism. The spray manifold may comprise a 316L pipe positioned by the shifter between the shifted plates. Flat-jet high pressure nozzles spaced at sufficient intervals might ensure partial, substantial, and/or full coverage of both cloth surfaces. In preferred embodiments, nozzles may be configured so as to achieve 100% overlap of spray paths, without limitation. Spray paths may also substantially ensure cleaning of plate sealing surfaces, without limitation. The spray manifolds, for example, when operating in automatic mode, may be capable of performing one, two, or three passes on each plate, at the discretion of the operator or as programmed (e.g., by the operator or during commissioning). Plate assembly positioning may be controlled to ensure that no damage to washer spray bar or plate may occur before the wash bar is permitted to pass over the plate. Once a first group of plates has been washed, the water may shut off, the washed plates may be moved to a "clean-side" plate stack via the shifter, the shifter may index a next unwashed second group of plates, the shifter may index the washer carriage, the shifter may move the washer carriage to the next unwashed second group of plates, and the washer carriage may position itself squarely with the next unwashed second group of plates - all of the aforementioned steps preferably being performed automatically.

FIGS. 21-24 and 26-37 show plate cloth hanging hardware designs according to certain embodiments. A competitive advantage may be obtained by providing minimal hardware required to hold a filter cloth and still allow for it to raise and lower during cloth shaking, without limitation. In the embodiments shown in FIGS. 22-24, a cloth bar 31 may rest on top of a filter plate 34 and may only be raised off of the plate during shaking, without limitation. The cloth bar 31 may be raised in a controlled vertical translation by means of a clearance hole in the bar sliding on one or more bolts or pins, and/or a plurality of the like, without limitation. The bolt or pin may be threaded into a metal threaded insert in the plastic plate, threaded directly in, or pressed in with an interference fit. This bolt or pin may have a head or no head. A spring, such as a coil spring, leaf spring, or torsion spring may

be mounted between the cloth bar 31 and filter plate 34, and may at least partially be housed in a pocket or void provided to at least one of or both of the cloth bar 31 and filter plate 34, without limitation.

Alternatively, as shown in FIGS. 26-37, a metal plate which may have vertical guide posts or vertical slides may be mounded to the top of each plastic filter plate providing the structure for the cloth hanging bars to be mounted on and/or allow vertical translation of the cloth bar 31, relative to the filter plate 34. It should be noted that in some preferred embodiments, springs or other spring means 33 may be utilized between the cloth bar 31 and filter plate to tension the filter cloth. In some embodiments, no springs/spring means 33 may be employed.

The simplified cloth bar 31 and cloth hanging hardware design(s) shown and described may substantially decrease weight, may lower costs to fabricate, may lower costs to ship, may be comprise a form which is more compact than prior designs, as well as may reduce complications or other issues that might arise when shaking, balancing, and/or aligning plates, without limitation. Such simplified cloth bar 31 and cloth hanging hardware design(s) may provide a competitive advantage in the filtration marketplace, and may enable or serve as a building platform for other designs and inventions.

At least FIGS. 14, 42, and 70 suggest a shifting link design according to certain embodiments. A competitive advantage may be obtained by providing a link between plates that is less expensive but just as effective at shifting a select number of plates with a generally controlled distance between them (e.g., an acceptable tolerance for an open plate stack). One idea is to use a flexible but strong fabric (e.g., nylon webbing such as what is used for automotive seatbelts) as the link between the plates. The nylon or other webbing could have holes melted, cut, or punctured through it (with or without grommets, tube fasteners, washers, and/or bushings), such that the webbing may be bolted to each plate that is it is desirable to link in the filter press plate stack. The bolts could be threaded into the plastic directly (e.g., such as the use of lag bolts or self-threading plastic screws, without limitation), or the bolts could be threaded into metal inserts that are provided in the plastic, thereby allowing for repeated removal of the bolts without damage to the plastic portion of the plate. Other fastening means such as plastic welding, clamps, rivets, or other inexpensive means for fabrication and joining webbing to plastic may be employed, without

limitation. The holes or attachment features may be provided at definably-spaced intervals, such that the plates may be pulled apart with near equal spacing between each plate (e.g., when portions of the filter are opened, such as when a predetermined number of plates within a filter cartridge are opened), without limitation. The spacings could, foreseeably, be  
5 unequal, if such controlled positioning is desired, and/or so long as the holes or attachment features on the webbing line up with the respective holes or attachment features on the plates (e.g., such that an absolute distance between plates is maintained), without limitation. It should be noted that links may comprise bands of flexible steel, or woven steel strands, braided cable, braided rope, or other woven material (e.g., woven nylon or other  
10 polymer, etc.), without limitation.

A high performance-to-cost value method of linking filter plates is anticipated. Using the methods of linking filter plates disclosed herein may drastically reduce fabrication costs, may shorten lead times for an item used in high quantities on a filter press. It may be easier to make, may be easier to install, and may be easier to remove and/or replace  
15 during a maintenance cycle. The conventional links currently employed in the filter press arts are generally very labor intensive and time consuming to install. Accordingly, there may be cost savings in both short (e.g., CAPEX) and long (OPEX) terms.

FIG. 43, as well as other figures, suggests a non-limiting guided carriage track design according to some embodiments. A filter press may comprise a carriage that  
20 translates down the length of the filter to various positions via a carriage track. The carriage track may facilitate moving a filter cloth shaking mechanism (e.g., a "first carriage" 10) into place, and/or for moving a cloth washing carriage (e.g., a "second carriage" 20) into place, for washing select filter plates 34 and cloths 32, or both. The track may comprise the tolerances and/or accuracies required, but with minimal costs, for example, by guiding  
25 carriages via a 90 degree or close to 90 degree edge of an extruded profile provided to a box-frame rail, without limitation (this may be best appreciated from FIG. 19, which shows a complementary "V"-shaped wheel). For example, in some preferred embodiments, a 90-degree elbow may be welded to the top of a square or rectangular extrusion, without limitation. A wheel with a mating profile (e.g., of approximately 90 degrees) may ride on the  
30 90-degree elbow. The riding surface could also be a square extrusion tipped on its side, thereby allowing for a mating wheel with a 90-degree profile to ride on the edge of the

square profile. Moreover, in other envisaged embodiments, a weld bead or strip of metal may be provided along a square or rectangular extrusion. Moreover, in yet further envisaged embodiments, elbows having an angle greater than or less than 90-degrees may be employed for use with wheels having lesser notches. Moreover, a flat wheel may follow  
5 a rail having a "U"-shaped channel (e.g., a carriage track rail formed via a square or rectangular extrusion having side lips that cradle the flat wheel.

There could be a 90-degree or "V"-shaped extrusion on the top and/or bottom, or on each side, (or just the top or just the bottom or just one side, without limitation), such that the guide extrusions may be configured to be "sandwiched" between guide rollers  
10 (e.g., guide rollers comprising a 90-degree or "V"-shaped profile) during operation, without limitation. Various permutations of a carriage track are envisioned. The "holding" and/or "staying" of the wheels in contact with top and bottom portions of the carriage track during translation down the extrusion length might be accomplished through the use of compliant means such as a spring and/or damping mechanism (e.g., a coil spring, spring washer,  
15 cylinder, etc.). The compliant means may allow for carriages riding along the guides without binding or damaging the wheels. The compliant means may allow carriages to ride along the guides without significantly binding or damaging the carriage (e.g., due to inaccuracies in track tolerances along the length of the filter), without limitation.

In some embodiments, guides may be used to limit generally horizontal travels  
20 (e.g., such as travels in the general direction of shifting mechanism movements and/or carriage movements), without limitation. In some embodiments, guides may be used to limit vertical travels, without limitation. In some embodiments, guides may support the travel of washer bars, without limitation. Vertical guides may be employed for shaking mechanisms that might interface with the filter cloth bars during shaking, without limitation.

25 Separate tracks may be used for washer and shaker carriages, allowing nested traveling, and thus, in some embodiments, it may be possible to shake and wash at the same time using different carriages, and/or it may be possible to allow one carriage traveling past another carriage along the filter. Such functionality might allow for both washer and shaker (or, more generally, "multiple" carriages) to be parked on the same end  
30 of the filter, thereby decreasing the required length of the filter. In other words, a single "parking space" may be provided for more than one carriage, wherein additional parking

spaces might not be needed for additional carriages, thereby shortening the overall length and footprint of the filter.

In some embodiments, carriages may be held in their vertical position with a roller suspension system. The frame of a carriage accompanying rollers on the opposite side of the track may comprise a guidance system that may not allow significant side to side movement, thus isolating translation of a carriage to only one line of direction. Springs may be employed within a suspension configured to damp wheel movement from side to side (see for example, FIG. 19).

FIGS. 9, 12, 13, 20, 63-67, and 72-74 suggests various washer designs according to certain embodiments. In some embodiments (e.g., FIGS. 9, 12, 13, 20, 63-67), shaking and washing functions may be decoupled and performed using separate carriages. In some embodiments (e.g., FIGS. 72-74), shaking and washing functions may be coupled and performed using a single carriage, without limitation. A washer carriage designed to wash a plurality of plate cloths may horizontally translate into position along a track down the length of the filter by attaching to a shifter 40 mechanism that may be configured to move it, or, it may horizontally translate via its own drive mechanism (e.g., a long stroke cylinder, chain, cable, rack and pinion with associated drive, cog drive, pulley system, drive wheel and track, combinations thereof, and/or the like, without limitation). A washer carriage may horizontally translate to a position such that spray means associated therewith is in proximity to, above, and/or between opened spaces formed between plate assemblies 30 that have been opened. The spray manifold may be provided to a lowering mechanism structure such that if a close proximity high pressure wash is required, the spray bars may be lowered between plate assemblies to wash filter cloths. Water or another fluid may be utilized. If only low pressure washing is required, the spray means may maintain its position above the plates, flooding water or other fluid from above to clean the cloth surfaces.

In some embodiments, components of a washer may be configured move up and down via lowering mechanism (e.g., which may comprise a hydraulic cylinder). In some embodiments, a telescoping hydraulic cylinder may be employed, due to the long strokes which may be required. In some embodiments, as suggested in FIGS. 65-67, components of a washer may move up and down via a chain, cable, or rack and pinion arrangement,

without limitation. Components of a washer may be supported by a vertical or relatively vertical track which may provide stability as components of the washing system are lowered and raised. The added stability may support raising and lowering functions, and may reduce/mitigate damage to the lifting means, for example, during horizontal translation to various positions along the filter.

In some embodiments, the lifting means may comprise a chain inside a standard extrusion, such as a strut member (e.g., a Unistrut® product), wherein the strut member may provide guarding and/or and guidance for the chain and may also serve as an attachment for a sliding mechanism with retention to the extruded profile. A chain inside of shaped extrusion strut product may, in some embodiments, provide an inexpensive, but effective means of chain driving over a distance, without limitation. Similar chain configurations could be employed for horizontal translation of filter components (e.g., carriages) down the length of the filter and/or for vertical motion of filter components (e.g., to move the wash manifolds and nozzles through their up and down washing paths), without limitation. FIG. 76 suggests such an embodiment for use with a washer carriage 20.

In some embodiments, a shaker design (see FIG. 46) may comprise a supported wheel which is configured to make contact with cloth bars. The supported wheel may be pulled into contact with a cloth bar by virtue of translation of the shifter 40. In yet another unseen embodiment, the wheel could alternatively be configured to push "down" on a cloth bar, so as to compress a cloth bar tensioning spring, without limitation. In some embodiments, the wheel could be mounted above a cloth bar and "pull up" to stretch a filter cloth, to shake remaining cake from the cloths 32, without limitation. In some embodiments (as shown in FIG. 47), a wedge-shaped object may be pulled into contact with the filter cloth supporting bars, by virtue of a traveling shifter mechanism 40. In some embodiments, a carriage supporting a cylinder or cylinders that push a cloth bar or directly engage the filter cloth may be employed in order to shake cake or debris from filter cloths 32. Shaker means disclosed herein may be configured to travel down a length of the filter press and shake select cloths or a plurality of cloths, for example, simultaneously (including individual, but substantially simultaneous shaking of cloths 32), without limitation. In some embodiments, a shaker carriage 10 may be pulled by means of attachment to a shifter

mechanism 40 that travels down the length of the filter. In some embodiments, a shaker carriage 10 may travel by other means such as under its own chain, cable, cylinder, pulley system, cogwheel, drive wheel, or rack and pinion drive, without limitation.

A cloth shaker design may be operably configured to shake filter cloths 32 to  
5 remove filtered particles or filter cake. This may be accomplished through means for stretching the filter cloths. The means for stretching the filter cloths may comprise a cloth hanging bar 31 positioned above each filter plate 34, the bar 31 suspending a respective filter cloth 32. The cloth bar 31 may be held in a position such that the cloth bar may move vertically but the plate may remain relatively motionless (e.g., wherein the cloth may move),  
10 without limitation.

Shaking to remove filtered particles or filter cake may be performed using means for pushing down on a cloth bar 31 that suspends a filter cloth 32, or may be performed using means for pushing up on a cloth bar 31 that suspends a filter cloth 32, without limitation. The cloth bar 31 may be suspended and biased from the filter plate 34 by an  
15 elastic means 33 such as a spring. The cloth bar 31 may be pushed into closer proximity to the filter plate 34 by any one or more of the following means: one or more hydraulic or pneumatic cylinders pushing an individual cloth bar 31; one or more hydraulic or pneumatic cylinders pushing a shaker bar into contact with and/or compressing multiple cloth bars 31 (e.g., an arrangement comprising the use of 4 cylinders and 2 shaker bars); a wheel set at  
20 a specific elevation and translated horizontally to make contact with a cloth bar and roll over it to compress a biasing spring 33 (e.g., wheels on both sides of a shaker carriage 10 for compressing the left and right sides of a filter cloth bar 31); an actuation system comprising a pneumatic or hydraulic cylinder and wheel as suggested in FIG. 46; an actuation system comprising a pneumatic or hydraulic cylinder and a blunt piston end of the  
25 cylinder; a cable or chain with a motor (e.g., for translating a shifter carriage 10; a wedge shape or cam configured to translate into contact with cloth bars 31 (e.g., compress the cloth tensioning bias springs 33 and loosen the filter cloth 32) as suggested in FIG. 47, and the like. The wedge could comprise a coating or surface made of a low friction material. The wedge may be configured with a length such that it could translate and make contact  
30 with a single cloth bar 31 or multiple cloth bars 31 at a time, as it travels along its path. Though not shown, in some embodiments, the shifter 40 may comprise a shaking

mechanism, wherein the shaker carriage 10 may comprise a cloth bar 31 actuation member, without limitation.

#### Long Shifter

5           FIGS. 48 and 49 show a shifter 40 utilizing only one shifting dog 42, without limitation. FIGS 50-53 show a shifter 40 utilizing more than one shifting dog 42, without limitation. In some embodiments, one dog 42 may pull plates 34, and another dog 42 may be used as a stop, for example, for changing directions of translation, without limitation. In some embodiments, a short dog may be used for pulling a select number of plates (e.g., via  
10 a second plate tab 37), wherein a long dog may remain in contact with another plate tab (e.g., a first plate tab 37). Contact between the long dog and said another plate tab may hold the long dog down, thereby allowing the shifter to move to its next position, without limitation.

#### 15   Magnetic Lock

          The second shifter dog may be held into position by a magnetic lock, without limitation. In some embodiments, an electromagnet associated with a magnetic lock may be controlled by the PLC, wherein an up or down position of each dog may be controlled, without limitation. In some embodiments, dogs 42 associated with a shifter 40 may be  
20 mechanically actuated with springs and without a magnetic lock.

#### Limit Switch or prox. sensor

          A limit switch may be connected to any of the dogs 42 discussed herein, such that the filter PLC may be able to determine a status of a respective dog. For example, the PLC  
25 may be able to determine when a dog is depressed (e.g., by a plate tab 37). After a specified time delay, after a limit switch is activated upon depression of a dog, the shifter 40 may change direction of translation. Change of direction of a shifter 40 may pull open a second group of plate assemblies 30 (e.g., open a second cartridge 39), while simultaneously closing a first group of plate assemblies 30 (e.g., close a first cartridge 39),  
30 without limitation. Instead of the trigger for the direction change of the shifter 40 coming from the limit switch, it could also come from a proximity sensor mounted near the dog

determining its proximity. Various types and configurations of optical-based sensors, lasers, camera-based sensors, and/or mechanical-based location detection systems may be employed, without limitation.

In some embodiments, one or more dogs 42 of a shifter 40 may be controlled using a solenoid. For example, a dog, may, in some embodiments, be provided adjacent an electric solenoid to activate or deactivate the dog (e.g., up or down), without limitation. Alternatively, a hydraulic or pneumatic cylinder may drive a respective dog into "up" or "down" positions. Even more alternatively, a hydraulic or electric motor with gearing may change a dog's relative positioning with respect to a shifter 40. Hydraulic and/or electric circuits may be valved, throttled, geared, governed, or otherwise restricted (e.g., via programming logic), such that a dog 42 may be configured to go down/retract quickly, and/or such that a dog 42 may be configured to go up/advance slowly, thus providing the latency required for the dog to make it to the correct position laterally prior to the dog rising high enough to engage an advancing plate tab 37.

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## EXAMPLE 2

According to some more preferred embodiments, sequences of operation of a filter may comprise various modes of operation, without limitation. The present non-limiting example and context herein may be better appreciated and understood in light of FIG. 78.

In some embodiments, the filter may be designed to run without substantial operator interaction. According to some embodiments, the operator may choose to control the filter remotely; wherein the filter may be controlled from an onsite *distributed control system* (DCS), for example, via a PLC. According to some embodiments, the operator may choose to control the filter locally; wherein the filter may be controlled from a local human machine interface (HMI) and/or pendant control component(s), without limitation.

According to preferred embodiments, the filter may be programmed to operate in "automatic" mode and/or "manual" mode. In some embodiments, the manual mode may be selected and the filter operated from a local control panel of the filter HMI and/or using manual pendant controls.

If a filter operator selects an automatic filter mode, and all start-up permissives have been met, a complete filtration cycle may be performed, without limitation. The operator may be able to select whether the filter may perform a single cycle or continuous operation (e.g., "multi-cycle" continuous operation), for example, from a toggle switch on a local HMI.

5 A timer may be included in the filter control system, for example, to allow an operator of the filter to set a delay between filtration cycles when the filter is operating in the automatic mode, without limitation. In some embodiments, if an emergency stop provided to the filter is tripped, or in the event of one or more ancillary equipment components failing, then the filter may be paused for a period of time or indefinitely, until further control input from the  
10 operator, without limitation. A filtration cycle may resume (e.g., finish its current process step) once the emergency stop or fault has been cleared, without limitation. In some embodiments, the operator may subsequently determine if the process can/should continue. In some embodiments, the operator may subsequently determine if the process is unable to be resumed safely, without limitation. Accordingly, in some embodiments, the  
15 operator may be provided with an option, via the HMI, to over-ride trips.

A manual mode may be provided to allow the operator to service and/or to inspect different components of the filter and/or to run the filter in real-time, without limitation. In some embodiments a limited number of process functions may be able to be performed using the manual functions (e.g., a process function comprising starting a filtration cycle). In  
20 some embodiments, no process functions may be performed using manual functions. According to some embodiments, a list of process functions which might be performed by an operator operatively interacting with a filter HMI with the filter control system set to a manual operational mode may be selected from one or more of the following, without limitation: extending a follower; retracting a follower; opening a drip tray; closing a drip tray;  
25 forwarding a shifter; reversing a shifter; raising a shaker; lowering a shaker; running a shaker; extending a right-hand pin of a shaker; retracting a right-hand pin of a shaker; extending a left-hand pin of a shaker; retracting a left-hand pin of a shaker; raising a washer (e.g., raising a washer sub frame and spray bar on a washer carriage); lowering a washer (e.g., lowering a washer sub frame and spray bar on a washer carriage); extending  
30 a right-hand pin of a washer; retracting a right-hand pin of a washer; extending a left-hand pin of a washer; retracting a left-hand pin of a washer; extending a lock pin of a washer;

retracting a lock pin of a washer; manually locally overriding one or more valves, for example, using HMI Hand-Off-Auto (HOA) controls provided on a HMI; and/or manually controlling one or more pumps, for example, using Hand-Off-Auto (HOA) controls provided on a HMI, without limitation.

5           According to some embodiments, one or more of the following functions may be able to be performed with the manual pendant with the filter set to manual: emergency stopping filter operations (e.g., push to stop, pull to start); resetting the filter or resuming filtration operations from the beginning of a filtration cycle, forwarding a shifter; reversing a shifter; raising a washer (e.g., raising a washer sub frame and spray bar on a washer carriage);  
10           and/or lowering a washer (e.g., lowering a washer sub frame and spray bar on a washer carriage), without limitation.

          It should be duly noted that according to some embodiments, all interlocks may be operable for each of the aforementioned actions. For example, the manual operation of any one of, some of, or all of the aforementioned steps may not be performed if the  
15           permissives are not met. In this regard, the safety of the operator may be ensured and/or damage to the equipment may be prevented. In some embodiments, traditional lockout/tagout practices may be employed to ensure operator safety and/or to prevent equipment damage, without limitation.

          According to some preferred embodiments, during operation of a filter, a number of  
20           filtration steps may be performed, without limitation. For example, according to some embodiments, an automated filter may operate in a batch process manner and may follow a pre-determined series of steps or instructions to dewater influent slurry provided to the filter. The steps/instructions may comprise any one or more the following, without limitation: close the filter; perform a filtration operation; perform a "squeeze" function; perform a cake  
25           blow function; perform a core blow function; depressurize the filter; open the drip trays; perform a cake discharge function and a cloth shaking function; close the drip trays; close the filter but do not allow feed pumping or other filtration operations to occur; perform a plate opening function and a low pressure wash function; perform a plate opening function and a high pressure wash function (e.g., once daily); and/or end a particular cycle, without  
30           limitation.

According to some embodiments, a number of operator actions may be performed, without limitation. Such actions may include, for instance: ensuring that the filter is in "automatic" mode from both the DCS and local HMI; pressing a "start cycle" pushbutton; performing one or more filtration operations; depressurizing the filter; opening the drip trays; discharging cake, and/or performing a cloth shaking function, without limitation.

In some embodiments, if no operator actions are performed, then no operator interactions may be required, without limitation. According to some embodiments, operator actions with regard to the filter may include, without limitation: with the drip trays confirmed to be open, the PLC may begin to open a portion of the filter and discharge the first few cakes (e.g., the first six cakes as shown in the preferred non-limiting embodiment). After the first six cakes are discharged, the following may occur: a closure cylinder "retract" solenoid may be energized, and the filter may begin to open, thereby discharging the first six cakes. A closure cylinder(s) may, in some embodiments, continue to retract until a follower home limit switch is activated, without limitation. The closure cylinder retract solenoid (e.g., XV-D16) may then be de-energized and the follower may stop, without limitation. It should be noted that in some embodiments, if the filter's cake chute level sensor indicates a full chute while the follower is moving, then follower movement may, in some embodiments, be paused until the level sensor is OFF (or otherwise indicates a non-full chute), without limitation. Also, if the cake chute level sensor indicates a full chute while the shifter is pulling plate sections, or while there is shifter movement, then the follower movement may, in some embodiments, be paused until the level sensor is OFF, (or otherwise indicates a non-full chute), without limitation.

To perform a cloth shake cycle for a first group of plates (e.g., the first six plates as suggested in the figures as a non-limiting preferred embodiment), the PLC may control the filter as follows. The shaker carriage (e.g., first carriage) may be confirmed to be coupled to the shifter, the shifter may be confirmed in its home position (e.g., position E-A1), and the shaker bars of the shaker carriage may be confirmed to be in the "up" or "clearance" position prior to movement of the shaker carriage, without limitation. The shifter, being coupled to the shaker carriage, may move from its home position, towards the cylinder bracket end of the filter. After traveling, the shifter may stop with its shifter dog's face being aligned with the head end of the handle of the second plate from the follower (e.g., position

variable value E-A2). The shaker carriage may rest in the track grooves at this location and may not change in its lateral position. The shaker carriage may then decouple from the shifter. In some embodiments, decoupling may be performed in various manners. Right-hand shaker retract solenoids and/or left-hand shaker retract solenoids may retract.

5 Subsequently to retraction, one or more confirmation communications may optionally be delivered to the operator indicating that the retract solenoids (e.g., the respective right-hand and/or left-hand shaker retract solenoids) are indeed, retracted. The shifter may then go to position variable value E-A3, wherein the shifter may hit against a hard stop, thereby activating a dog (e.g., in the form of a pawl) to spring up and stay in the up position, without  
10 limitation. The shifter may then move toward the head end of the filter, and may stop at position variable value E-A4 after traveling for some time, without limitation. After stopping, the shifter may then reverse direction, and then may eventually stop with the shifter dog's face being aligned with the head end of the handle of the second plate (e.g., from the follower position variable value E-A5). The shifter' dog's face may engage a plate tab,  
15 without limitation. The shifter may not necessarily stop there (e.g., at position E-A5) and/or the shifter may not change position, without limitation. Readings from an encoder may be utilized to confirm that the position does not change by more than a specified number of pulses (e.g., by not more than +/- 10 pulses) in either direction. In some embodiments, there may be as many as 100 encoder pulses per revolution, without limitation. Other  
20 embodiments may comprise more or less than 100 encoder pulses per revolution, without limitation.

Thereafter, the shaker carriage may then re-couple to the shifter, without limitation. Right-hand and/or left-hand shaker pin "extend" solenoids may be energized. Right-hand and/or left-hand shaker pin extend position(s) may be confirmed prior to performing  
25 subsequent steps. The shaker carriage may perform two full engagements with the cloth shaker bar, without limitation. The number of engagements with the cloth shaker bar may be set or otherwise predetermined by an operator. For example, a variable "shake cycle quantity" may initially be set at "2", without limitation. In some embodiments, delays between shaker bar engagements may be controlled, for example, by setting a variable  
30 called "between shake delay timer", without limitation. The shaker carriage may comprise shaker bars on right and/or left hand sides of the filter. The shaker bars on the right-hand

and left-hand sides may be activated, for example, by energizing shaker "extend" solenoids. The shaker bars may be confirmed to be in the "up" position prior to the shaker carriage traveling laterally along the filter to the next position, without limitation. In this regard, impingement and/or risk of cloth damage may be mitigated. Cake discharging and shaking of the next few filtration chambers (e.g., the next six chambers) may then be performed. The shifter with shaker carriage coupled thereto may continue to travel towards the head end of the filter, for example, traveling just past the next plate stack primary plate dog (e.g., to encoder position variable value E-A6). The shifter may then, after passing the next plate stack primary plate dog, change directions - heading toward the cylinder bracket end of the filter towards encoder position variable value E-A7, without limitation. The shifter may travel past the point in which it can reach pulling the plate stack to position variable value E-A7. When the position value does not deviate by +/- 10 pulses to either direction for more than two seconds, the shifter may stop at that position. Such a time delay may comprise an adjustable variable "pull delay timer" (e.g., which may be initially set at 2.00 seconds), without limitation.

The shaker carriage may then similarly perform two (e.g., if the variable "shake cycle quantity" initially set at "2") full engagements of a cloth shaker bar with the new plate stack. The delay between shaker bar engagements may (as previously described) be controlled with a variable "between shake delay timer", without limitation. While the non-limiting number of full engagements suggested for a non-limiting preferred embodiment is two, the shake cycle quantity may be set to less than two (e.g., 1 for one full engagement), or more than two (e.g., to 3 for three full engagements), without limitation. The cloth shaker bars on the right-hand and/or left-hand sides of the filter may be activated, for example, by energizing one or more shaker bar "extend" solenoids. In some preferred embodiments, shaker bars may be confirmed to be in the "up" position prior to traveling to a subsequent next position.

Repeated discharge of cake, shaking of plate assemblies, and/or indexing through the other chambers of the filter plate stack of the filter may occur, without limitation. Thereafter, the shifter pulling the shaker carriage may then repeat the aforementioned step(s) of cake discharging and shaking; that is, it may index through the entire stack of plates and shake groups of plates at a time. The shaker may move to position E-A8 and

then may pull a plate stack to E-A9 and may then shake the respective plate stack, without limitation. This cycle may repeat until finally shaking a last set of plates at encoder position E-A31 (see the encoder position diagram shown in FIG. 78). Cycling through the entire stack of plates and shaking all of the plates may happen within a specified or

5 predetermined timeframe. The specified or predetermined timeframe may be adjustable, in some embodiments. For example, a "discharge and shake timer" variable may be employed, wherein the discharge and shake timer may be started at the beginning of the cake discharging and shaking process. For example, the discharge and shake timer may comprise, without limitation, an internal timer which may be programmed from the service  
10 screen on the filter's HMI, without limitation. The running time for this set of operations may be displayed on the service screen. The adjustable limit for this time variable "discharge and shake timer" may be, for example, initially set at 3.50 minutes, without limitation. It should be understood that the discharge and shake timer may be initially set to less than 3.50 minutes, or more than 3.50 minutes, without limitation.

15 In some embodiments, once the "discharge and shake timer" lapses, the PLC may perform one or more of the following actions, without limitation: showing/displaying an alert on the HMI, for example, via the PLC, if a set or predetermined time was exceeded for discharging and shaking; and/or displaying the lapsed time for the discharging and shaking with an optional alert, without limitation.

20 After discharging and shaking, the shaker carriage may be returned to a home position (e.g., a shaker carriage home position). In preferred embodiments, the aforementioned discharge and shaking operations may be completed and/or verified as being completed, prior to returning the shaker carriage returning to its home position, without limitation. The shaker bars may be confirmed to be in their "up" position(s) prior to  
25 the shaker carriage traveling to its home position, without limitation. This may be performed or otherwise achieved using a right-hand and/or left-hand "up proximity switch signal", without limitation. The shifter with the shaker carriage operably coupled to it, may travel to encoder position variable value E-A1. Finally, the shaker carriage may be confirmed to be at a home position using a limit switch "shaker home" or the like, without limitation.

30 After the above discharging and shaking operations have been performed, the drip trays may be closed (e.g., to prevent wash water from contaminating the discharged filter cake),

the filter may be closed (e.g., all filter plates and chambers therebetween may be closed), and a series of plate-opening and low-pressure wash actions may occur. It should be understood that in some embodiments, high pressure wash actions may occur, and/or flood wash actions may occur, without limitation. In some embodiments, the plate-opening and low-pressure wash actions may occur automatically, with no operator interactions required to begin or otherwise implement the wash actions. For example, a filter press program may require "plate-opening" and "low-pressure wash" actions to follow the "close drip trays" step and "close filter" steps of the program, without limitation. In preferred embodiments, to prevent flooding of dry discharged cake, it is preferred that "low-pressure wash" actions do not prematurely begin until the "close drip trays" step is completed and/or until the filter has finished its "closed" state. It should be duly noted that in some embodiments, one or more filter operations may be performed simultaneously; for example, the step of shaking with shaker bars may continue during the step of performing low and/or high-pressure washing actions. In this regard, less water may be necessary to perform a flood wash, and/or the flood wash duration may be shortened due to the extra motion between spray nozzles and cloth interfaces.

In some embodiments, the PLC program may be written to include plate opening and/or low pressure wash steps of the cycle. The PLC program may include a "plate opening and low pressure wash timer", which may be programmable (in minutes) via the HMI, without limitation. If the "plate opening and low pressure wash timer" is set to zero, for example, the program may perform the next step of the sequence, and may disregard a delay.

Filter actions occurring after closure of the drip trays may include the following, without limitation. With the drip trays closed, the PLC may open the filter. With the drip trays confirmed closed, the PLC may begin to open the filter allowing space to wash between the plates. To perform a cloth wash cycle for the first specified number of plates (e.g., six plates as shown, without limitation), the PLC may control the filter as follows.

The washer carriage may be confirmed to be coupled to the shifter, the shifter may be confirmed in the washer home position E-A3, and the washer may be confirmed to be in the up position, prior to movement. Right-hand and left-hand washer shifter pin-extending solenoids may be energized. Right-hand and left-hand washer shifter pin-extend positions

may be confirmed after they have been energized. The encoder may verify that the shifter is coupled to the washer carriage, and/or is in the washer carriage home position variable value E-A3. A washer up proximity switch signal may be utilized.

5 The shifter, coupled with the washer carriage, may move from the washer home position (e.g., position E-A3) towards the head end of the filter, traveling past the second plate to position E-A4, and then may change direction to head back toward the cylinder bracket end, and then may stop with the shifter dog face aligned with the head end of the handle of the second plate from the follower (position variable value E-A5). Readings from the encoder may confirm that position does not change by more than +/- 10 pulses to either  
10 direction (e.g., wherein 100 encoder pulses may equal one revolution, without limitation).

In some embodiments, an appropriate low pressure water pump may be on, by default, but bypassing to a tank, wherein the wash header valves provided to the washer carriage may be closed.

The washer carriage sub frame that travels up and down may be unlocked from a "pinned up" position, for example, by activating a washer lock pin "retract" solenoid. The pin's  
15 position may be validated to be in a fully retracted state (e.g., with the washer lock pin fully retracted). The washer may perform a low pressure wash (and/or a high pressure wash, without limitation), along with a lower and rise cycle. For example, a lower cycle and a rise cycle may be controlled with the down/up variable "washer up down count" which may  
20 normally be set to "1", without limitation. If set higher (e.g., such as set to "2", rather than "1"), the washer carriage sub frame may go down and up twice before proceeding to next steps.

The washer hydraulic motors may drive a chain which down-lowers the washer sub frame and spray bars. Alternatively, pneumatic cylinders may be used to down-lower the  
25 washer sub frame and spray bars. When the sub frame has been lowered into close proximity to a "wash water on/off" proximity switch, the water may be released to exit the upper and/or lower nozzles provided to each of the spray bars, without limitation. The water may be released by opening the respective wash header valves. It should be understood that while not shown, spray bars may only have one set of center nozzles  
30 facing in any direction, rather than upper and lower opposing nozzles, without limitation. Other nozzle configurations and design permutations are envisaged.

For embodiments using a chain, the washer hydraulic motors may continue to drive the chain, thereby down-lowering the washer sub frame and spray bars. The motors may continue to lower the spray bars until the sub frame comes into contact with a "washer down" proximity switch, at which point the hydraulic motors may switch direction and/or  
5 may drive the chain in the other direction, thereby up-raising the sub frame and spray bars. The sub frame and spray bars may raise until the sub frame comes into contact with the wash water on/off proximity switch, at which time if the variable "washer up down count" counter has not reached "0", then the washer sub frame and sprayer bars may travel down again, via the washer hydraulic motors driving the chain, the low-pressure wash be  
10 repeated, etc. As soon as the counter reaches "0", the sub frame and spray bars may continue to travel up, for example, being driven by the hydraulic motor. In most preferred cases, the washer may only travel down and up once per wash cycle.

As the sub frame and spray bars raise, they may continue up until they come into proximity with and activate a "washer up" proximity switch. Thereafter, once the sub frame  
15 and spray bars are deemed to be in the "up" position, the sub frame and spray bars may be locked into place by activating the washer lock pin extend solenoid(s), and validating that the washer lock pin extend solenoid(s) is in the extended position (e.g., with the washer lock pin in an extended configuration). Once the washer lock pin is deemed to be extended, the wash manifold valves may be closed to prevent water from exiting the spray bars. The  
20 "washer up" proximity switch may, in some embodiments, remain activated during the next steps wherein the wash carriage may traverse the rails and move along the filter. Deactivation of the "washer up" proximity switch may, in some embodiments, set off an alarm and may stop the shifter motor (e.g., to pause the lateral translation of the carriage along the filter).

25 Filter actions occurring after closure of the drip trays and washing may further comprise repeated shifting (e.g., movement of shifter along the filter), repeated opening of plates, and/or repeated pressure washing (e.g., low and/or high pressure washing, without limitation), repeated indexing through the other chambers of the stack of plates, repeated engagement/disengagement/movement of a shifter with a shaker carriage or wash  
30 carriage, etc.

The shifter, coupled with the washer carriage, may travel towards the head end (e.g., away from the main closure cylinders), and may travel just past the next plate stack primary plate tab, for example, to encoder position variable value E-A6. Thereafter, the shifter may then change directions and head toward the cylinder bracket end of the filter, for example, towards encoder position variable value E-A7. The shifter may try to travel past the point it can reach by pulling the plate stack to position variable value E-A7. When the position value does not deviate by +/- 10 pulses to either direction for more than two seconds, the shifter may stop at that position, without limitation. This time delay may comprise an adjustable variable, "pull delay timer" (e.g., which may be initially set at 2.00 seconds), without limitation.

The shifter pulling the washer carriage may then repeat the steps comprising the washer carriage moving from a home position, indexing through the stack of plates, and washing them all, etc. For example, the shifter may move the washer carriage to E-A8 then pull the plate stack to E-A9 and then wash the plate stack. This cycle may repeat until washing occurs at encoder position E-A29 (see the encoder position diagram).

The shifter pulling the washer carriage may then go to encoder position variable E-A28 and may decouple from the washer carriage, thereby leaving the washer carriage uncoupled. Decoupling may comprise, for instance, performing the following steps, without limitation: activating right-hand and/or left-hand washer shifter pin retract solenoids; and/or validating that the right-hand and/or left-hand washer shifter pin pins are retracted. After decoupling, the shifter may, by itself, go to encoder position variable E-A30. The shifter may then change directions and head toward the cylinder bracket end of the filter (e.g., towards encoder position variable value E-A31), pulling the last set of plates open (e.g., the last set of 6 plates open, without limitation). When/if the position value does not deviate by +/- 10 pulses to either direction for more than two seconds, the shifter may be configured to stop at that position. This time delay is an adjustable variable, "pull delay timer" (e.g., initially set at 2.00 seconds). As the encoder tries to reach position variable E-A31, it may really stop short at the actual position variable E-A32. This actual position E-A32 may be recorded to memory for reuse.

The shifter by itself may then travel toward the head end of the filter to position E-A1, for example, in order to push the shifter pawl/dog down. The shifter may then change

direction to head toward the cylinder bracket end to position E-A28, to pick up the washer carriage. For example, the washer carriage may be picked up by the shifter by activating right-hand and/or left-hand washer shifter pin extend solenoids. A validation step may further occur so as to validate that the pins are extended (e.g., the right-hand and/or left-hand washer shifter pin extend solenoids are extended). Once the washer and shifter are joined, the shifter/washer combination may travel towards the head end to encoder actual position E-A32. At position E-A32, washing of the last set of plates may take place. The washing operation may follow any one of the above steps, or may follow any listing of the above steps, without limitation.

According to some embodiments, all wash manifold valves may be opened. For example, if there are six manifolds (as shown, without limitation), then up to six manifold valves may be opened. In some embodiments, less than all manifold valves may be opened (e.g., for high-pressure wash). In some embodiments, manifold valves may be alternated or otherwise "cycled", to high-pressure wash/cloth wash individual filter chambers. Air may be purged from the wash headers/spray bars by opening a valve; wherein the valve may be opened, for example, by activating a valve solenoid. A verification step may be performed to ensure that the valve is open. The time to purge may be controlled by a variable "wash air purge timer". The variable "wash air purge timer" may be set, for example, with values ranging from 0.0 to 999.9 seconds, without limitation. For the purge to be offset or otherwise disregarded the variable may be set to 0.0 seconds; however, in some preferred embodiments, it may be normally set to 6.0, for example, as a default setting. The air purge process may, in some embodiments, operate during other operations which are to follow. After the respective time has elapsed, the valve may be closed, for example, by activating the valve solenoid. A verification step may be performed to ensure that the valve is closed.

After closing all wash manifold valves (e.g., after closing all six wash manifold valves), and after the completion of washing of the last set of plates, the shifter and washer carriage may travel together towards the cylinder bracket end of the filter, to encoder position variable E-A3. The washer carriage may be dropped off at washer home position E-A3, and the shifter pawl may come up. The cycling through the entire stack of plates and washing all of the plates may happen within a specified time frame. For example, a "plate

opening and low pressure wash timer" may be started at the beginning of the cloth wash cycle. The "plate opening and low pressure wash timer" may comprise an internal timer which may be programmed from the service screen of the HMI. The running time for this set of cloth washing operations may be displayed. The adjustable limit for this "plate  
5 opening and low pressure wash timer" time variable may be initially set at 9.00 minutes, without limitation.

Once the "plate opening and low pressure wash timer" time variable lapses, the PLC may perform the following actions, without limitation. An alert may be shown on the PLC that the time was exceeded for plate opening and low pressure washing. The lapsed time  
10 for the discharging and shaking may be displayed with the alert, without limitation.

The washing operations may be complete prior to returning the shifter to home position (E-A1). For example, after dropping off the washer carriage at position E-A3, the shifter may travel alone towards the head end of the filter to position E-A1. At position E-A1, the shifter pawl may be forced down. The shifter may then be coupled to the shaker  
15 carriage by doing the following: activating a right-hand and/or left-hand shaker pin extend solenoid, and validating that the pins are extended (e.g., with right-hand and/or left-hand shaker pins extended), without limitation.

Every so often (for example, once daily, without limitation), a plate opening and high pressure wash process may be performed. In some embodiments, no operator actions or  
20 interaction may be required; however, manual high pressure wash cycles may be manually commenced. In some embodiments, this step may only be periodically performed by the filter press program (e.g., typically set to once a day). This step of the program may similarly follow the "close drip trays" step and "close filter" steps of the program (e.g., similarly to the plate opening and low pressure wash). It is generally important that this  
25 step does not begin until the "close drip trays" step is substantially completed, and the filter may be in the closed state prior to the plate opening and high pressure wash process commencing.

The filter's PLC program may be written to include the plate opening and/or high pressure wash to occur once a day. For example, the program might include a "high  
30 pressure wash period timer", which may be programmable (e.g., with acceptable values of 0.1 to 99.9 in hours), and which may typically be set at "24.0" for "each day") from the HMI,

without limitation. When the "high pressure wash period timer" activates (typically once a day), the filter cycle following the current filter cycle (e.g., the next filter cycle after finishing a current filter cycle) may run the high pressure wash cycle, instead of (or in series with) the low pressure wash cycle, without limitation.

5           The PLC program may be written to include a "high pressure wash quantity" variable that may, for example, be set to "1" as a default, without limitation. In some non-limiting embodiments, if set to "0", the high pressure wash may not run. In some non-limiting  
10           embodiments, if set to "1", the high pressure wash may run once, for example, replacing one low pressure wash cycle with one high pressure wash cycle for that particular day, without limitation. In some embodiments, if the high pressure wash quantity variable is set to 2, then two of the low pressure wash cycles may be replaced with high pressure wash cycles, for example, after the high pressure wash period timer activates, without limitation. According to some non-limiting embodiments, this high pressure wash quantity variable  
15           may be adjustable (e.g., from 0 to 9), without limitation. If an operator wishes to have all low pressure wash cycles, and does not wish to run high pressure cycles, the operator may, for instance, set the high pressure wash quantity variable to zero, without limitation.

          As another example, if an operator wishes to replace all low pressure wash cycles with high pressure wash cycles, they may, for example, set the high pressure wash quantity  
20           variable to "9", and may set the time of the high pressure wash period timer to be less than the time it might take to run nine complete filtering cycles, without limitation. However, since high pressure wash cycles may take more time than low pressure wash cycles, the latter scenario may not be recommended in all instances.

          For instances where a high pressure wash is to be performed, one or more of the following steps may take place, without limitation.

25           The washer may perform a "high-pressure-wash, lower and rise cycle". This activity may be controlled with a variable "HP washer up/down for all *N* count". The variable "HP washer up/down for all *N* count" may normally be set to "1", without limitation. If set higher (e.g., set to "2"), the washer may go through it's down and up cycles for all plates twice before proceeding (e.g., for the embodiment shown, the washer may go through its down  
30           and up cycles twice for each of the six chambers, without limitation).

The washer hydraulic motors may drive the chain down, thereby lowering the washer sub frame and spray bars. When the sub frame/spray bars have been lowered in proximity to the "wash water on/off" proximity switch, the water may be released to exit the nozzles. The water may be released by opening the first of six valves (high-pressure cloth wash for a first chamber), rather than by opening all valves together (e.g., low-pressure/flood wash for all six chambers), without limitation.

The washer hydraulic motors may continue to drive the chain down lowering the washer sub frame and spray bars. The motors may continue to lower the spray bars until the sub frame is in proximity to the "washer down" proximity switch, at which point the hydraulic motors may switch direction and drive the chain the other direction, thereby raising the sub frame and spray bars of the washer.

The sub frame and spray bars may raise until the sub frame comes into proximity to the "wash water on/off" proximity switch, at which time the respective open wash manifold valve may be returned to the closed position, (e.g., closing the first of six wash manifold valves).

The washer hydraulic motors may drive the chain down, thereby lowering the washer sub frame and spray bars. When the sub frame/spray bars have been lowered in proximity to the "wash water on/off" proximity switch, the water may be released to exit the nozzles. The water may be released by opening the second of six valves (high-pressure cloth wash for a second chamber), rather than by opening all valves together (e.g., low-pressure/flood wash for all six chambers), without limitation.

The washer hydraulic motors may continue to drive the chain down lowering the washer sub frame and spray bars. The motors may continue to lower the spray bars until the sub frame is in proximity to the "washer down" proximity switch, at which point the hydraulic motors may switch direction and drive the chain the other direction, thereby raising the sub frame and spray bars of the washer.

The sub frame and spray bars may raise until the sub frame comes into proximity to the "wash water on/off" proximity switch, at which time the respective open wash manifold valve may be returned to the closed position, (e.g., closing the second of six wash manifold valves).

The washer hydraulic motors may drive the chain down, thereby lowering the washer sub frame and spray bars. When the sub frame/spray bars have been lowered in proximity to the "wash water on/off" proximity switch, the water may be released to exit the nozzles. The water may be released by opening the third of six valves (high-pressure cloth wash for a third chamber), rather than by opening all valves together (e.g., low-pressure/flood wash for all six chambers), without limitation.

The washer hydraulic motors may continue to drive the chain down lowering the washer sub frame and spray bars. The motors may continue to lower the spray bars until the sub frame is in proximity to the "washer down" proximity switch, at which point the hydraulic motors may switch direction and drive the chain the other direction, thereby raising the sub frame and spray bars of the washer.

The sub frame and spray bars may raise until the sub frame comes into proximity to the "wash water on/off" proximity switch, at which time the respective open wash manifold valve may be returned to the closed position, (e.g., closing the third of six wash manifold valves).

The above may continue for subsequent fourth, fifth, and sixth manifold valves, etc., for respective for subsequent fourth, fifth, and sixth chambers, etc., wherein if the variable "HP washer up/down for all N count" counter has not reached "0", the washer may travel and performs the respective number of down and up cycles again, repeating the aforementioned steps (e.g., six times, for six filter chambers associated with a filter cartridge). As soon as the counter has reaches "0", the sub frame and spray bars may continue to travel up, for example, being driven by a hydraulic motor. In some embodiments, the "HP washer up/down for all N count" may be equal to "1", without limitation. After high pressure washing takes place, all wash manifold valves may be opened and purged, without limitation. Subsequently, all wash manifold valves may be closed, without limitation.

At the end of a complete filtration cycle, an operator may not necessarily be required to perform any actions or interactions. The filter may be programmed to return to a preparatory state ready for the next filter cycle. In some embodiments, the filter may maintain a cycle count comprising the total number of filter cycles; wherein only fully-completed cycles may be counted, without limitation. In some embodiments, the cycle

counter may be set at "0" and may go to "1" after the first filtration cycle is completed. The cycle count may be displayed as a value, for example on a screen of the HMI, and may be called "filter cycle count". In some embodiments, the filter may maintain a run hour count, which may keep track of the number of hours the filter may be running in automated mode.

5 In some embodiments, the run hour counter may be initially set at zero and it may go to "1" after the first hour the filter is running in automated mode. Similar to filter cycle count, the run hour count may be a displayed value and may be labeled "filter run hours". Filter actions that might occur at the end of a filtration cycle may comprise, for instance, all valves, pumps, and/or hydraulics, returning to their initial preparatory state; wherein if  
10 another filter cycle is to be performed, such as the case of being in automated mode, the above sequence(s) may repeat from the beginning, without limitation.

- - - - -

A contractor or other entity may provide a system having a filter press in part or in  
15 whole as shown and described. A contractor or other entity may provide a filter press in part or in whole as shown and described. For instance, the contractor may receive a bid request for a project related to designing a filter press system or process, or the contractor may offer to design such a system or a process for a client. The contractor may then provide, for example, any one or more of the devices or features thereof shown and/or  
20 described in the embodiments discussed above. The contractor may provide such devices by selling those devices or by offering to sell those devices. The contractor may provide various embodiments that are sized, shaped, and/or otherwise configured to meet the design criteria of a particular client or customer or work advantageously with a particular filtration system or filter press. The contractor may subcontract the fabrication, delivery,  
25 sale, or installation of one or more components of a filtration system or filter press, or of other devices used to provide such one or more components. The contractor may also survey a site and design or designate one or more storage areas for stacking the material used to manufacture the systems discussed herein. The contractor may also maintain, modify, or upgrade one or more provided or existing filter presses, and/or components  
30 thereof. The contractor may provide such maintenance or modifications by subcontracting such services or by directly providing those services or components needed for said

maintenance or modifications. In some cases, the contractor may modify an existing filter press with a “retrofit kit” to arrive at a modified filter or filtration process, or arrive at a filter having one or more of the process steps, devices, components, or features discussed herein.

5           Although the invention has been described in terms of particular embodiments and applications, one of ordinary skill in the art, in light of this teaching, can generate additional embodiments and modifications without departing from the spirit of or exceeding the scope of the claimed invention. Accordingly, it is to be understood that the drawings and descriptions herein are proffered by way of example to facilitate comprehension of the  
10 invention and should not be construed to limit the scope thereof.

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## REFERENCE NUMERAL IDENTIFIERS

|    |     |                                             |
|----|-----|---------------------------------------------|
|    | 1   | filter                                      |
|    | 2   | frame                                       |
|    | 3   | track                                       |
| 5  | 10  | first carriage (e.g., shaker carriage)      |
|    | 10a | shaker bar                                  |
|    | 10b | shaker cylinder                             |
|    | 10c | wheel assembly (optionally damped)          |
|    | 10d | frame                                       |
| 10 | 10e | first carriage cover                        |
|    | 11  | upper washing nozzles                       |
|    | 12  | first washing means                         |
|    | 13  | lower washing nozzles                       |
|    | 20  | second carriage (e.g., washer carriage)     |
| 15 | 20c | wheel assembly (optionally damped)          |
|    | 20d | frame                                       |
|    | 20e | second carriage cover                       |
|    | 21  | upper washing nozzles                       |
|    | 22  | second washing means                        |
| 20 | 23  | lower washing nozzles                       |
|    | 25  | lowering mechanism                          |
|    | 27  | first fixed portion of lowering mechanism   |
|    | 29  | second moving portion of lowering mechanism |
|    | 30  | filter plate assemblies                     |
| 25 | 31  | cloth bar                                   |
|    | 31a | washer                                      |
|    | 31b | grommet                                     |
|    | 32  | filter cloth                                |
|    | 33  | spring means                                |
| 30 | 34  | filter plate                                |
|    | 35  | bracket                                     |
|    | 35a | cup                                         |
|    | 35b | boss                                        |
|    | 35c | threaded surface                            |
| 35 | 35d | cloth bar to bracket fastener               |
|    | 35e | bracket to filter plate fastener            |
|    | 36  | handle                                      |
|    | 36c | hook                                        |
|    | 36d | a receiving portion                         |
| 40 | 37  | plate tab                                   |
|    | 38  | link                                        |
|    | 39  | filter plate cartridge                      |
|    | 40  | shifter                                     |
|    | 42  | shifter dog                                 |
| 45 | 200 | hoist                                       |

- 202 lift point
- 204 hoist bar
- 206 chain
- 210 saddle frame
- 5 212 side rail
- 214 leg

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## CLAIMS

What is claimed is:

1. A filter (1) having a frame (2) supporting a track (3), and a first carriage (10) on the track (3) which is configured to shake a plurality of filter cloths (32) simultaneously, the filter cloths (32) being attached to respective filter plate assemblies (30) supported by the frame (2), each of the filter plate assemblies (30) comprising a filter plate (34), a cloth bar (31) operably connected to the filter plate (34), and spring means (33) provided between the filter plate (34) and the cloth bar (31).  
10
2. The filter (1) according to claim 1, wherein the first carriage (10) further comprises first washing means (12).  
15
3. The filter (1) according to claim 2, wherein the first washing means (12) is configured to wash the plurality of filter cloths (32) simultaneously.  
20
4. The filter (1) according to claim 2, wherein the first washing means (12) comprises upper (11) and/or lower (13) washing nozzles.  
25
5. The filter (1) according to claim 4, wherein the upper (11) and/or lower (13) washing nozzles are fixed to the first carriage (10).  
30
6. The filter (1) according to claim 2, wherein the first washing means (12) comprises a flood wash.
7. The filter (1) according to claim 6, wherein the flood wash is configured to remove cake from the plurality of filter cloths (32), simultaneously.
8. The filter (1) according to claim 6, wherein the flood wash comprises a low pressure wash.

9. The filter (1) according to claim 6, wherein the flood wash comprises a high pressure wash.

10. The filter (1) according to claim 1, wherein the filter (1) further comprises a second carriage (20) on the track (3).

11. The filter (1) according to claim 10, wherein the second carriage (20) is independently movable on the track (3) with respect to the first carriage (10).

12. The filter (1) according to claim 11, wherein the second carriage (20) moves less frequently than the first carriage (10), relative to the track (3).

13. The filter (1) according to claim 11, wherein when the second carriage (20) moves relative to the track (3), the first carriage (10) remains stationary, relative to the track (3).

14. The filter (1) according to claim 11, wherein when the second carriage (20) moves relative to the track (3), the first carriage (10) remains stationary, relative to the track (3).

15. The filter (1) according to claim 11, wherein when the second carriage (20) moves relative to the track (3) via a shifter (40) comprising a dog (42), and wherein the first carriage (10) moves relative to the track (3) via the same shifter (40).

16. The filter (1) according to claim 15, wherein the filter plate assemblies (30) also move relative to the track (3) via the same shifter (40).

17. The filter (1) according to claim 10, wherein the second carriage (20) comprises second washing means (22).

18. The filter (1) according to claim 17, wherein the second (20) washing means (22) is configured to wash the plurality of filter cloths (32) simultaneously.

19. The filter (1) according to claim 17, wherein the second washing means (22) comprises upper (21) and/or lower (23) washing nozzles.

20. The filter (1) according to claim 17, wherein the second washing means (22)  
5 comprises a high pressure wash.

21. The filter (1) according to claim 20, wherein the high pressure wash is configured to penetrate the plurality of filter cloths (32) simultaneously.

10 22. The filter (1) according to claim 17, wherein the upper (21) and/or lower (23) washing nozzles are movable with respect to the second carriage (20).

23. The filter (1) according to claim 22, wherein upper (21) and/or lower (23) washing nozzles are movable via a lowering mechanism (25) comprising a first portion (27) which is  
15 fixed to a frame of the second carriage (20), and a second moving portion (29) which moves relative to the first portion (27).

24. The filter (1) according to claim 23, wherein the upper (21) and/or lower (23) washing nozzles are fixed to the second moving portion (29) of the lowering mechanism  
20 (25).

25. A filter (1) having a frame (2) supporting a track (3), and a second carriage (20) on the track (3) which is configured to wash a plurality of filter cloths (32) simultaneously, the filter cloths (32) being attached to respective filter plate assemblies (30) supported by the  
25 frame (2).

26. The filter (1) according to claim 25, wherein each of the filter plate assemblies (30) comprise a filter plate (34), a cloth bar (31) operably connected to the filter plate (34), and spring means (33) provided between the filter plate (34) and the cloth bar (31).

27. The filter (1) according to claim 25, wherein the second carriage (20) comprises second washing means (22).

28. The filter (1) according to claim 27, wherein the second washing means (22) is  
5 configured to wash the plurality of filter cloths (32) simultaneously.

29. The filter (1) according to claim 27, wherein the second washing means (22) comprises upper (21) and/or lower (23) washing nozzles.

10 30. The filter (1) according to claim 27, wherein the second washing means (22) comprises a high pressure wash.

31. The filter (1) according to claim 30, wherein the high pressure wash is configured to penetrate the plurality of filter cloths (32).

15 32. The filter (1) according to claim 27, wherein the upper (21) and/or lower (23) washing nozzles are movable with respect to the second carriage (20).

33. The filter (1) according to claim 32, wherein the upper (21) and/or lower (23)  
20 washing nozzles are movable via a lowering mechanism (25).

34. The filter (1) according to claim 33, wherein upper (21) and/or lower (23) washing nozzles are movable via a lowering mechanism (25) comprising a first portion (27) which is fixed to a frame of the second carriage (20), and a second moving portion (29) which  
25 moves relative to the first portion (27).

35. The filter (1) according to claim 34, wherein the upper (21) and/or lower (23) washing nozzles are fixed to the second moving portion (29) of the lowering mechanism (25).

36. The filter (1) according to claim 25, wherein the filter (1) further comprises a first carriage (10) on the track (3).

37. The filter (1) according to claim 36, wherein the first carriage (10) further comprises  
5 first washing means (12).

38. The filter (1) according to claim 37, wherein the first washing means (12) is configured to wash the plurality of filter cloths (32) simultaneously.

10 39. The filter (1) according to claim 37, wherein the first washing means (12) comprises upper (11) and/or lower (13) washing nozzles.

40. The filter (1) according to claim 39, wherein the upper (11) and/or lower (13) washing nozzles are fixed to the first carriage (10).

15 41. The filter (1) according to claim 37, wherein the first washing means (12) comprises a flood wash.

42. The filter (1) according to claim 41, wherein the flood wash is configured to remove cake from the plurality of filter cloths (32).

20 43. The filter (1) according to claim 41, wherein the flood wash comprises a low pressure wash.

44. The filter (1) according to claim 41, wherein the flood wash comprises a high  
25 pressure wash.

45. The filter (1) according to claim 37, wherein the second carriage (20) is independently movable on the track (3) with respect to the first carriage (10).

30 46. The filter (1) according to claim 45, the second carriage (20) moves less frequently than the first carriage (10), relative to a track (3) provided to the filter frame (2).

47. The filter (1) according to claim 36, wherein the second carriage (20) moves relative to the track (3) via a shifter (40) comprising a dog (42), and wherein the first carriage (10) moves relative to the track (3) via the same shifter (40).

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48. The filter (1) according to claim 47, wherein the filter plate assemblies (30) also move relative to the track (3) via the same shifter (40).

49. A method of using/operating a filter (1) according to claim 1, comprising:

10 separating a first group of filter plate assemblies (30),  
moving the first carriage (10) adjacent the separated first group of filter plate assemblies (30),

shaking the plurality of filter cloths (32) of the separated first group of filter plate assemblies (30) simultaneously, and,

15 flood washing the separated first group of filter plate assemblies (30) simultaneously.

50. The method of claim 49, wherein the first group of filter plate assemblies (30) comprises a filter plate cartridge (39) of multiple filter plate assemblies (30) connected by links (38) which may or may not be flexible.

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51. The method according to claim 49, further comprising the steps of:

closing the separated first group of filter plate assemblies (30),

separating a second group of filter plate assemblies (30),

moving the first carriage (10) adjacent the separated second group of filter plate

25 assemblies (30),

shaking the plurality of filter cloths (32) of the separated second group of filter plate assemblies (30), and,

flood washing the plurality of filter cloths (32) of the separated second group of filter plate assemblies (30).

30

52. The method according to claim 49, further comprising the steps of:

moving the first carriage (10) away from the separated first group of filter plate assemblies (30),

moving a second carriage (20) adjacent the separated first group of filter plate assemblies (30), and

5 cloth washing the plurality of filter cloths (32) of the separated first group of filter plate assemblies (30).

53. The method according to claim 52, further comprising moving the second carriage (20) adjacent the separated second group of filter plate assemblies (30), and cloth washing  
10 the plurality of filter cloths (32) of the separated second group of filter plate assemblies (30).

54. A method of using/operating a filter (1) according to claim 25, comprising:  
separating a first group of filter plate assemblies (30),  
15 moving the second carriage (20) adjacent to the separated first group of filter plate assemblies (30), and  
cloth washing the plurality of filter cloths (32) of the separated first group of filter plate assemblies (30) simultaneously.

20 55. A filter plate cartridge (39) comprising: a plurality of filter plates (34) which are each configured to receive a filter cloth (32); wherein the plurality of filter plates (34) are connected together with at least one link (38) which may or may not be flexible; wherein the at least one link (38) is configured to allow each plate within the plurality of filter plates (34), to be moved against an adjacent plate within the plurality of filter plates (34); and wherein  
25 the at least one link (38) is configured to allow each plate within the plurality of filter plates (34), to be moved away from an adjacent plate.

56. The filter plate cartridge (39) of claim 55, wherein each of the filter plates (34) comprises a handle (36) having a hook (36c), the hook (36c) comprising a receiving portion  
30 (36) configured to receive a hoist bar (204) of a hoist (200).

57. The filter plate cartridge (39) of claim 55, wherein the filter plate cartridge (39) may be engaged by a hoist (200) to remove the plurality of filter plates (34) from a filter (1), simultaneously.

5 58. The filter plate cartridge (39) of claim 55, wherein at least one of the filter plates (34) comprises a plate tab (37) which is configured to engage a dog (42) of a shifter (40).

59. The filter plate cartridge (39) of claim 58, wherein only one of the plurality of filter plates (34) comprises the plate tab (37).

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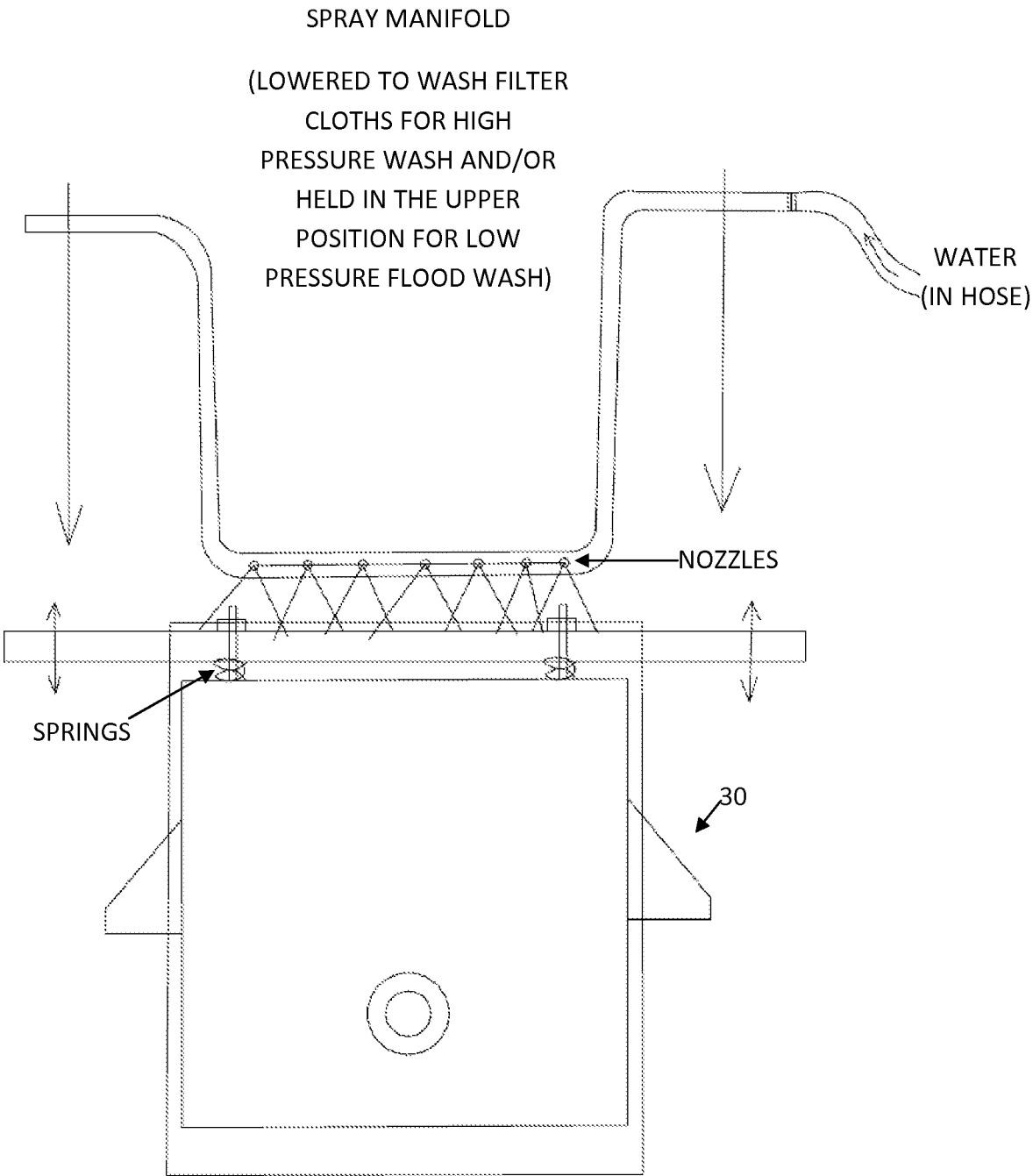


FIGURE 1

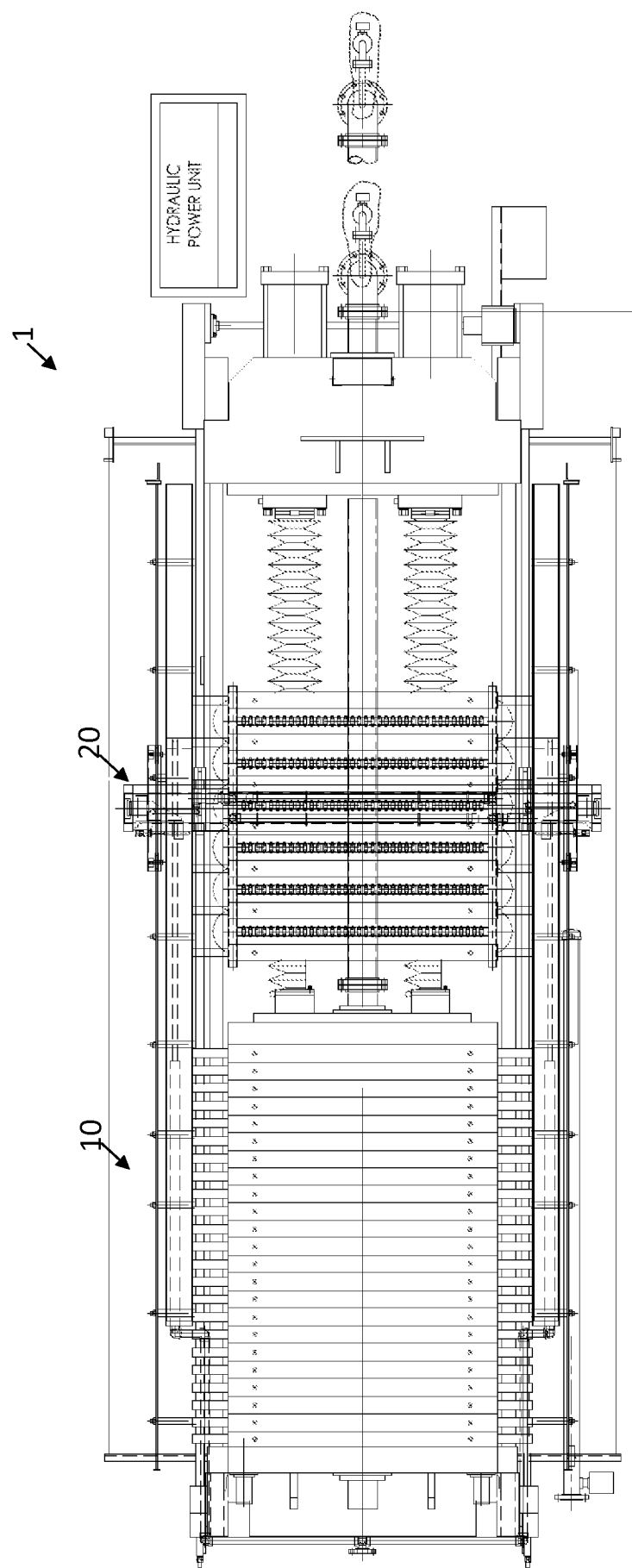


FIGURE 2

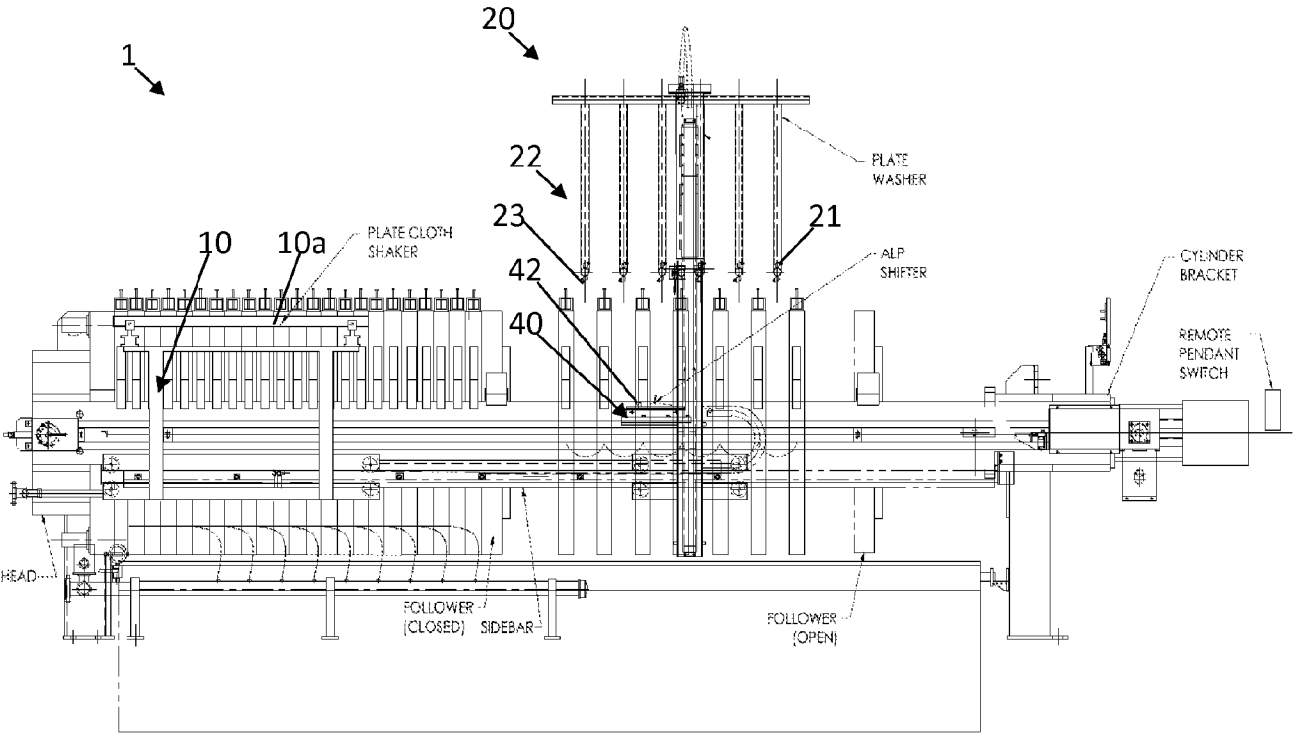


FIGURE 3

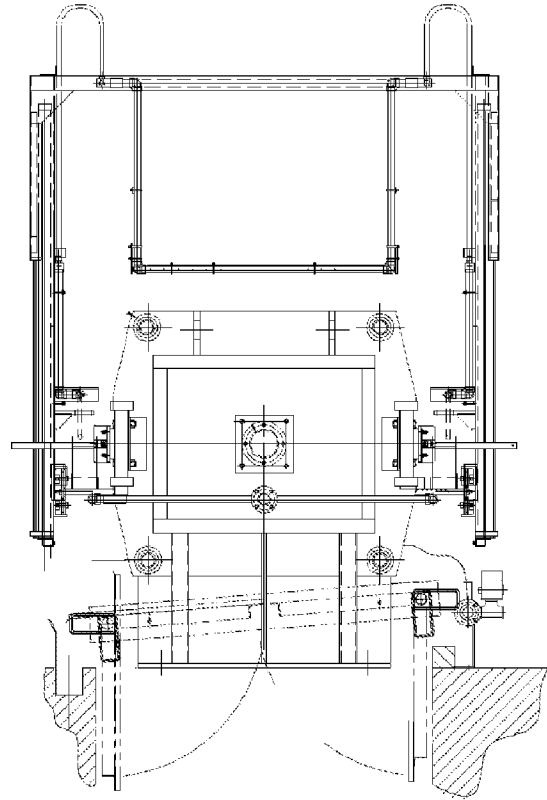


FIGURE 4

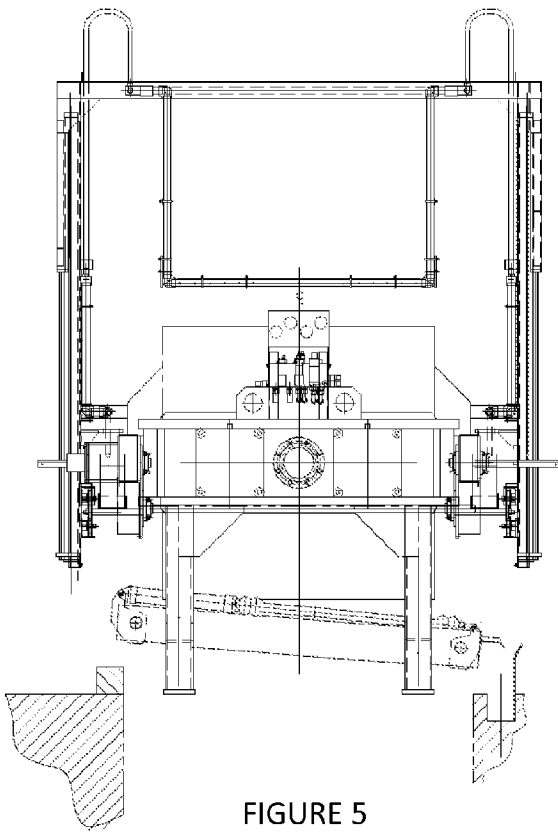


FIGURE 5

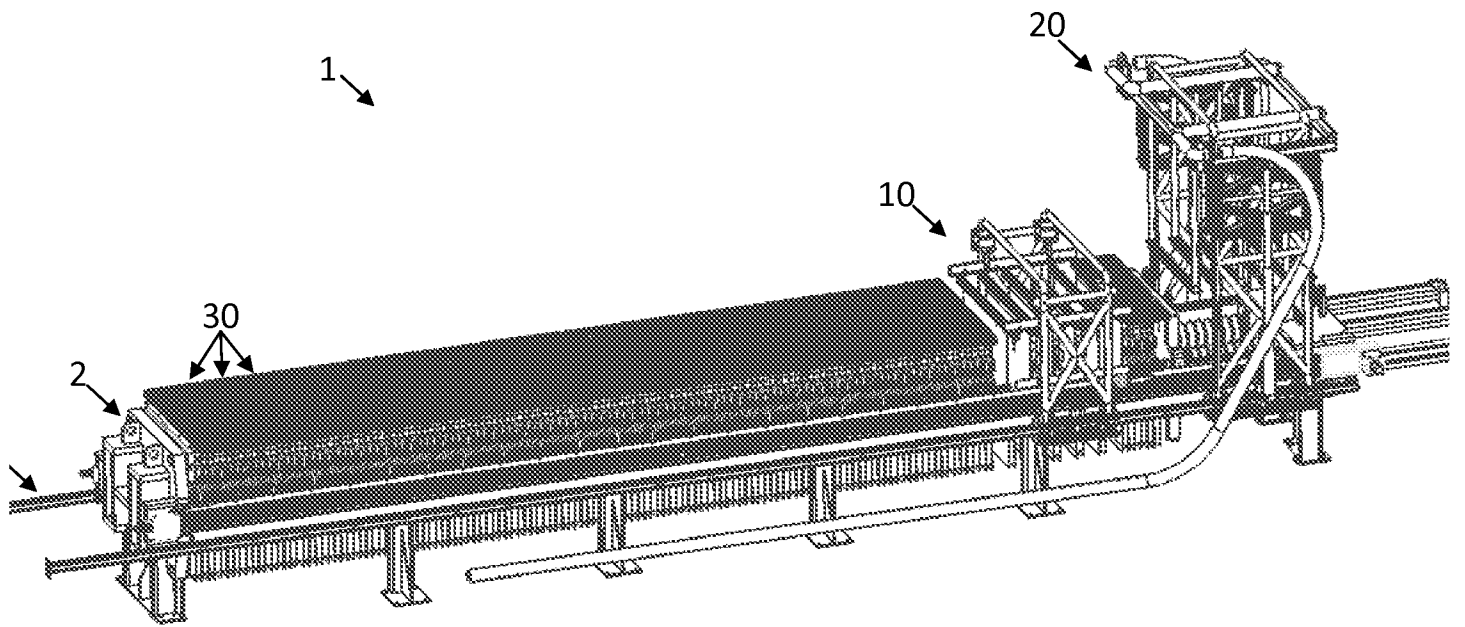


FIGURE 6

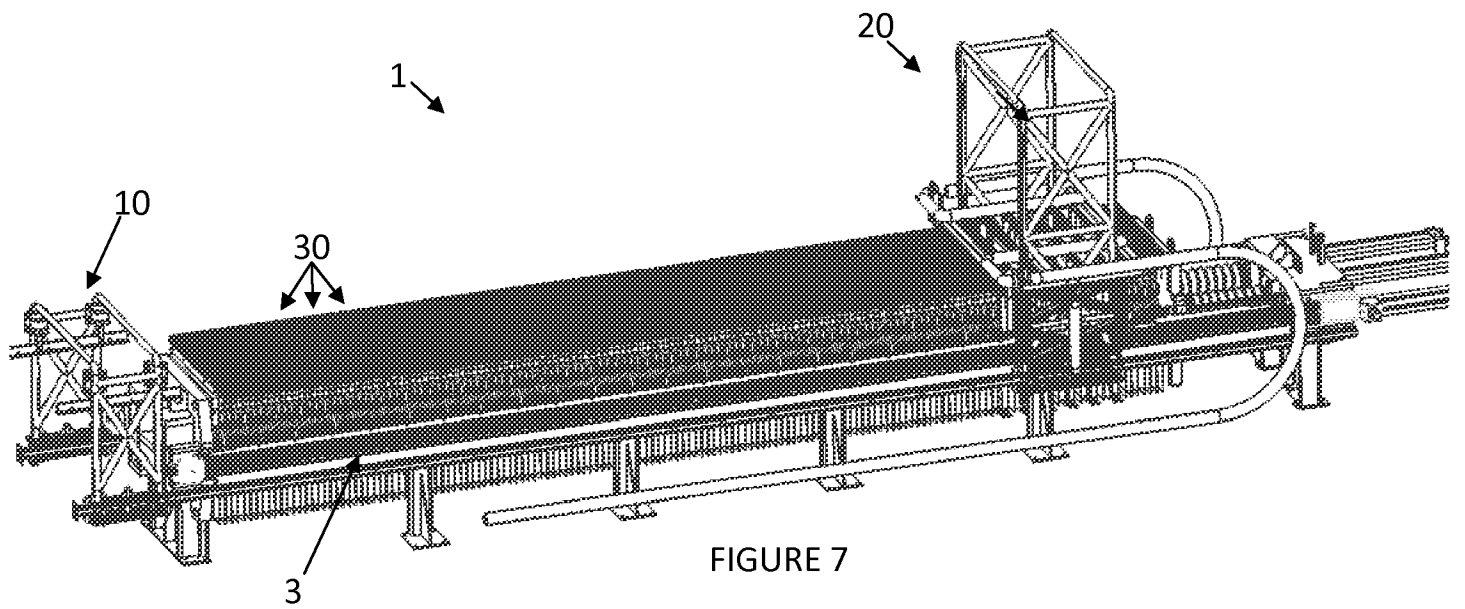


FIGURE 7

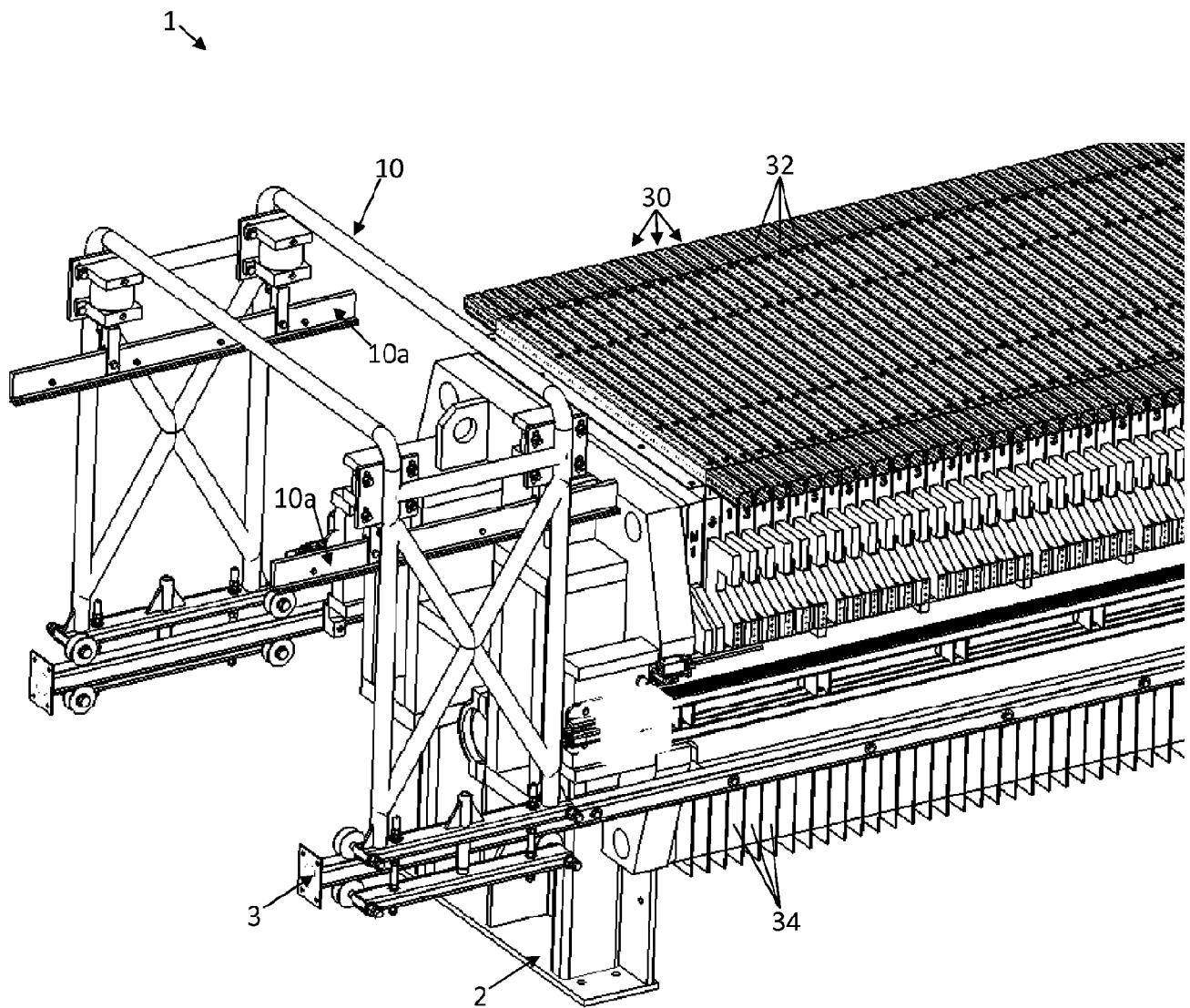


FIGURE 8

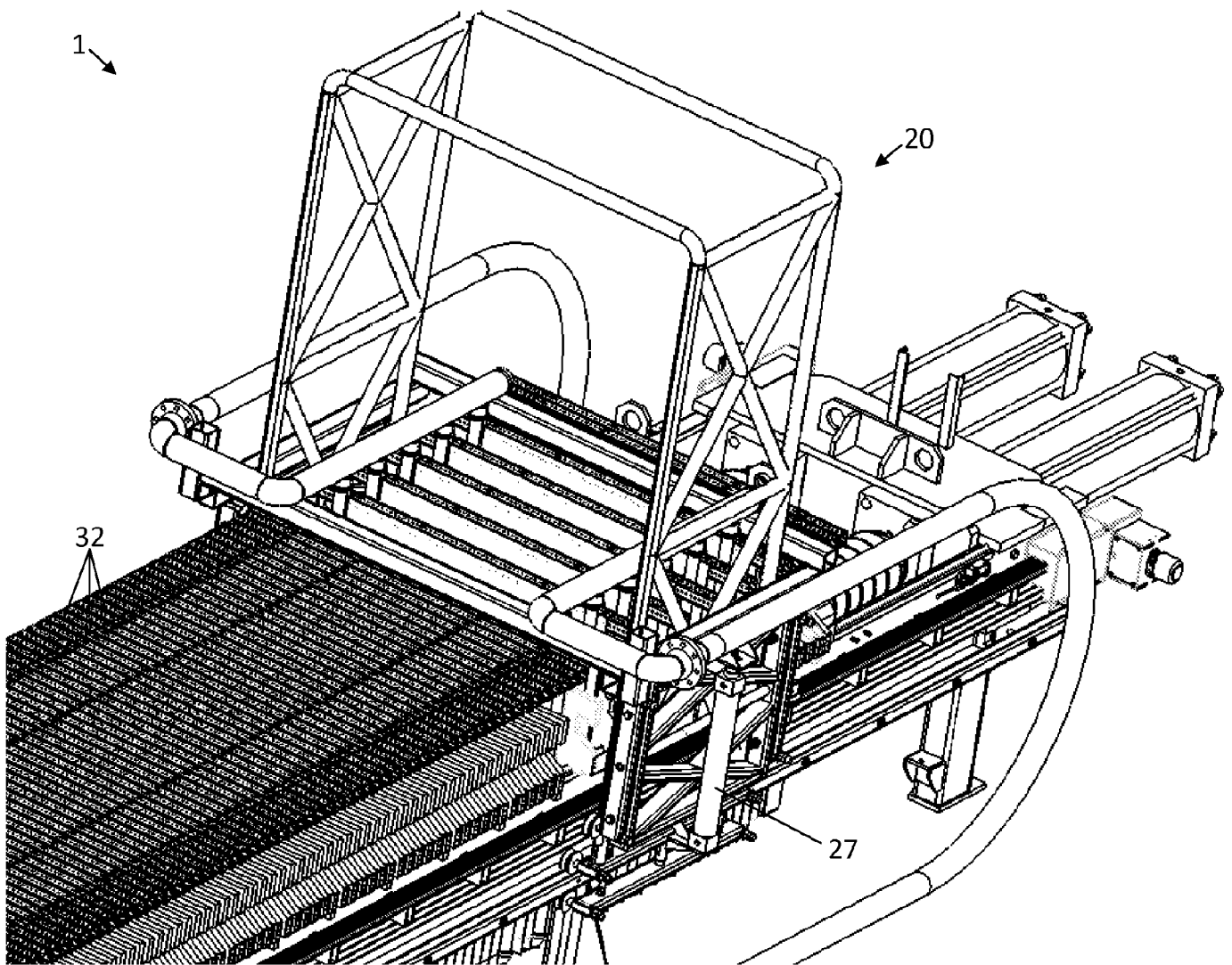


FIGURE 9

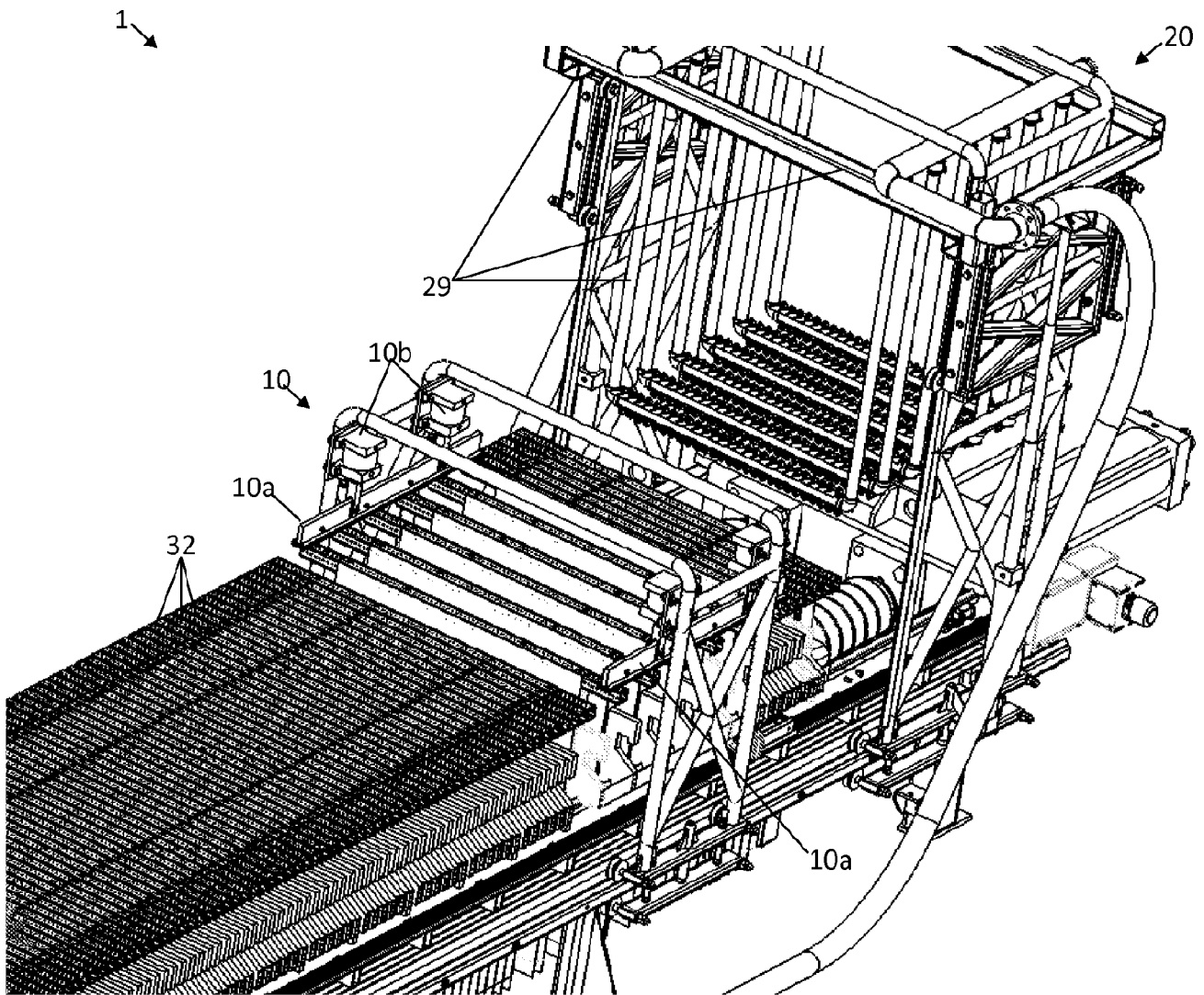


FIGURE 10

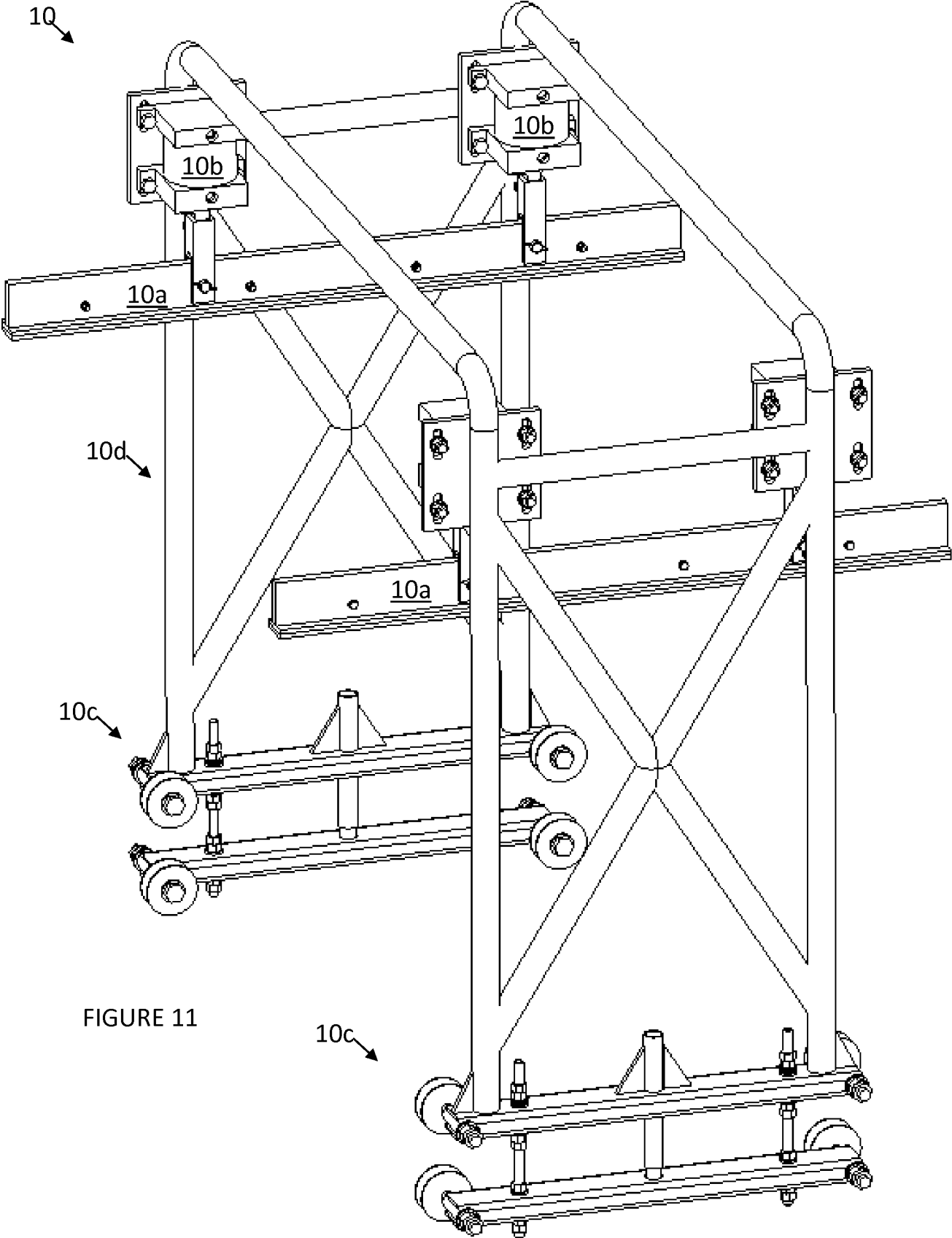


FIGURE 11

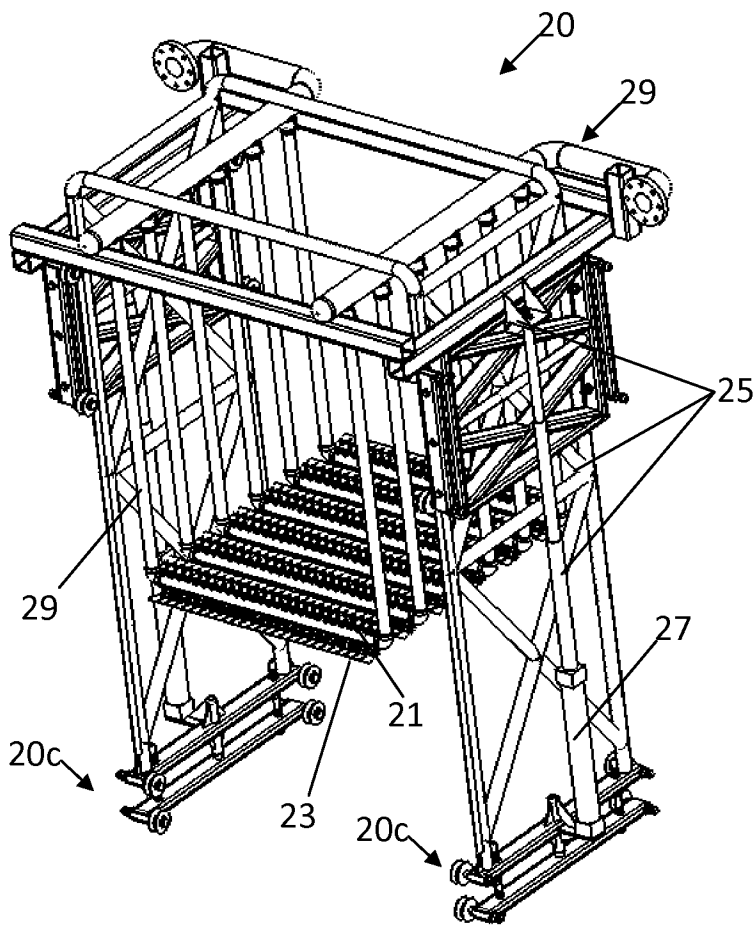
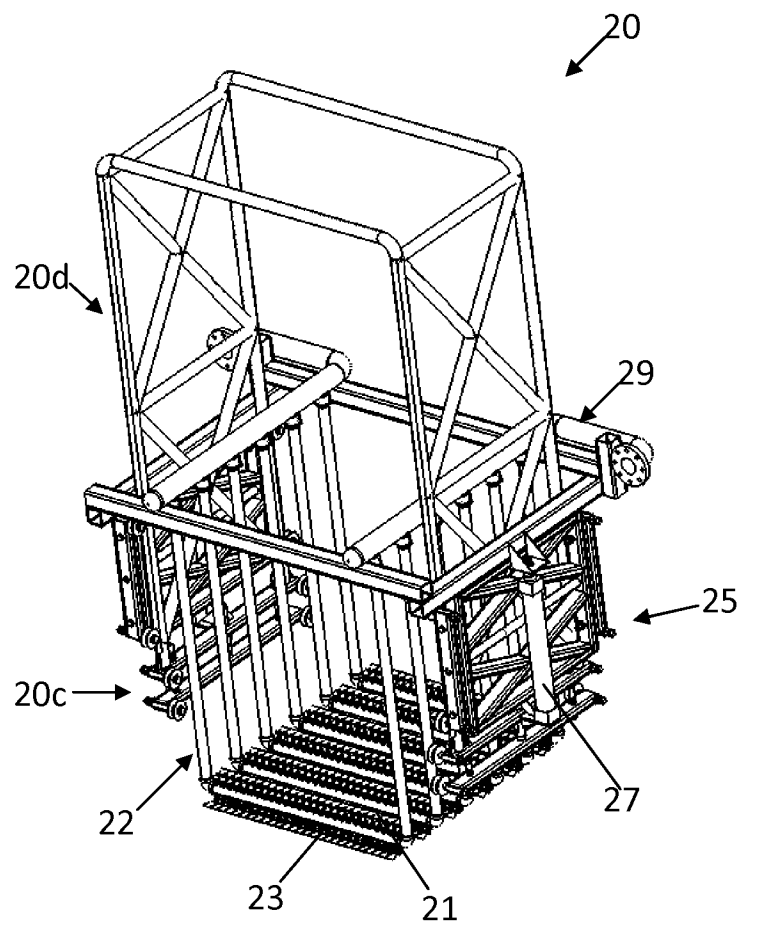
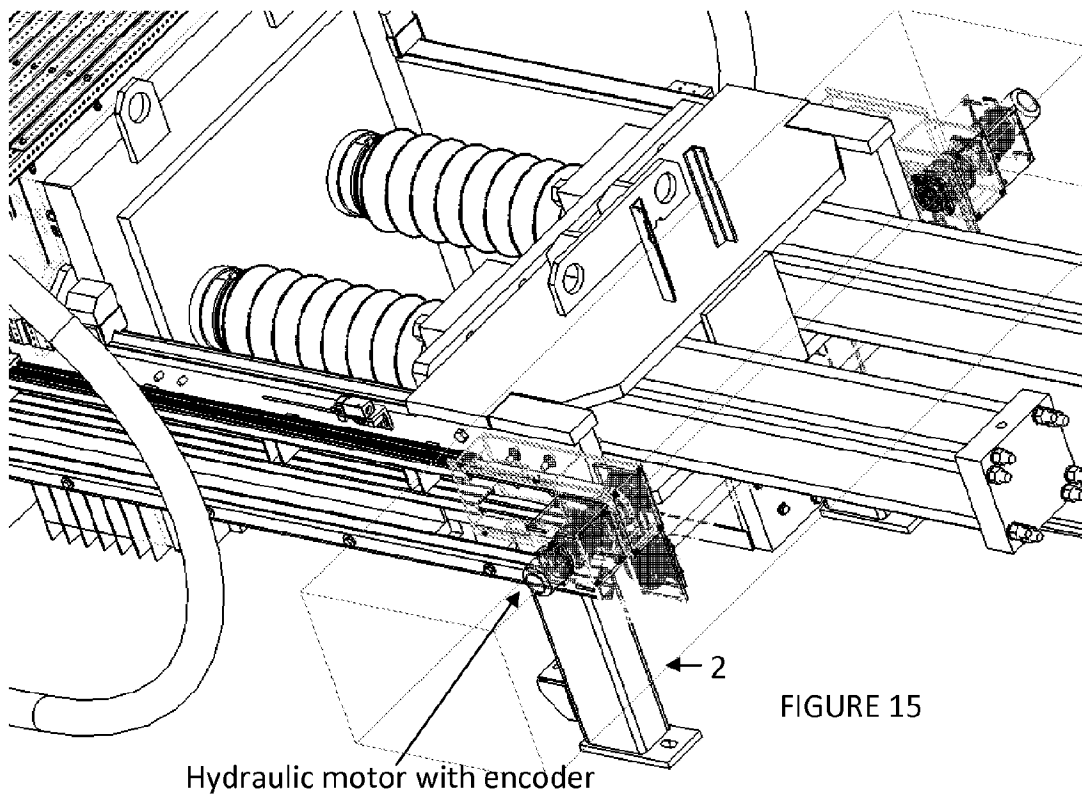
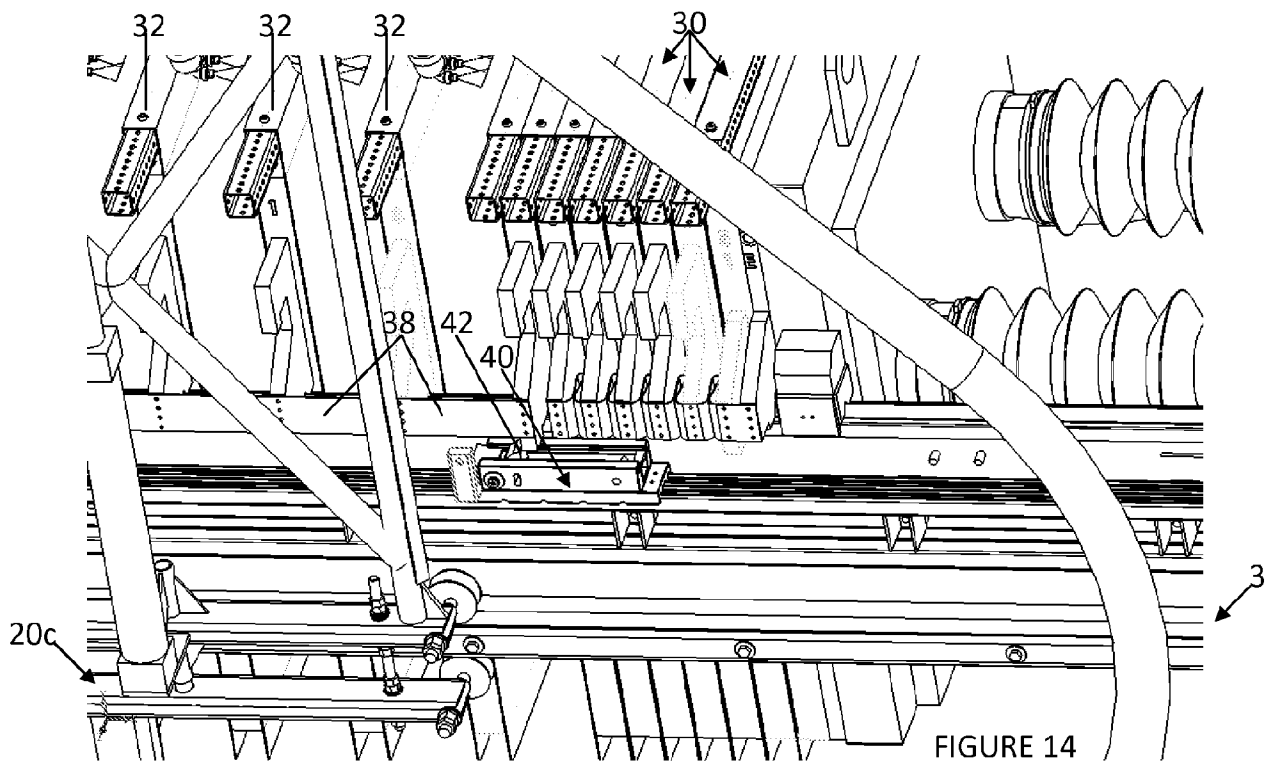


FIGURE 13





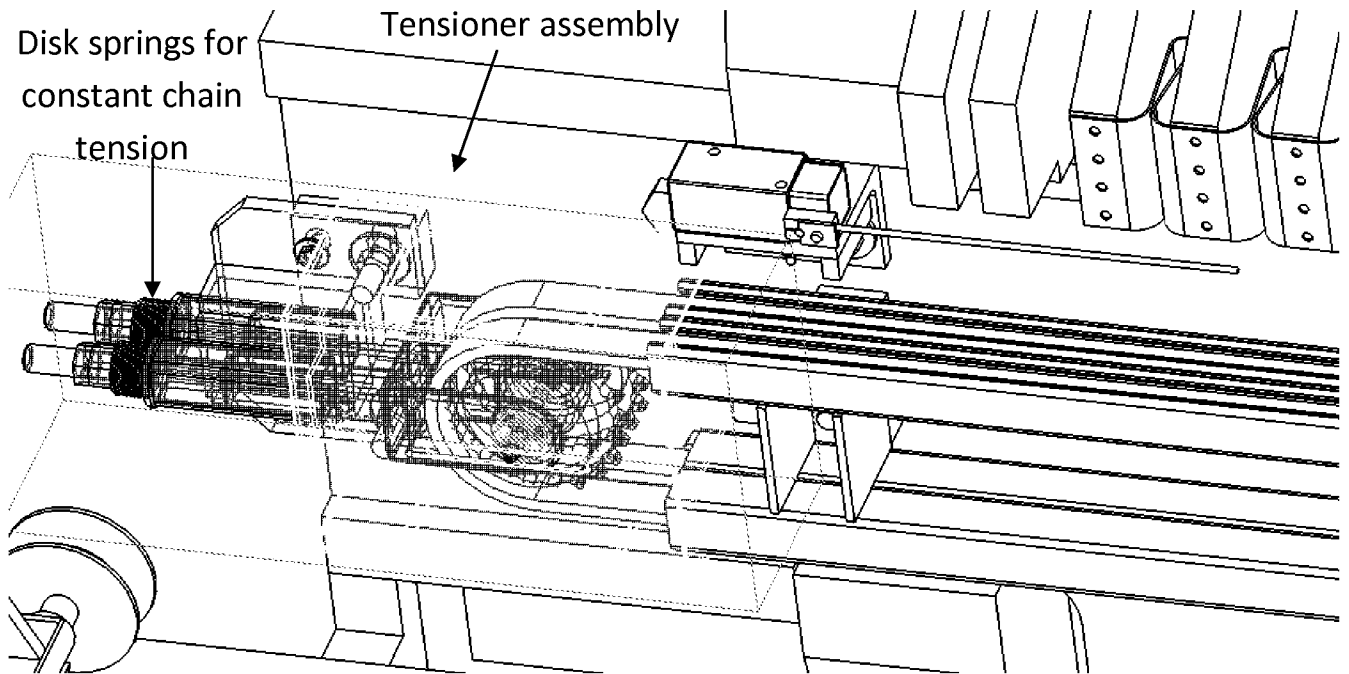


FIGURE 16

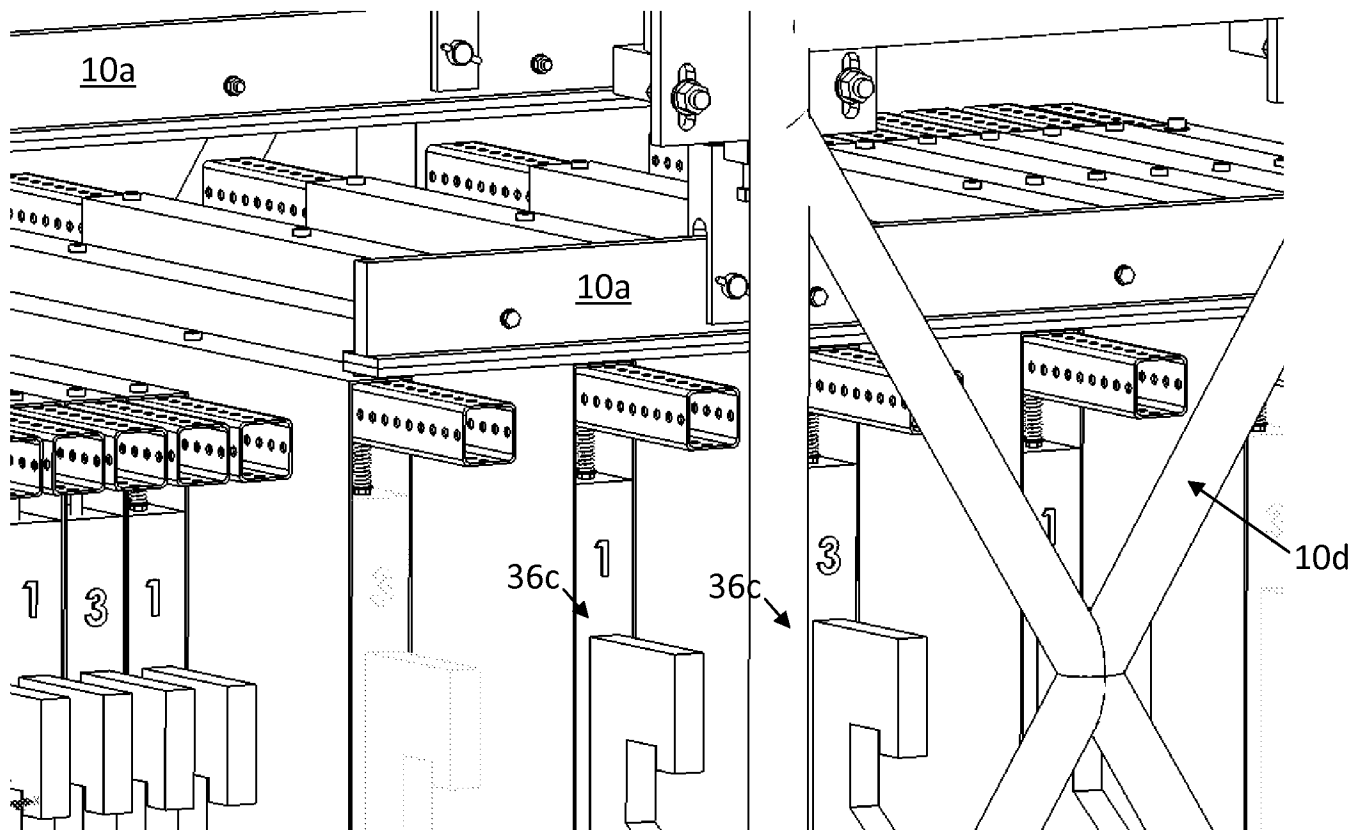


FIGURE 17

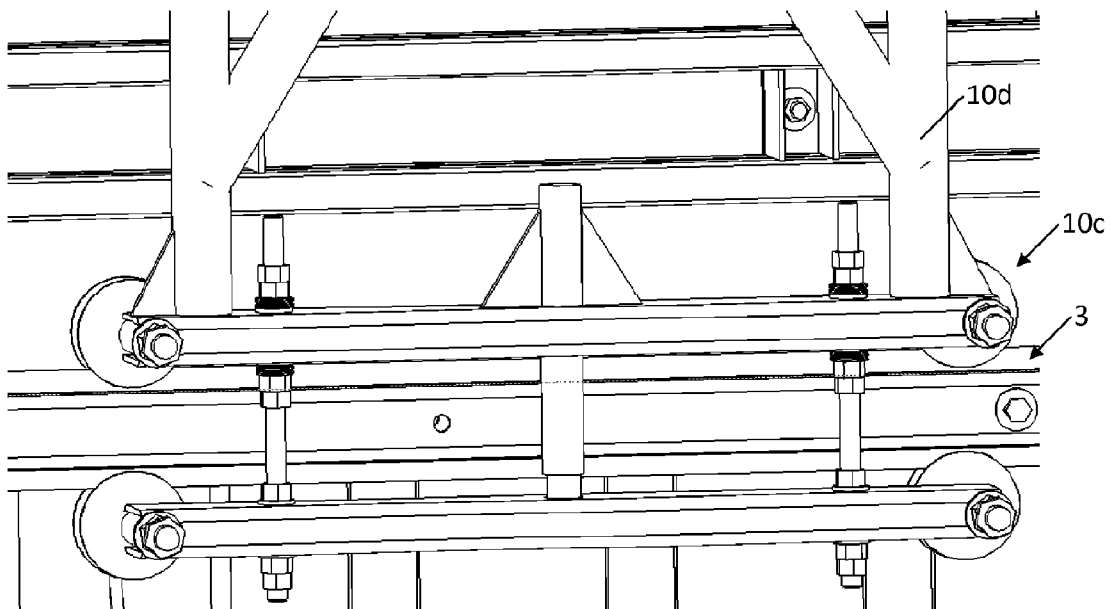


FIGURE 18

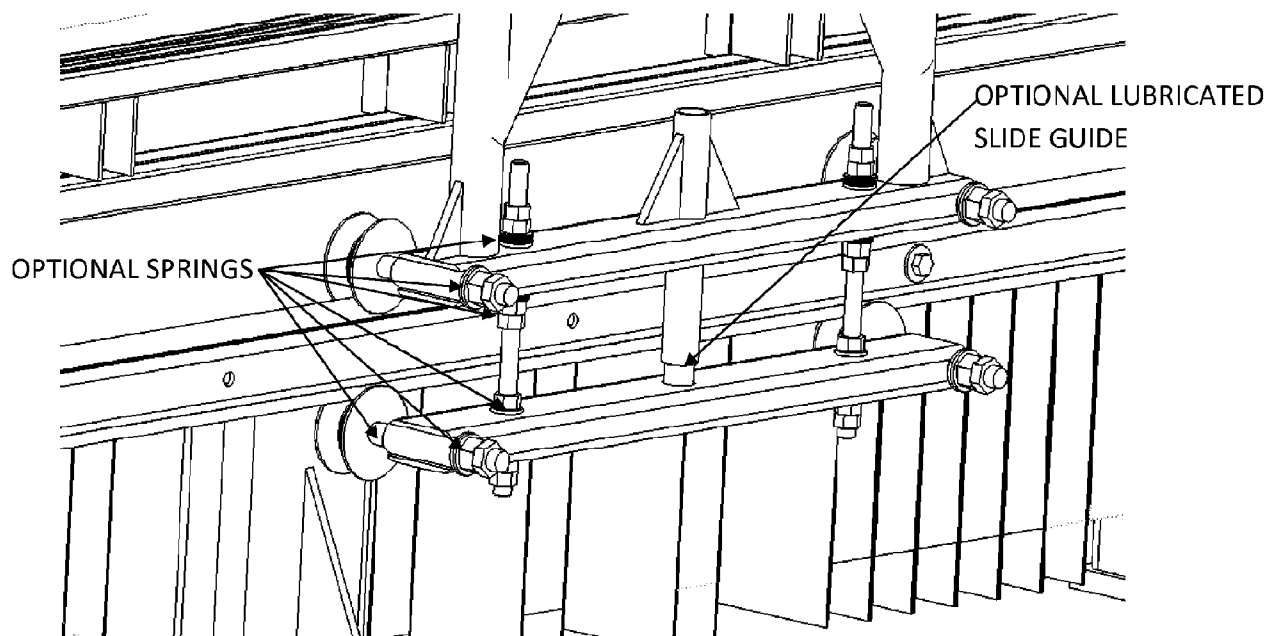
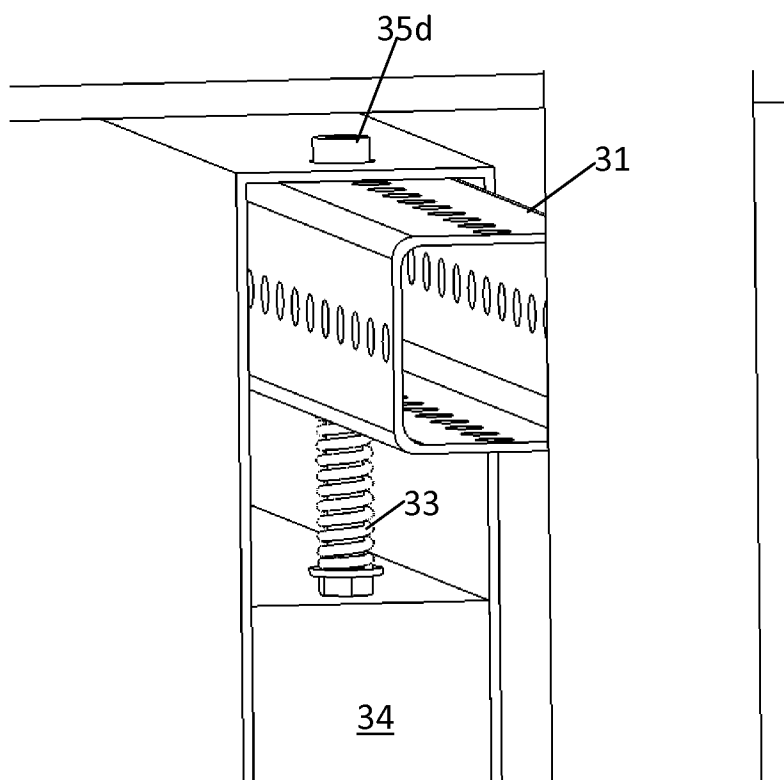
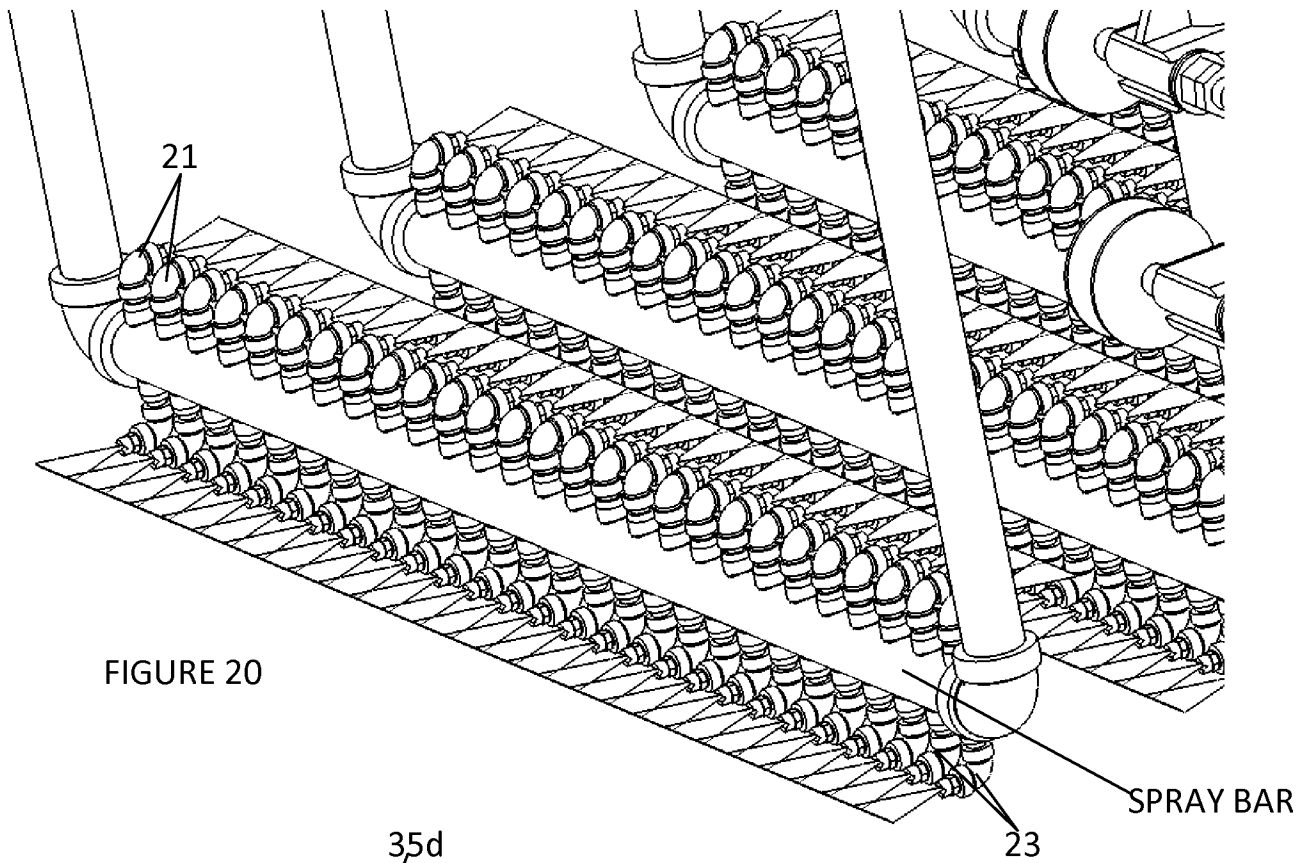


FIGURE 19



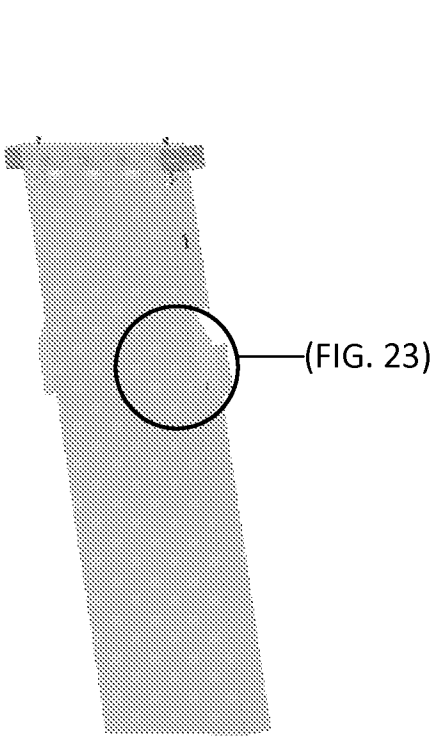


FIGURE 22

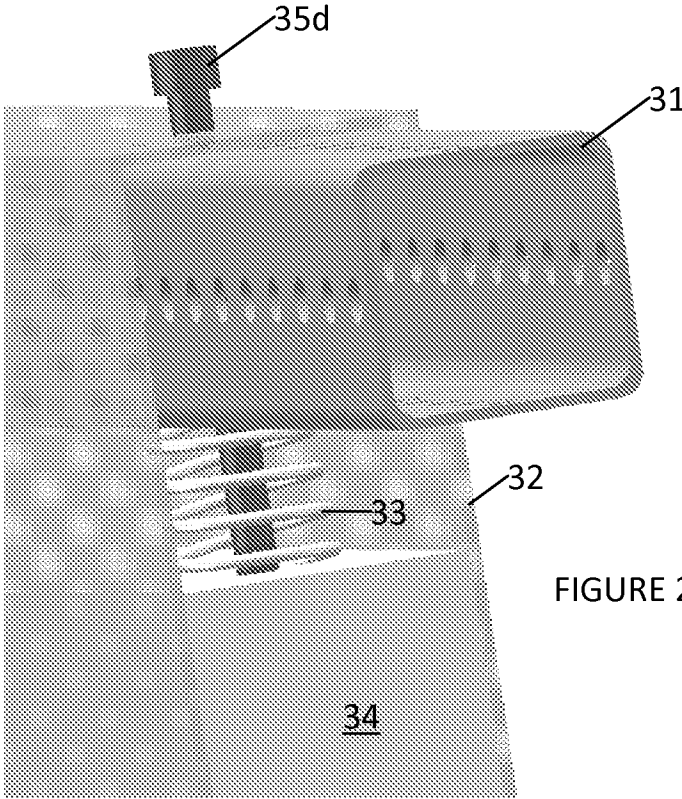


FIGURE 23

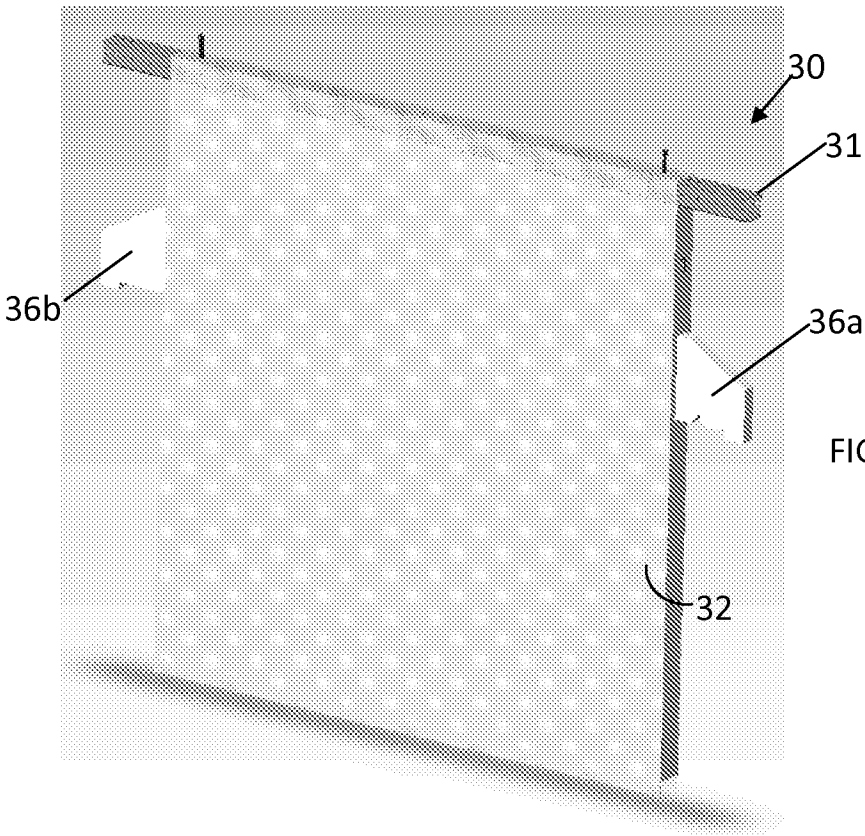


FIGURE 24

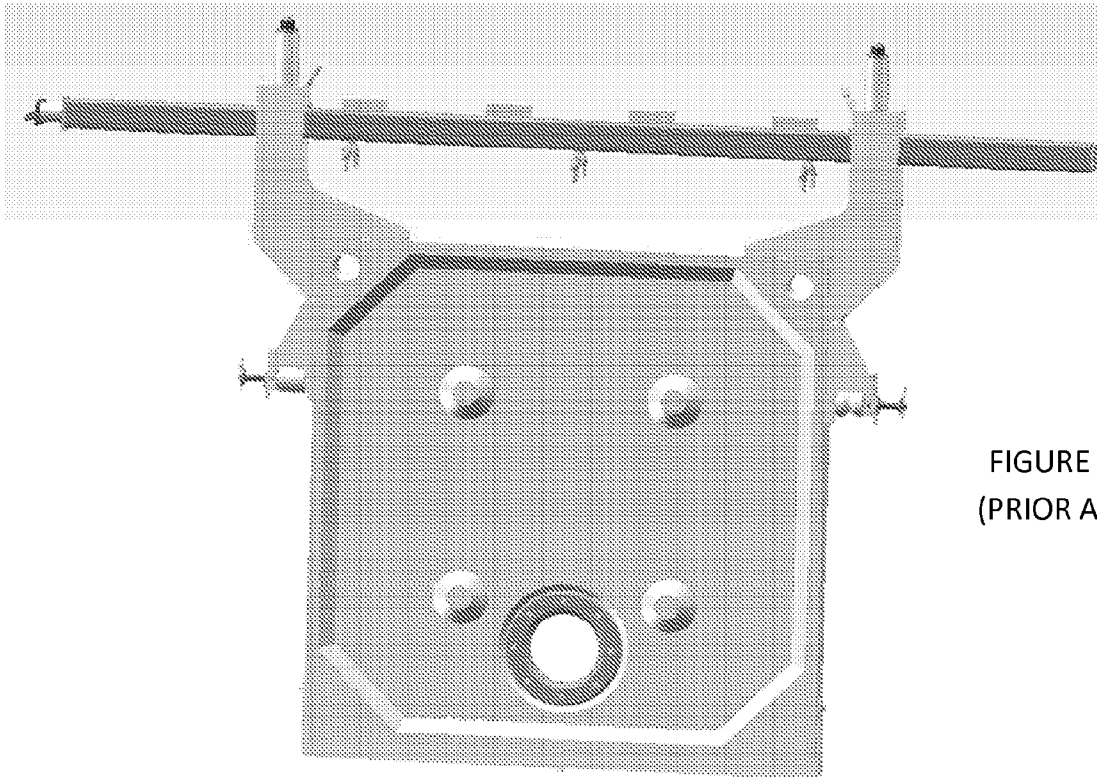


FIGURE 25  
(PRIOR ART)

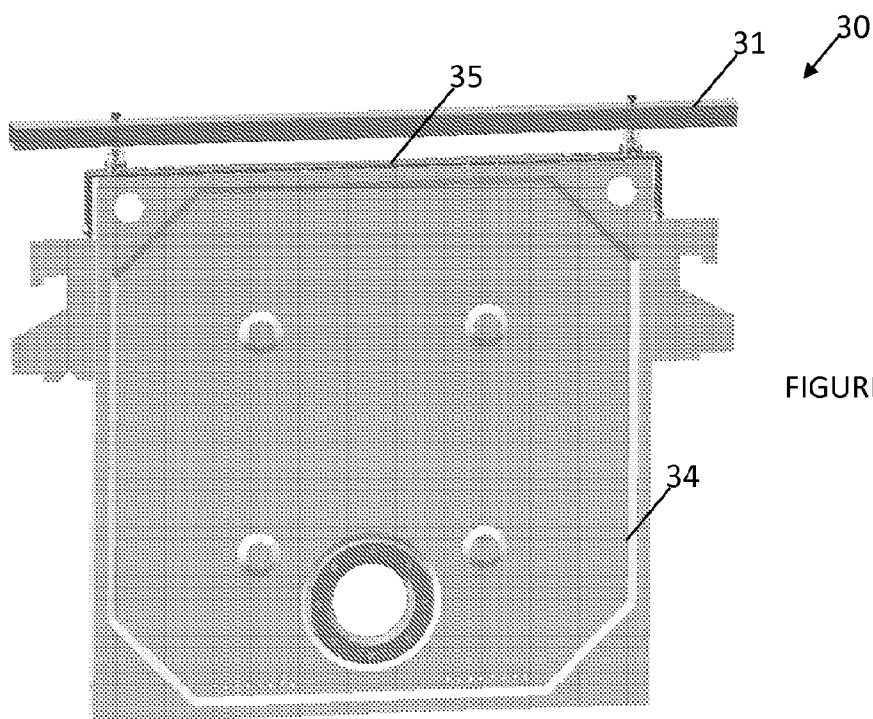
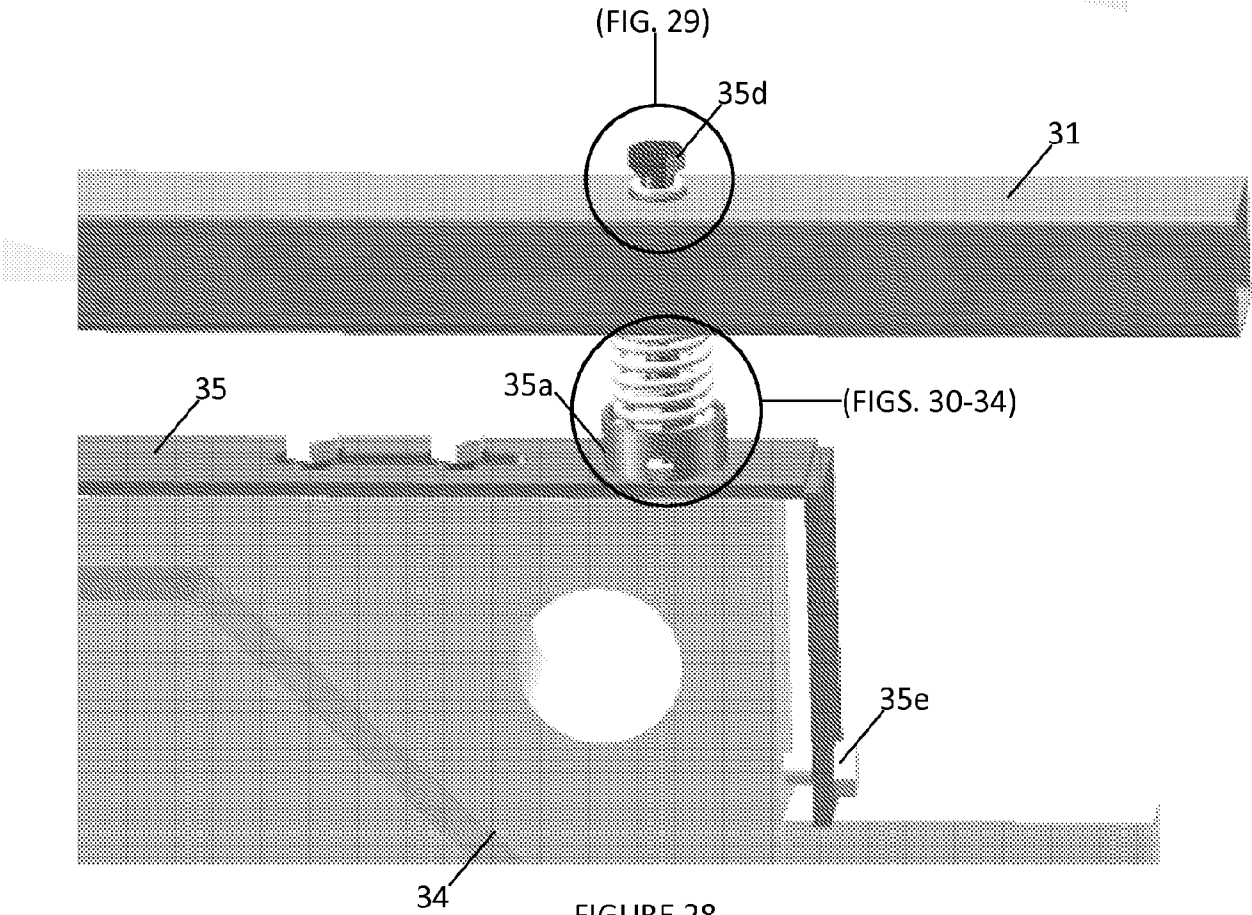
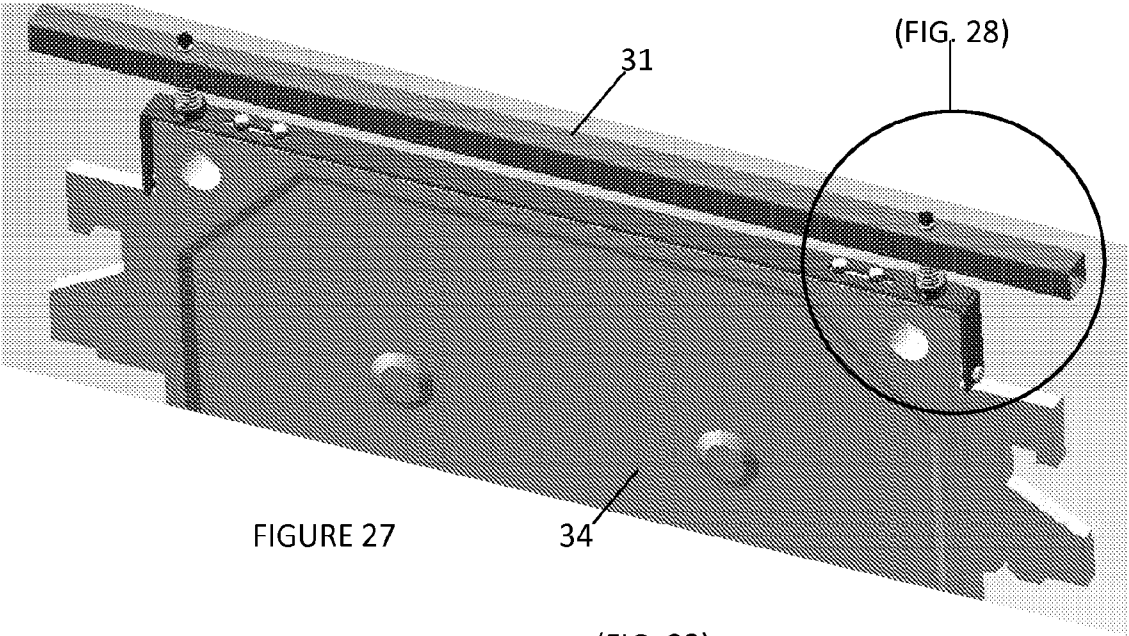


FIGURE 26



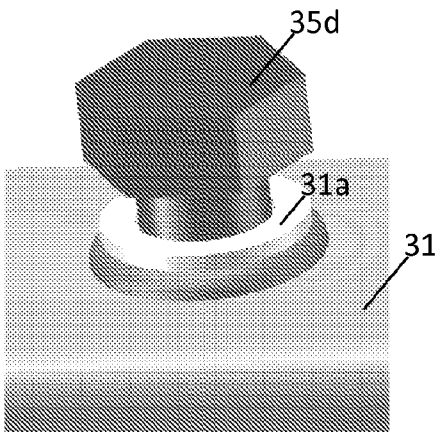


FIGURE 29

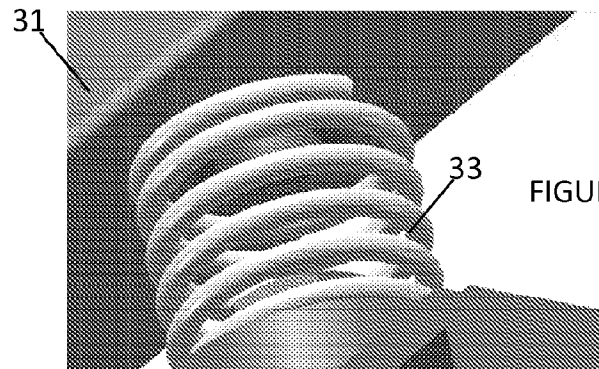


FIGURE 32

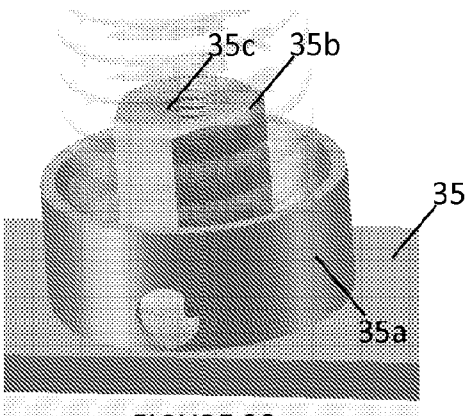


FIGURE 30

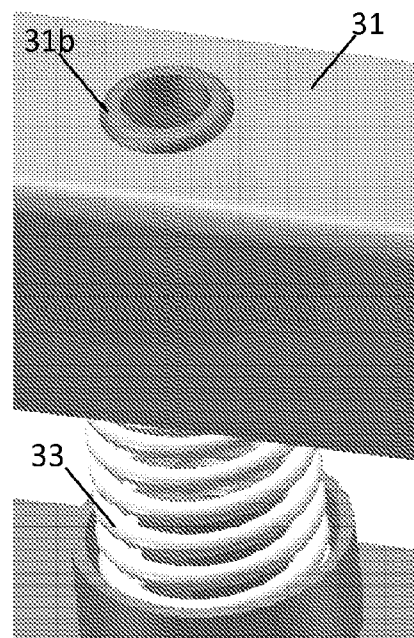


FIGURE 33

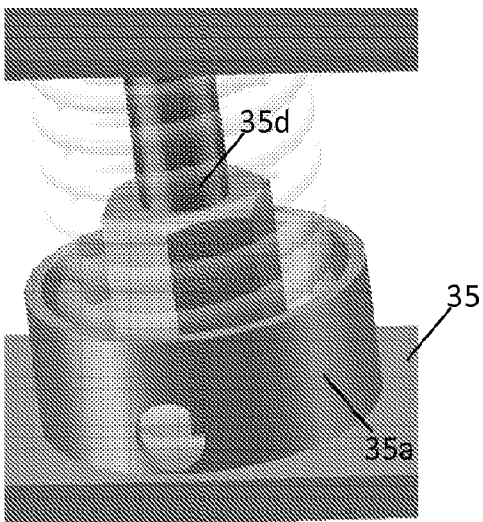


FIGURE 31

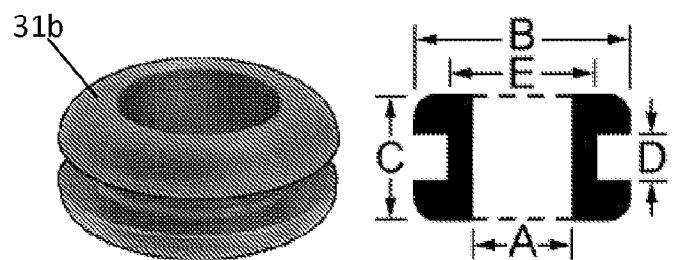
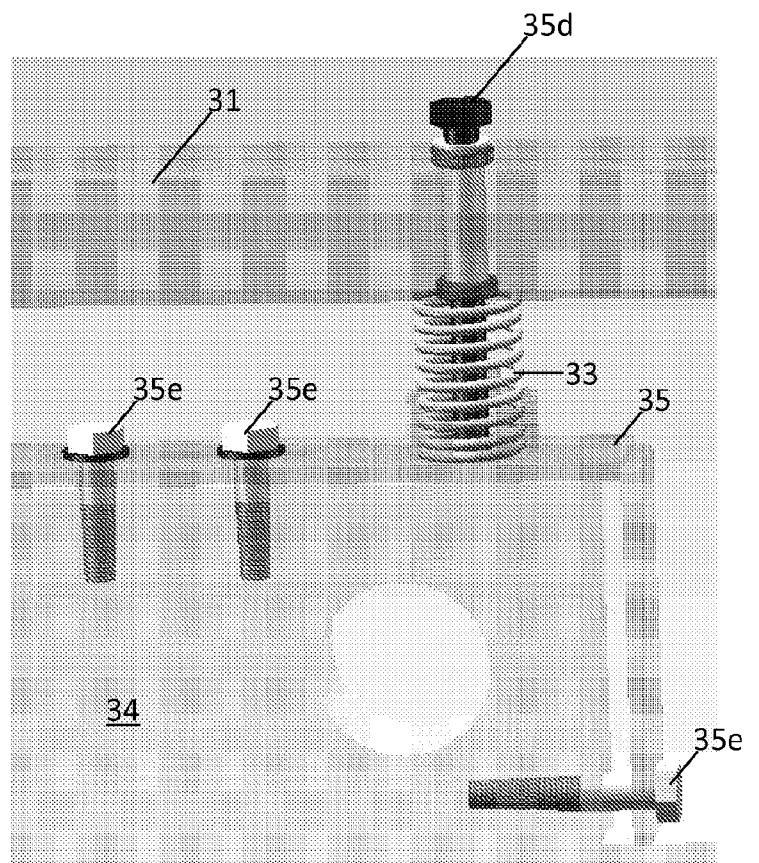
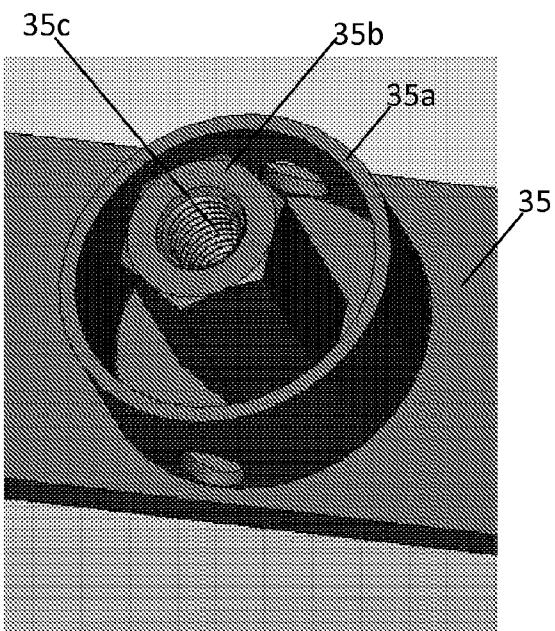
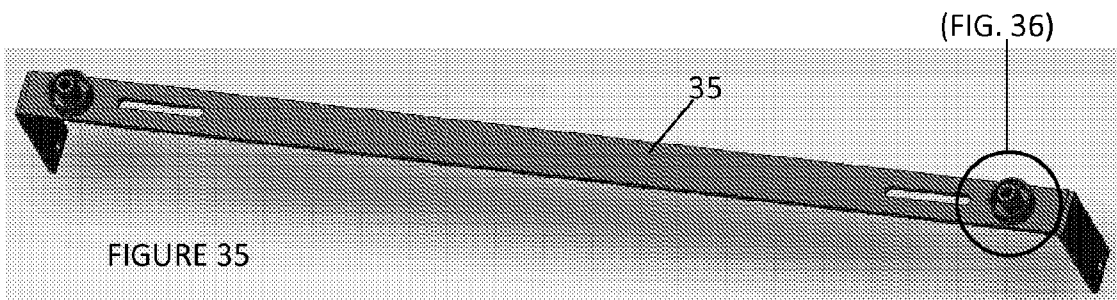
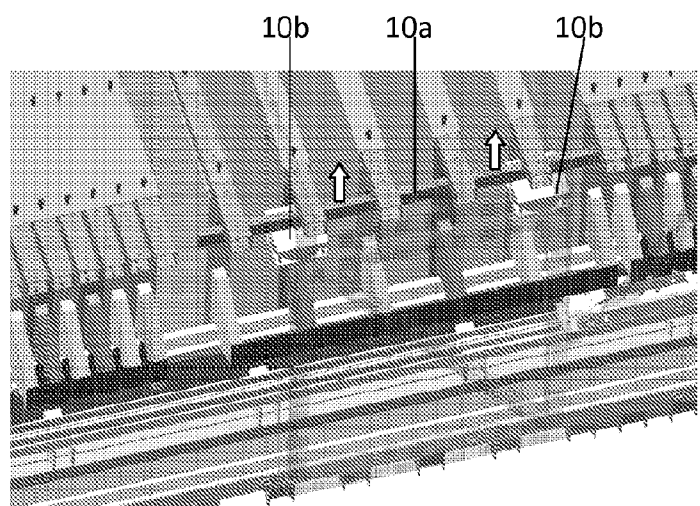
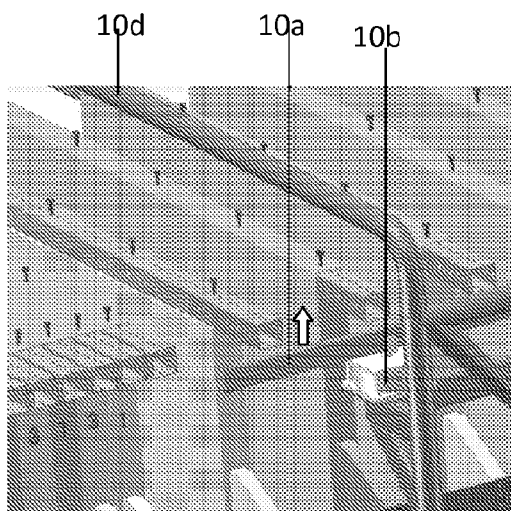
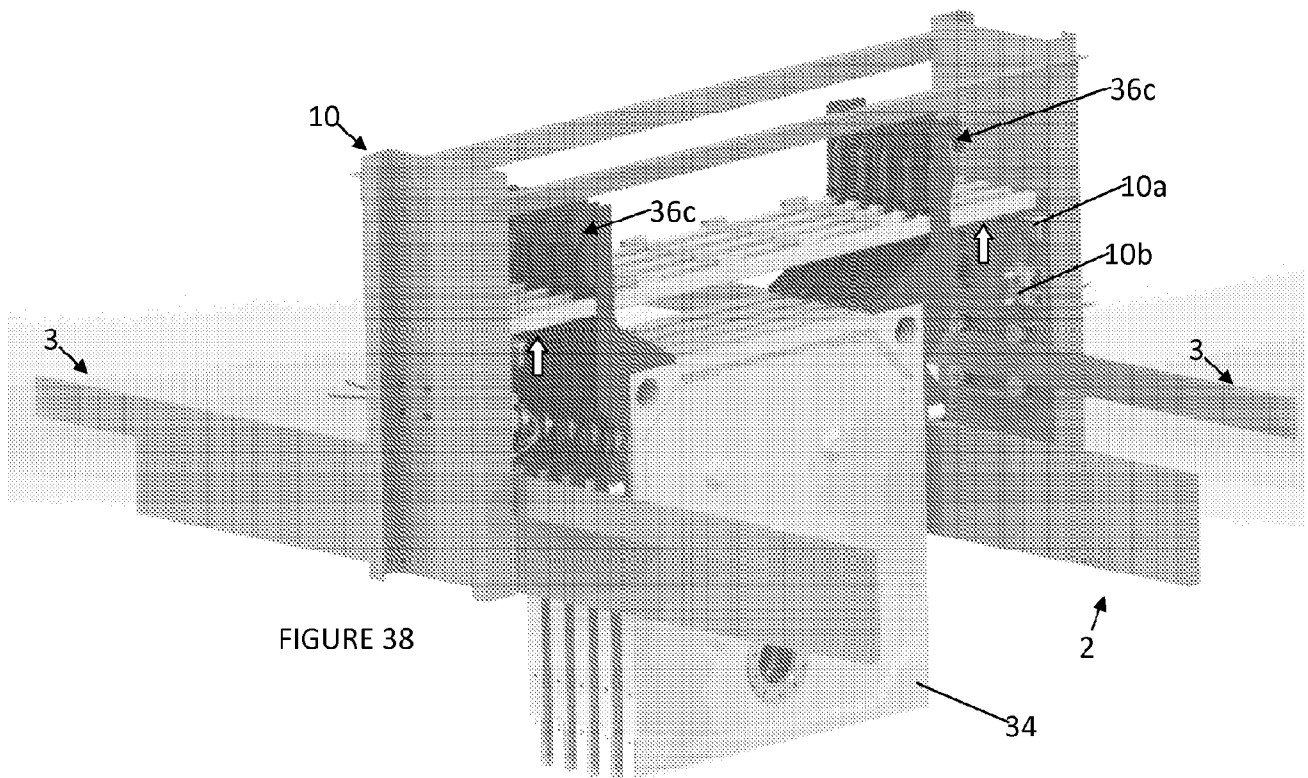


FIGURE 34





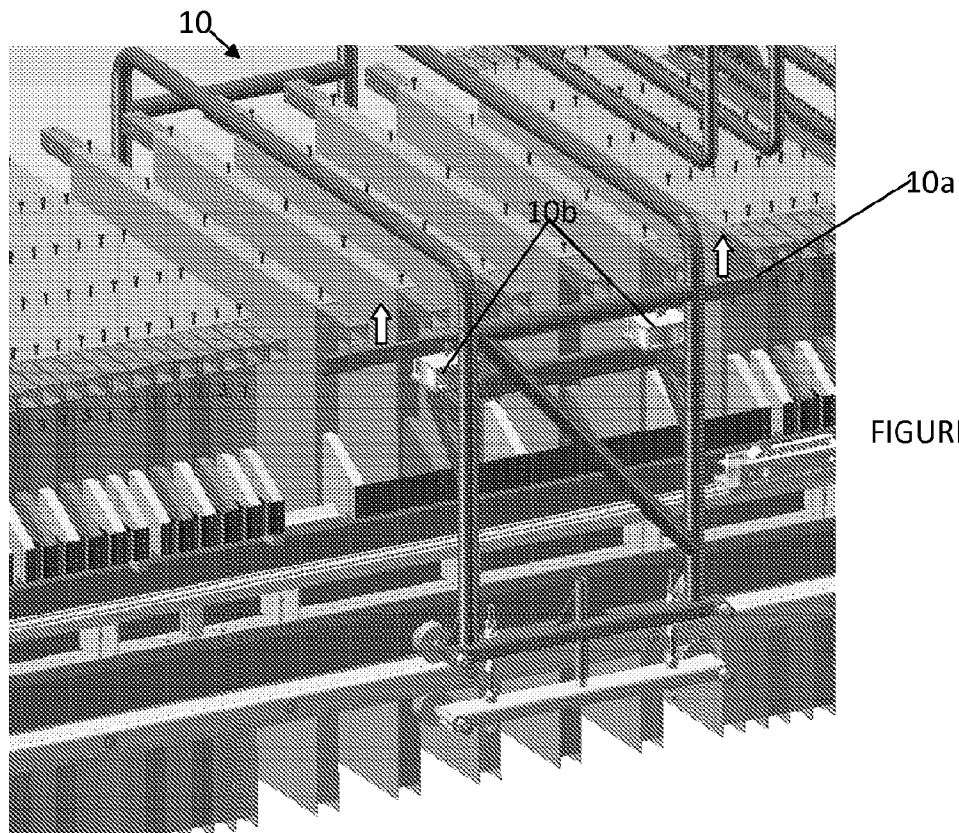


FIGURE 41

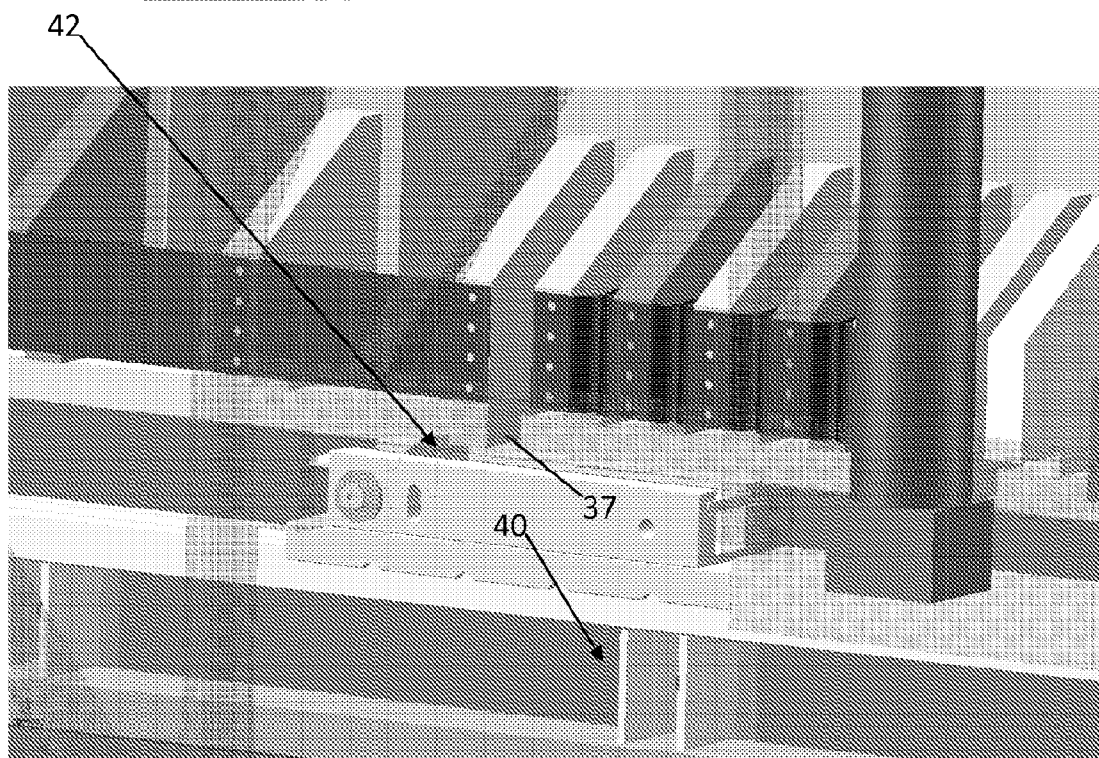


FIGURE 42

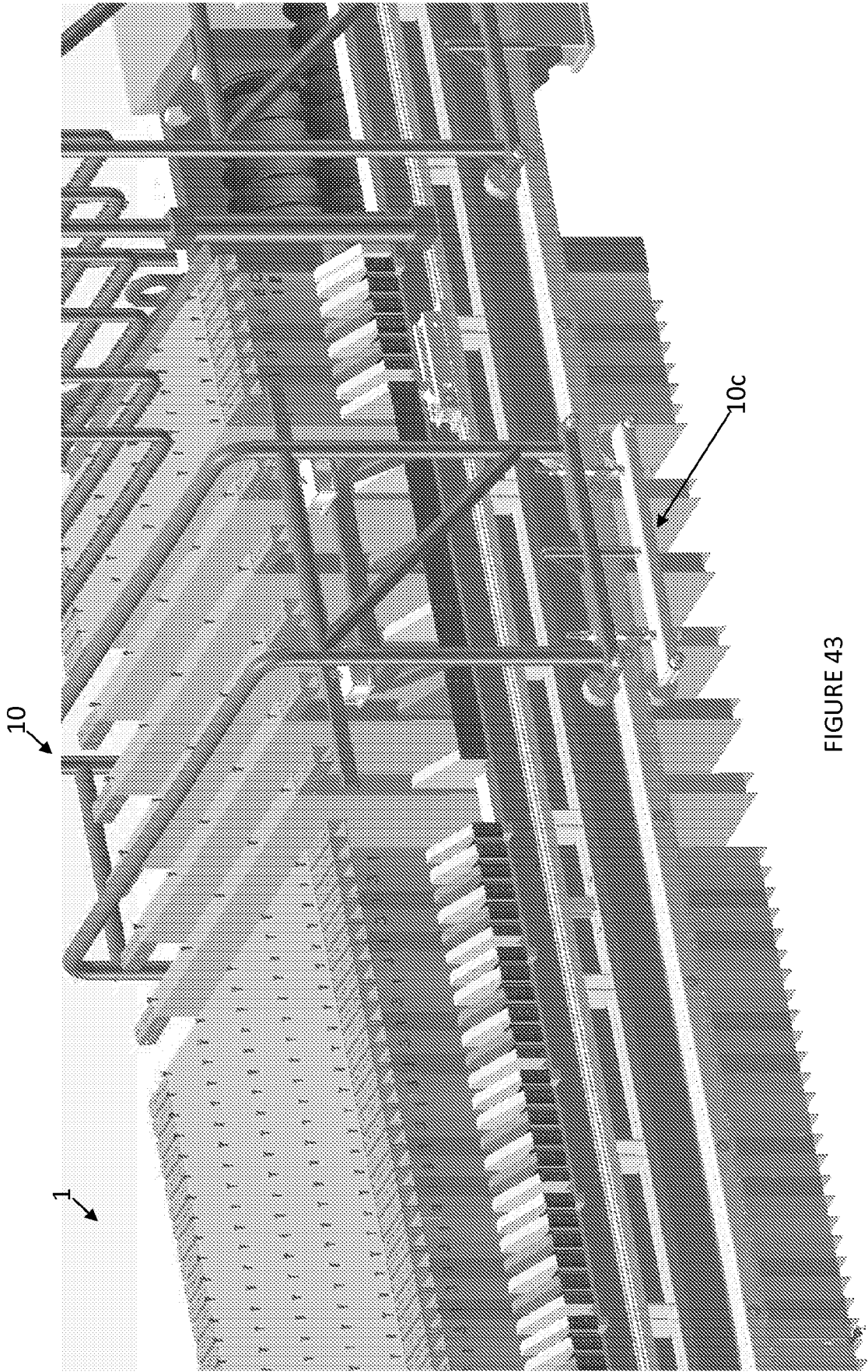
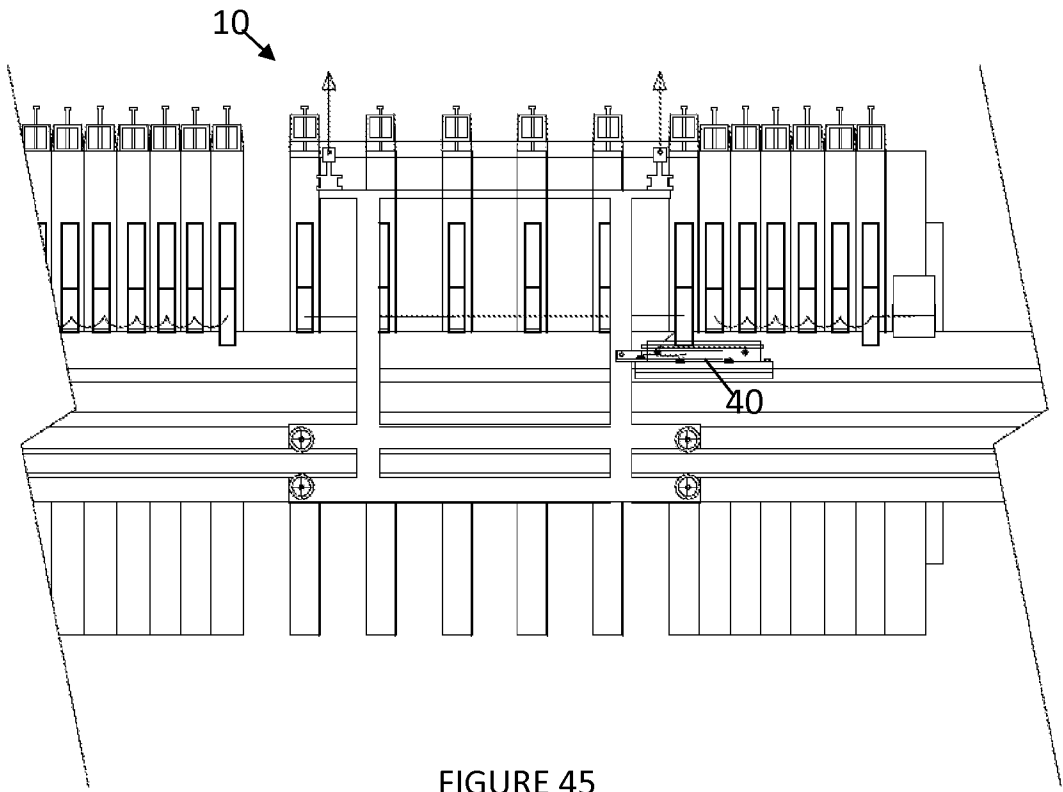
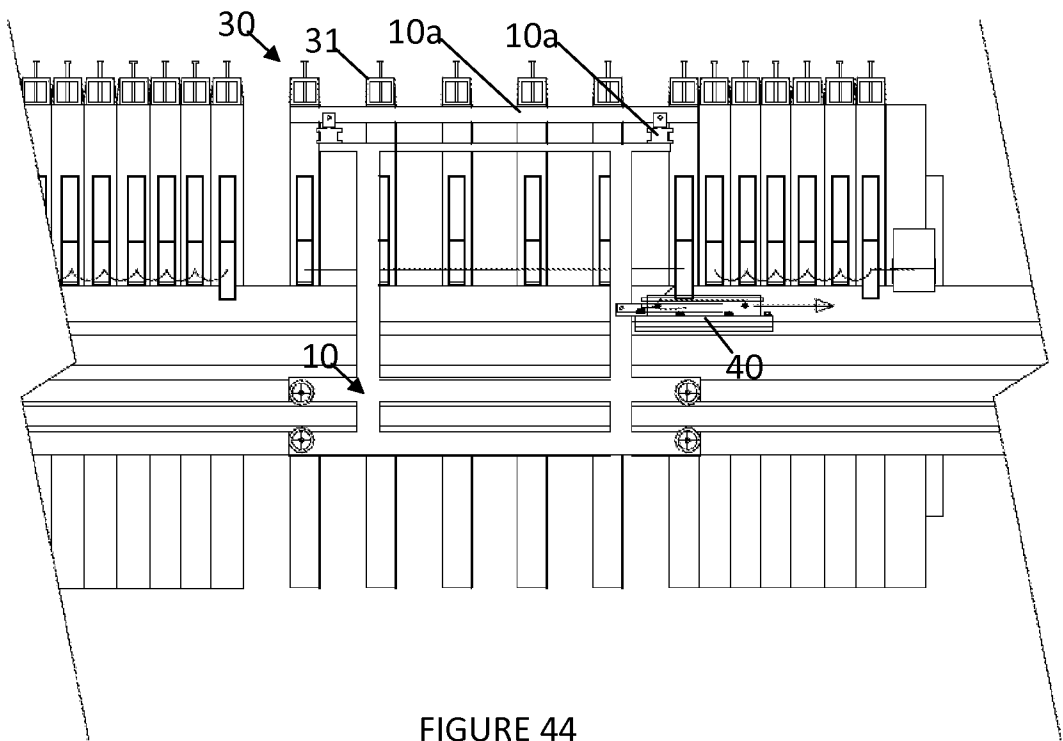
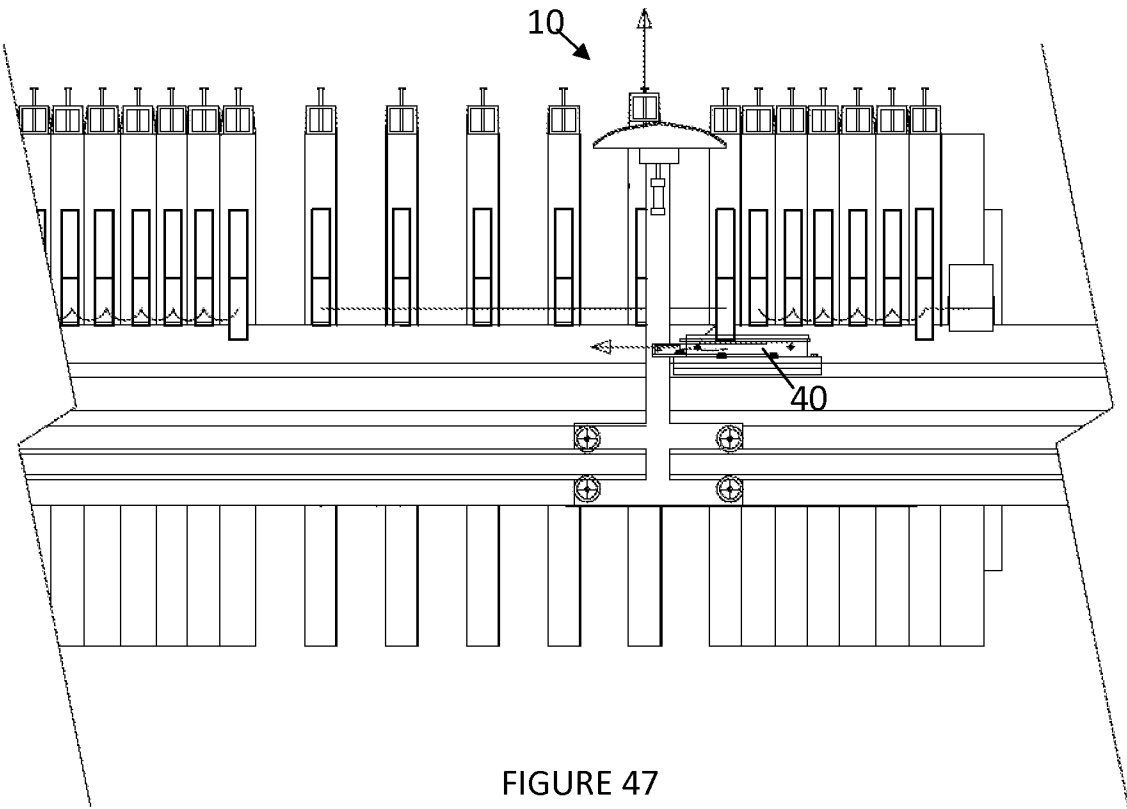
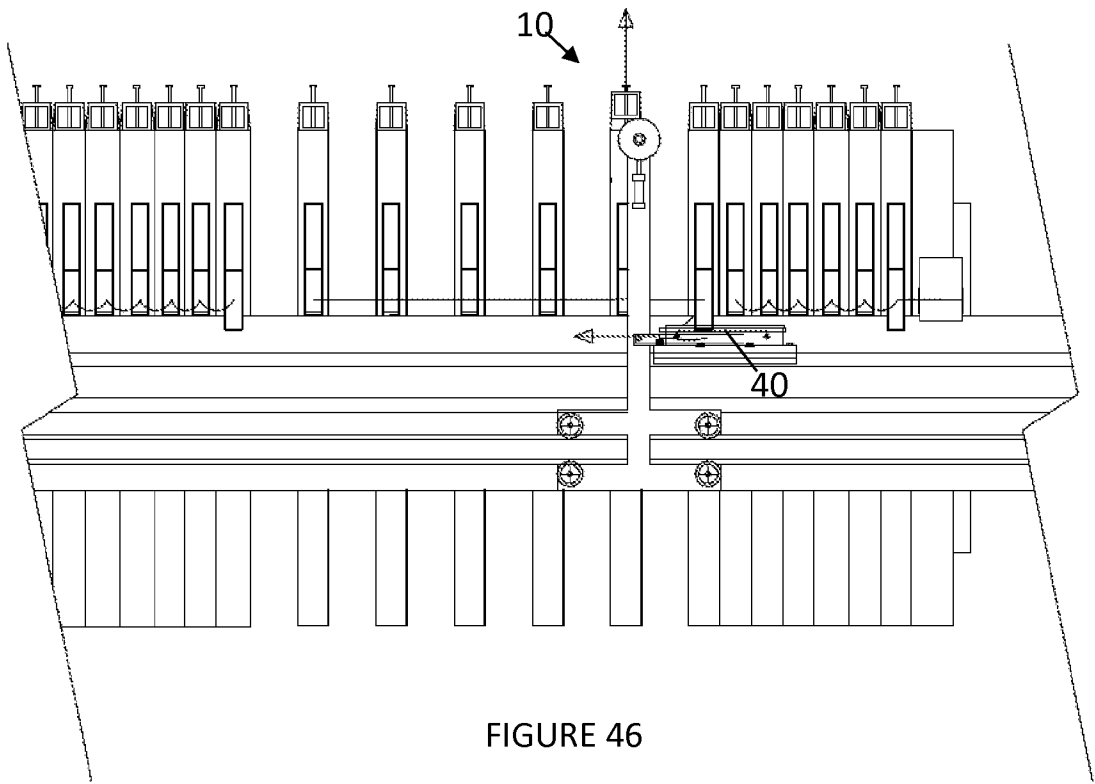
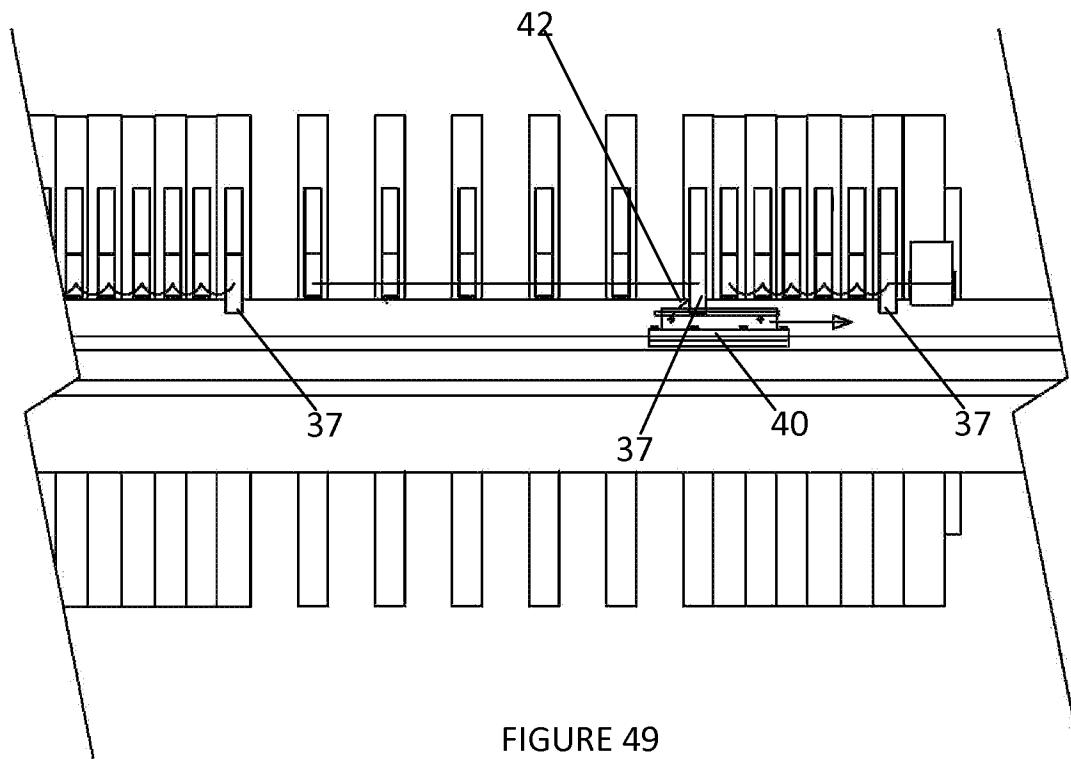
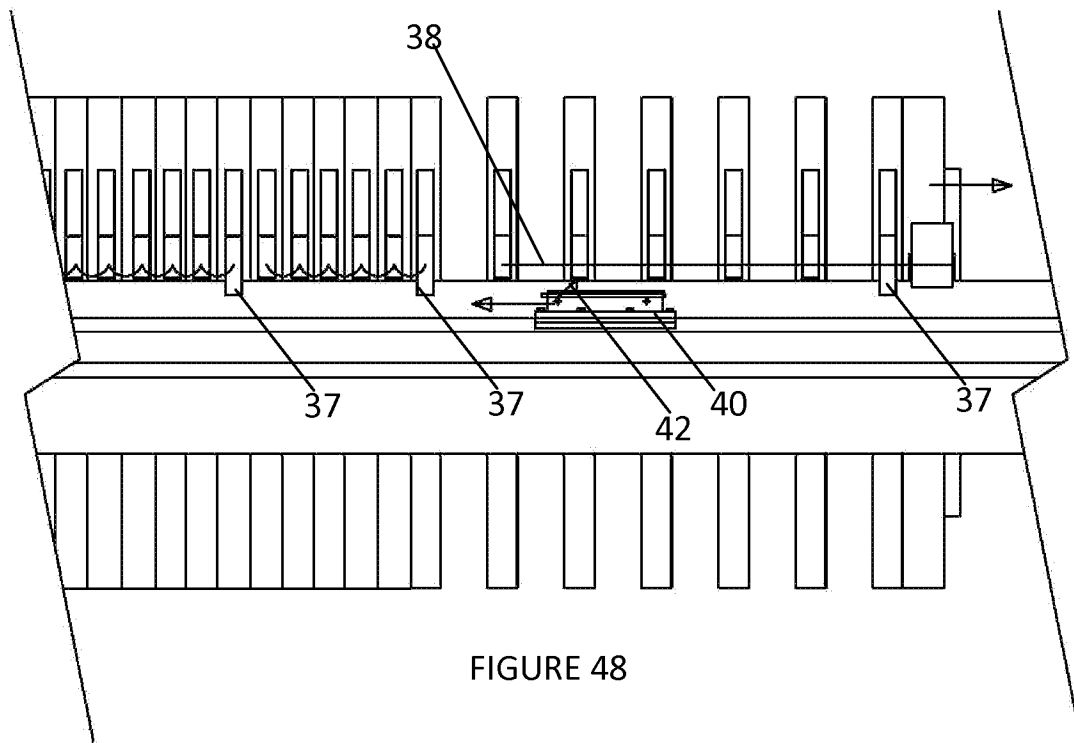
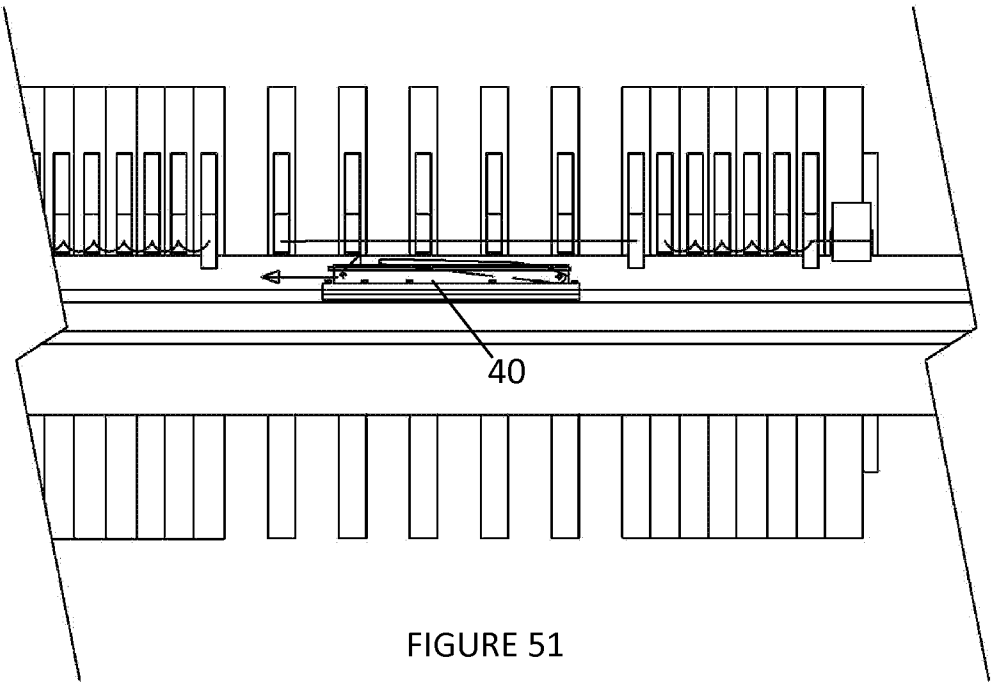
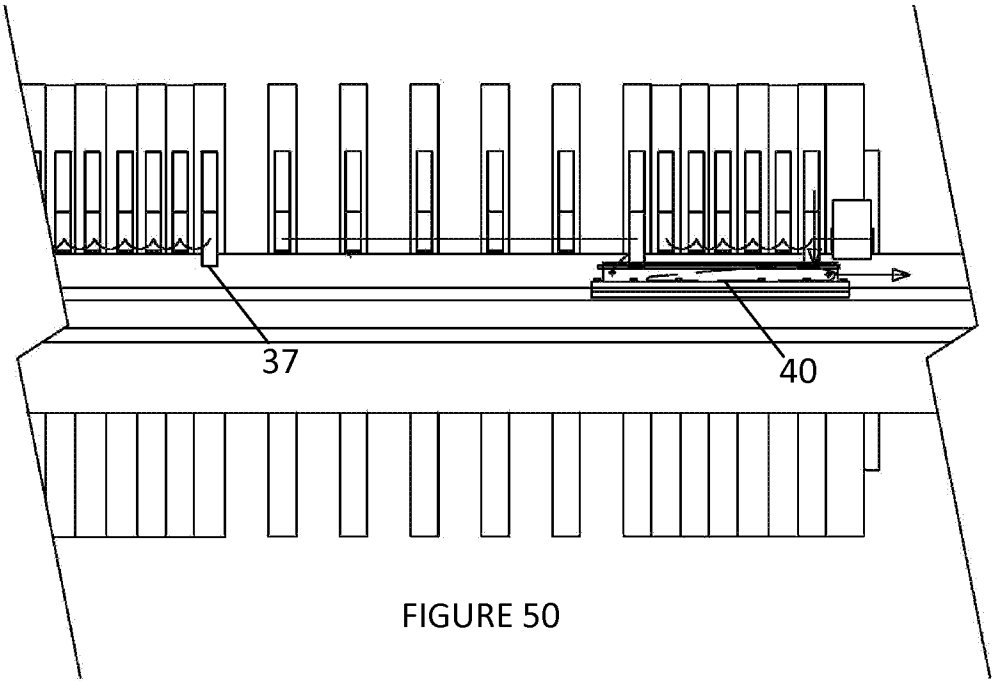


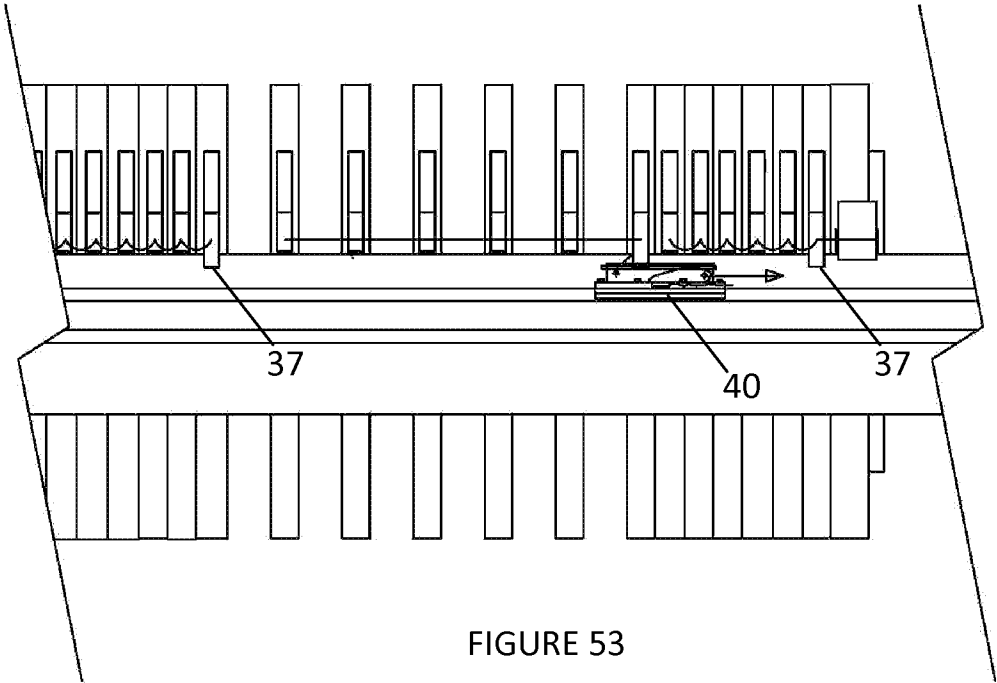
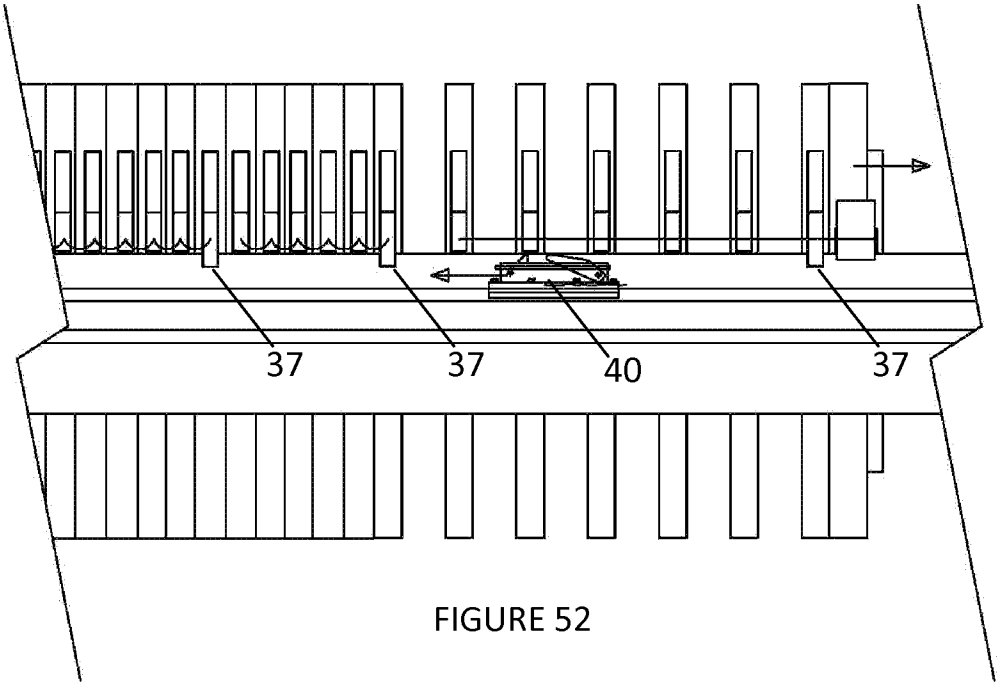
FIGURE 43

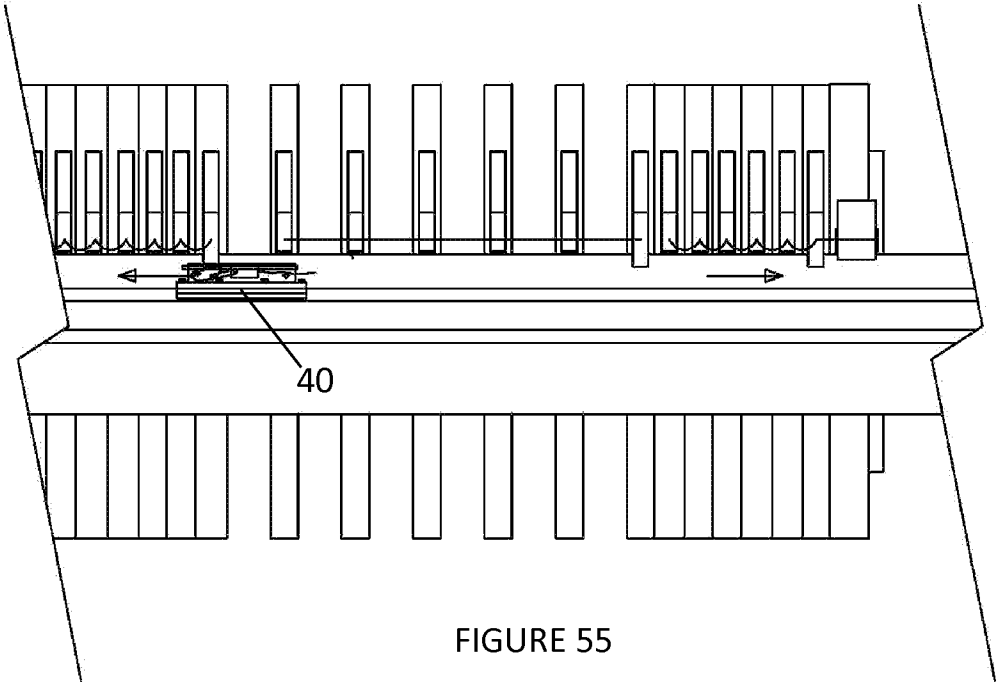
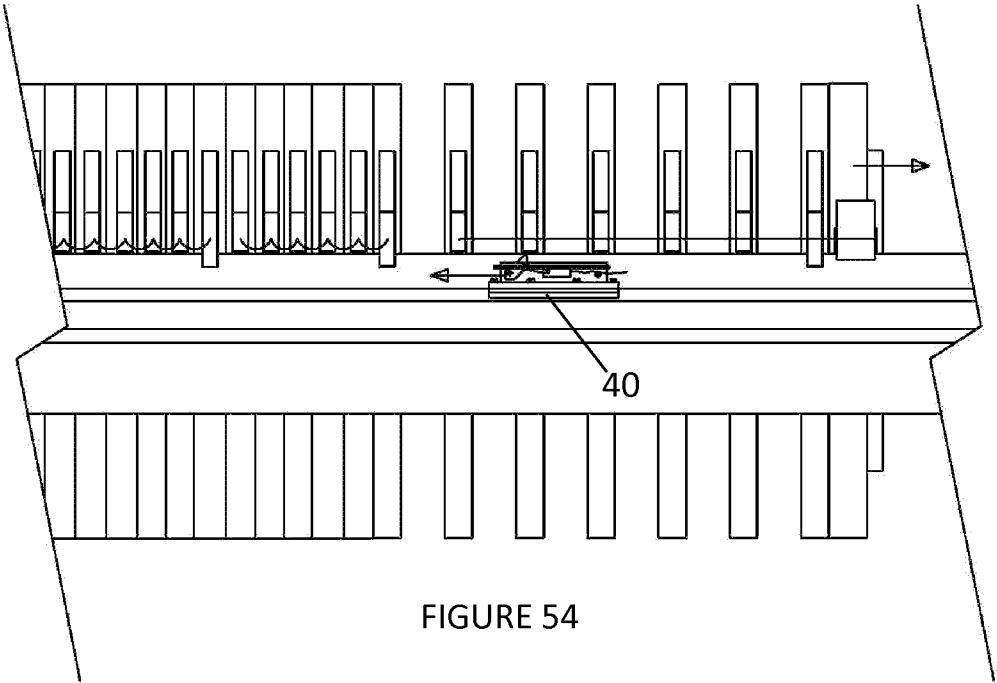


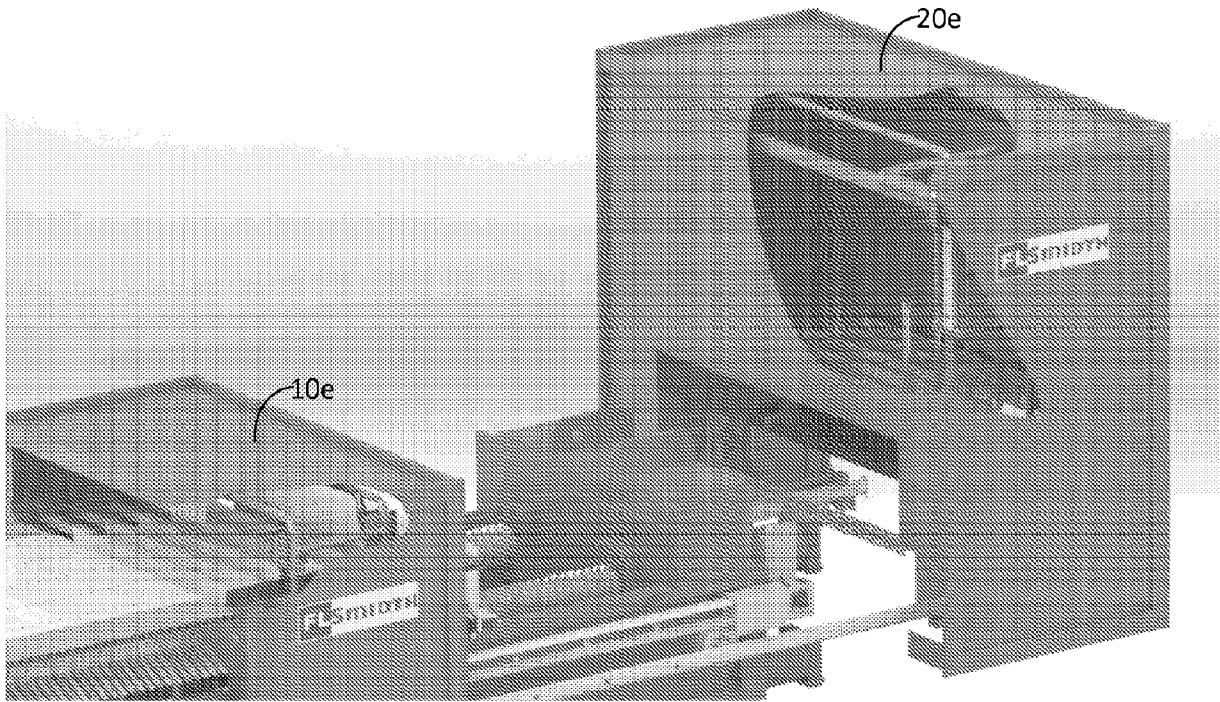
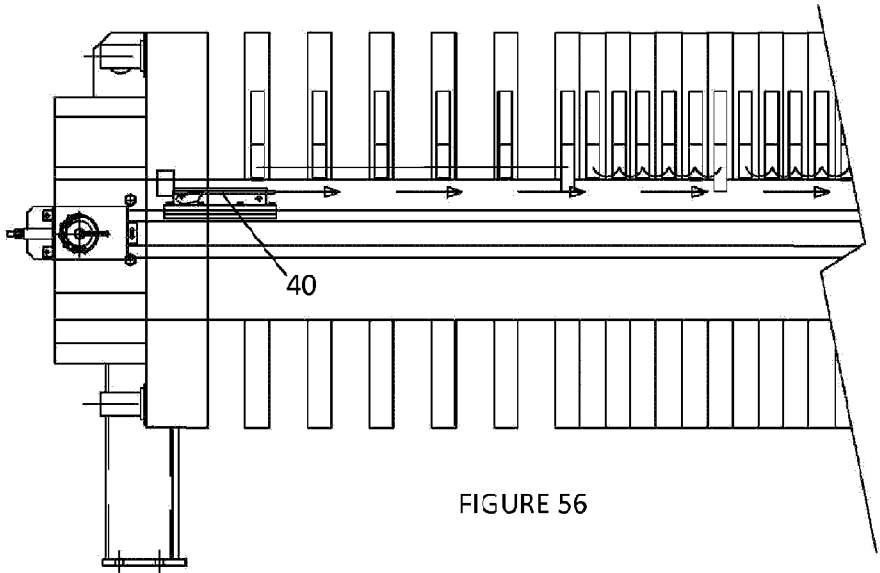












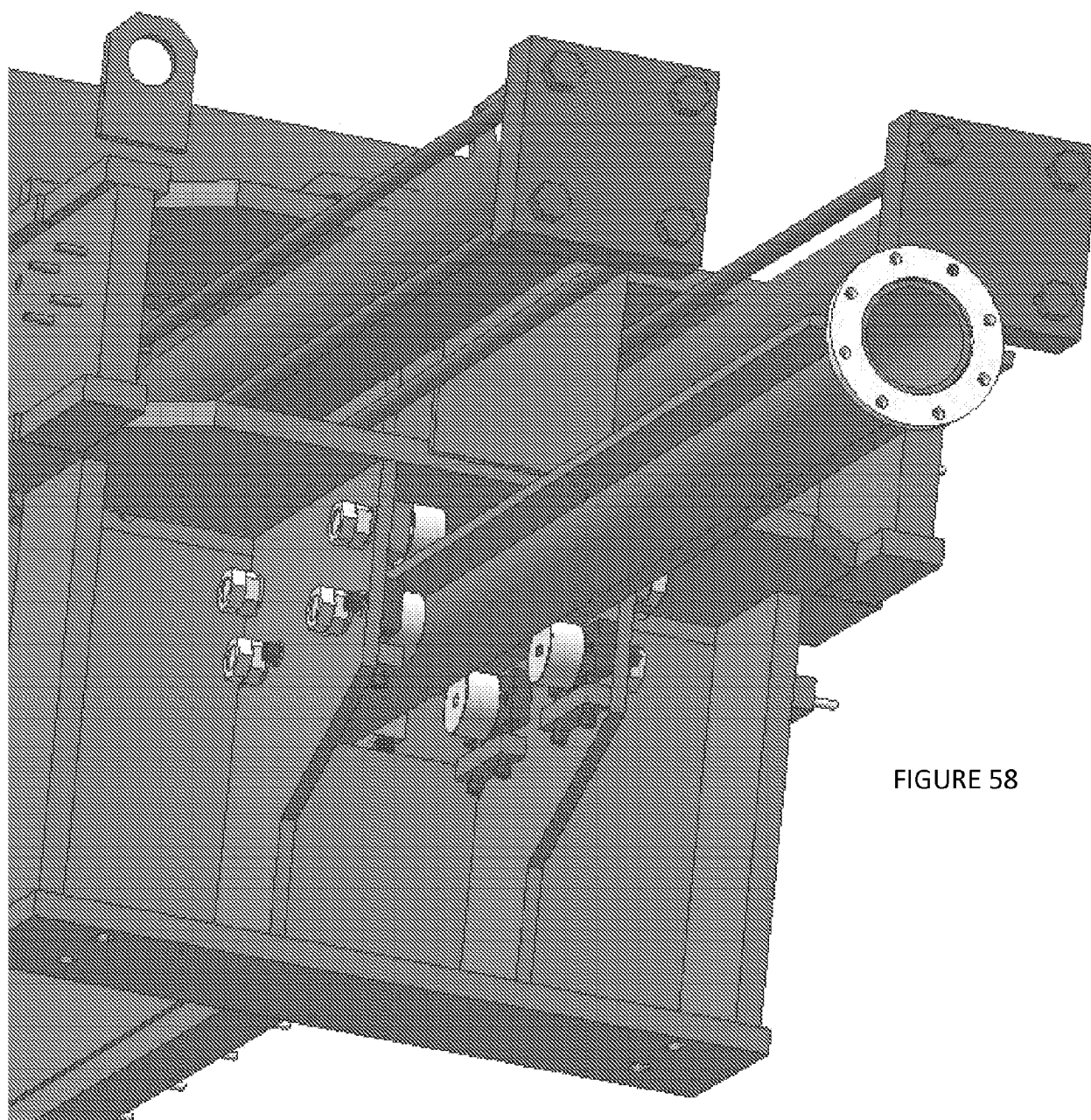


FIGURE 58

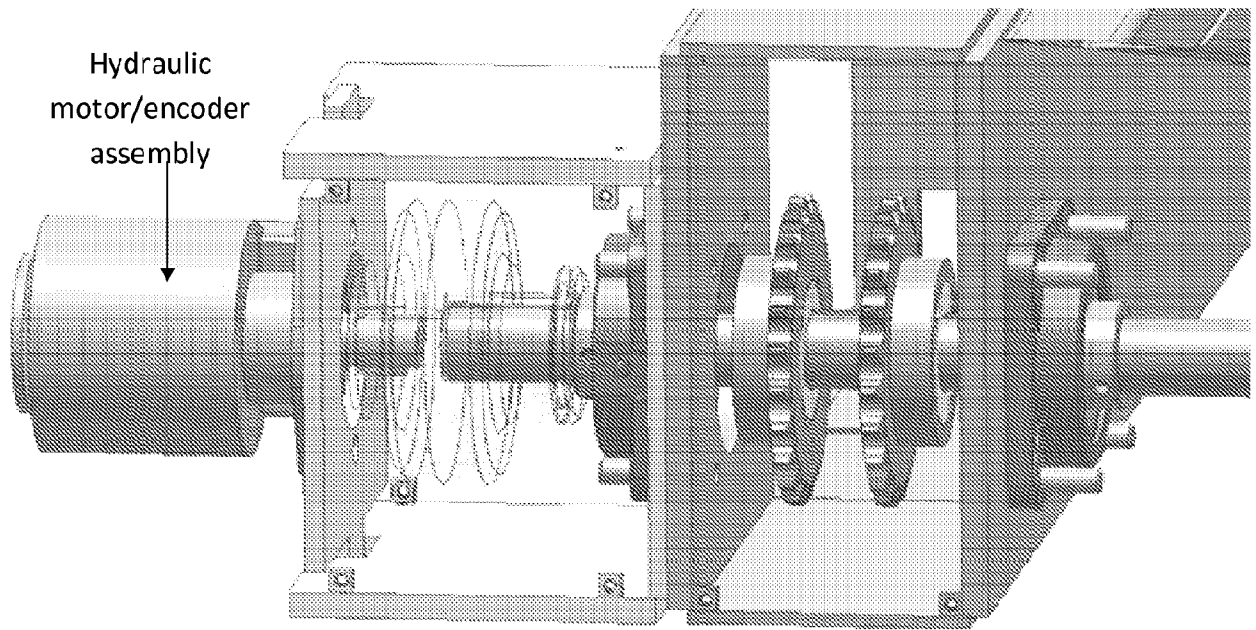


FIGURE 59

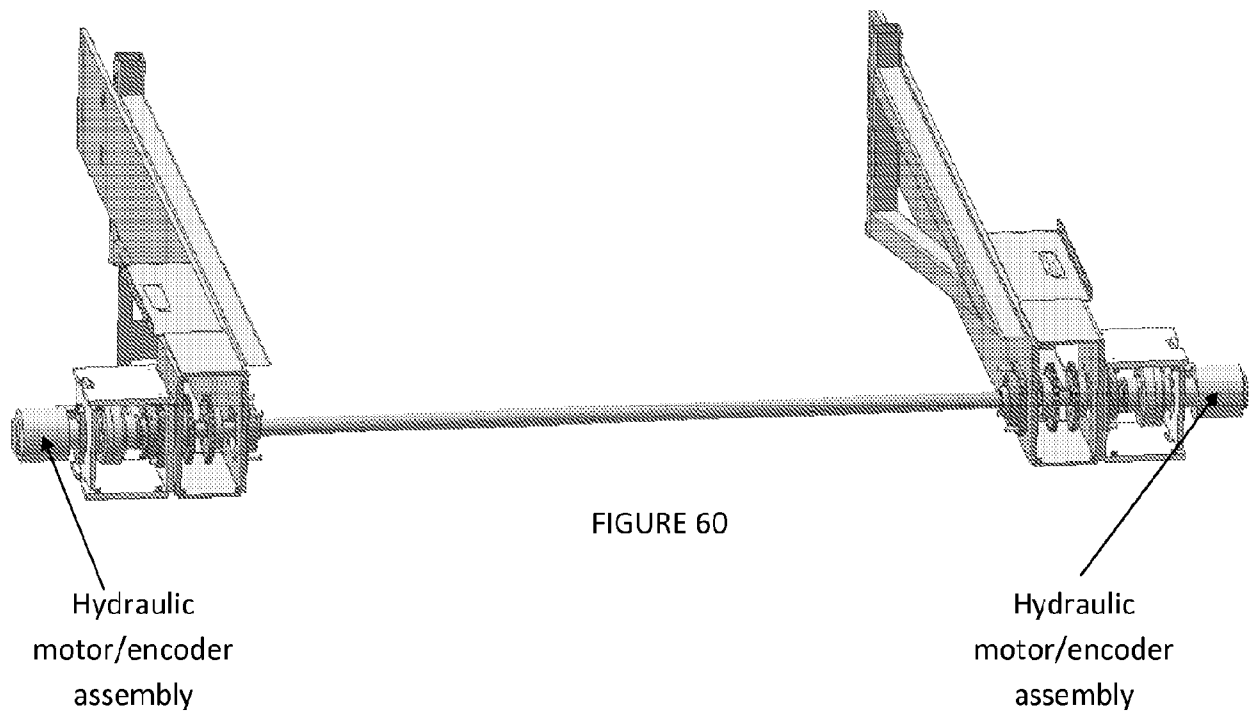


FIGURE 60

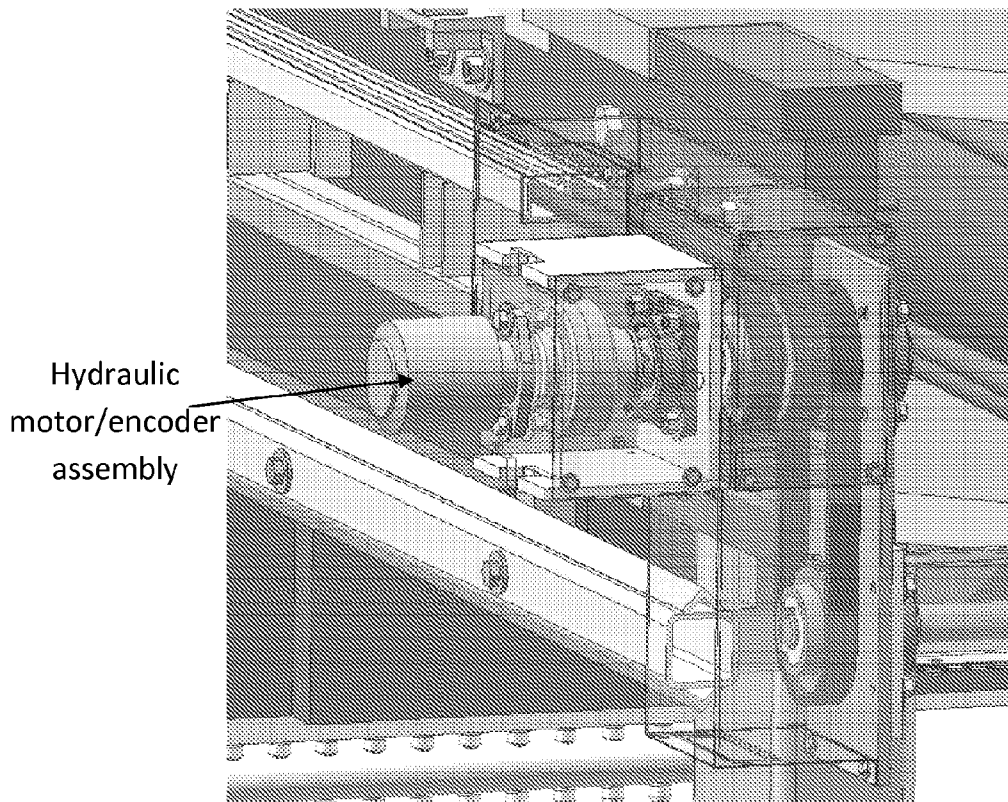


FIGURE 61

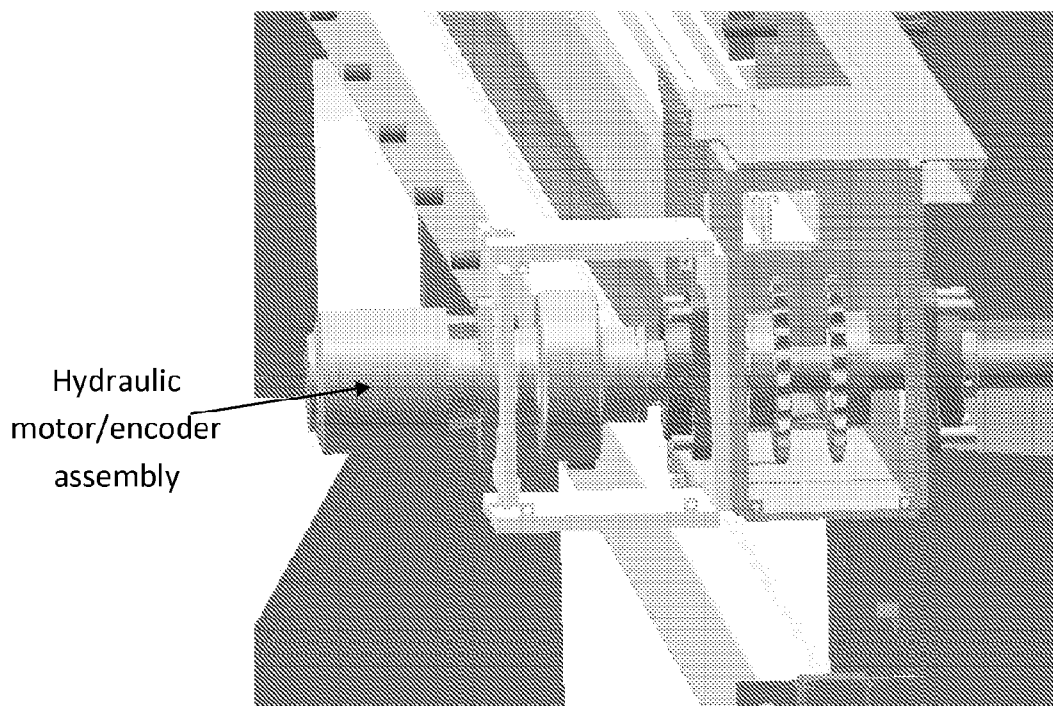


FIGURE 62

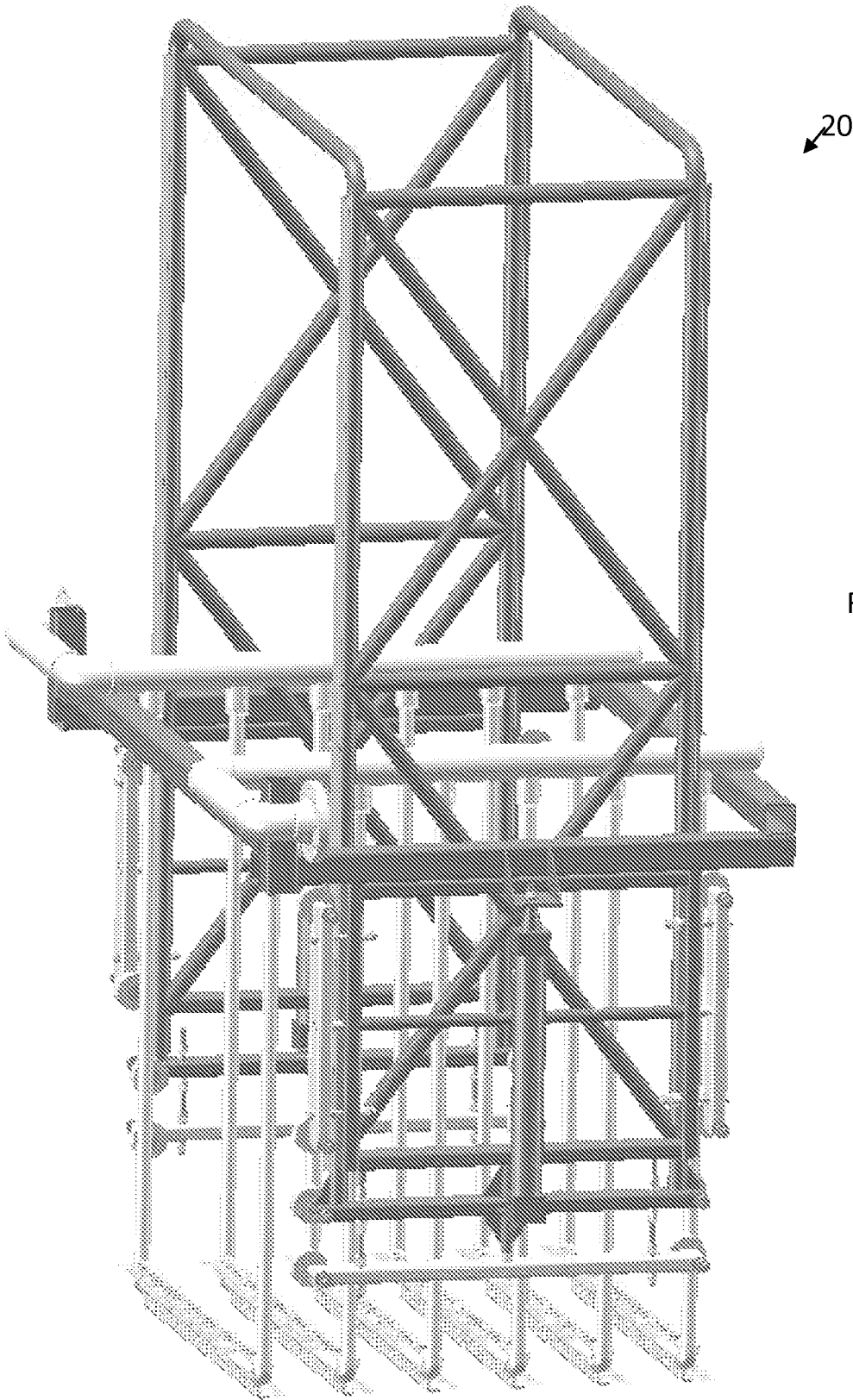


FIGURE 63

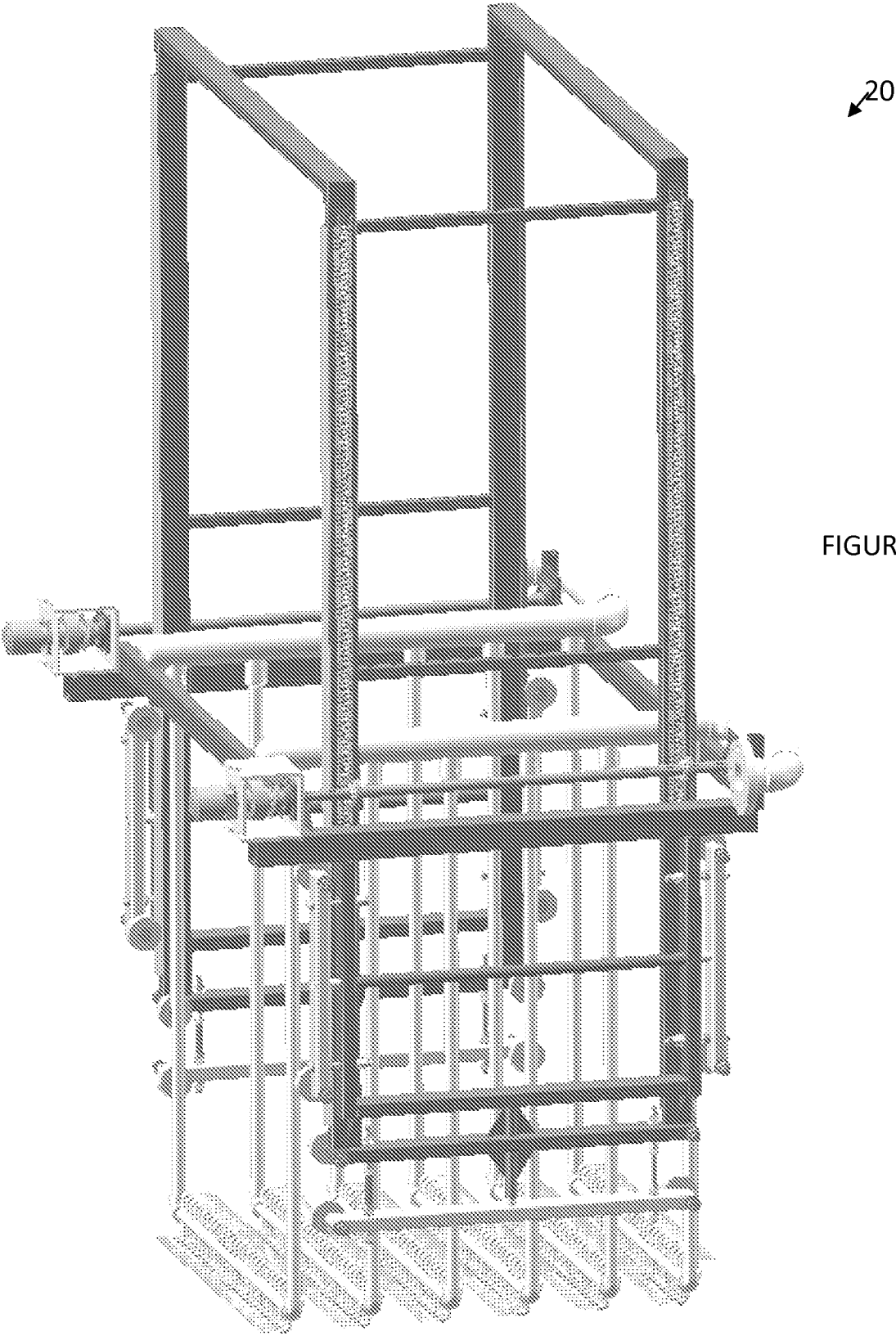


FIGURE 64

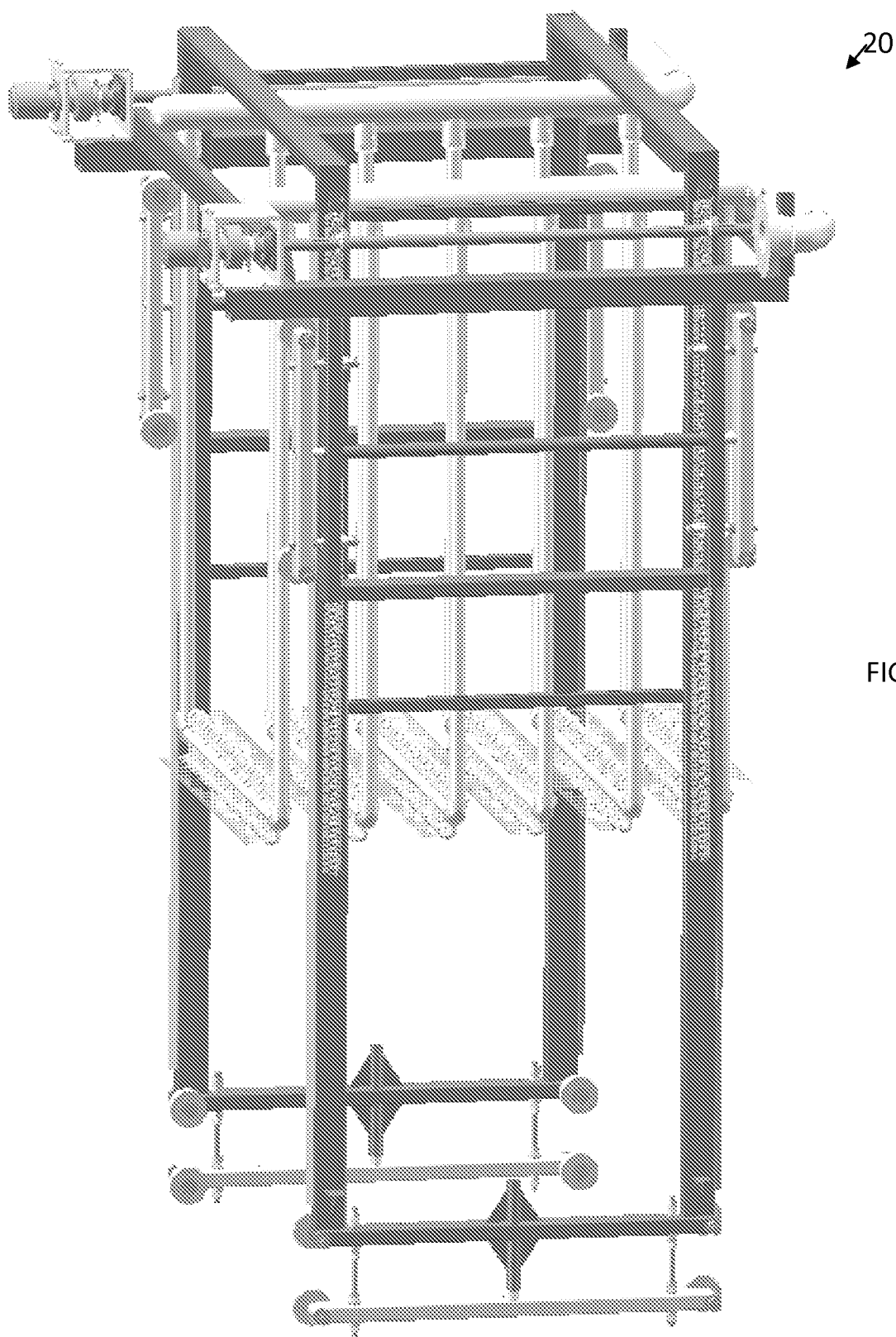


FIGURE 65

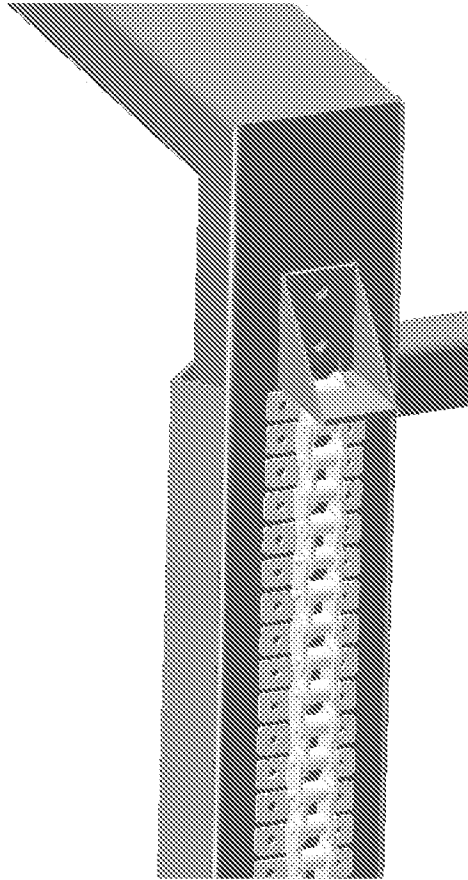


FIGURE 66

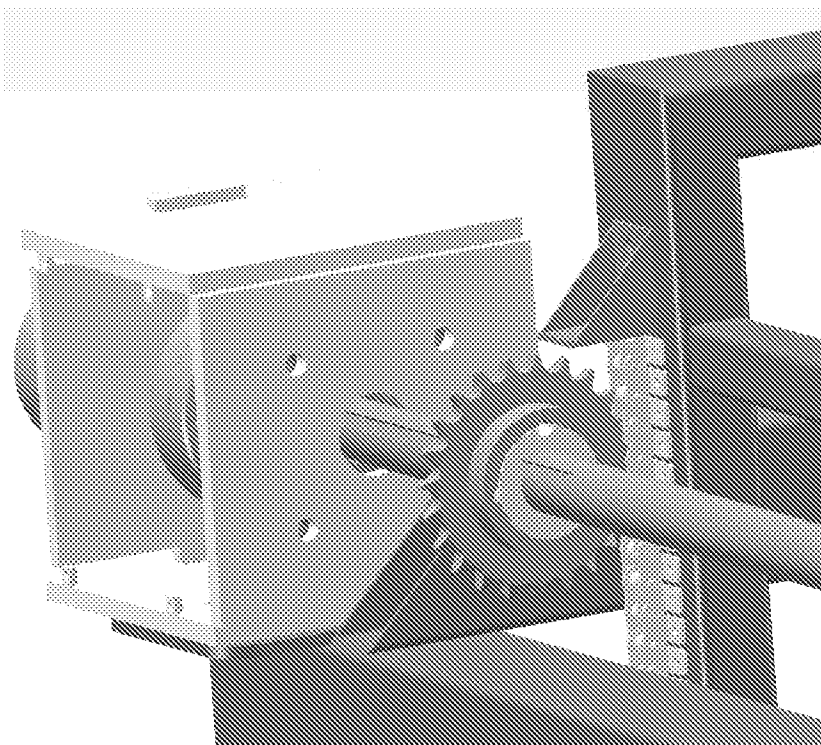


FIGURE 67

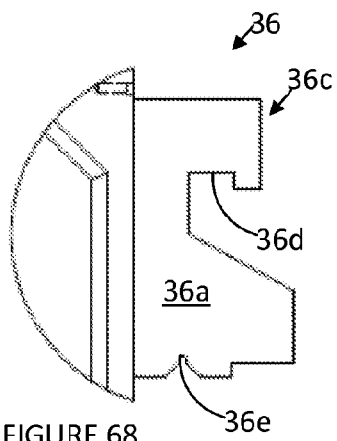


FIGURE 68

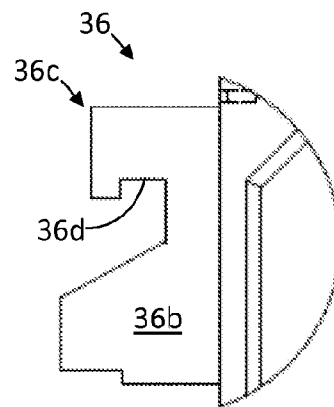


FIGURE 69

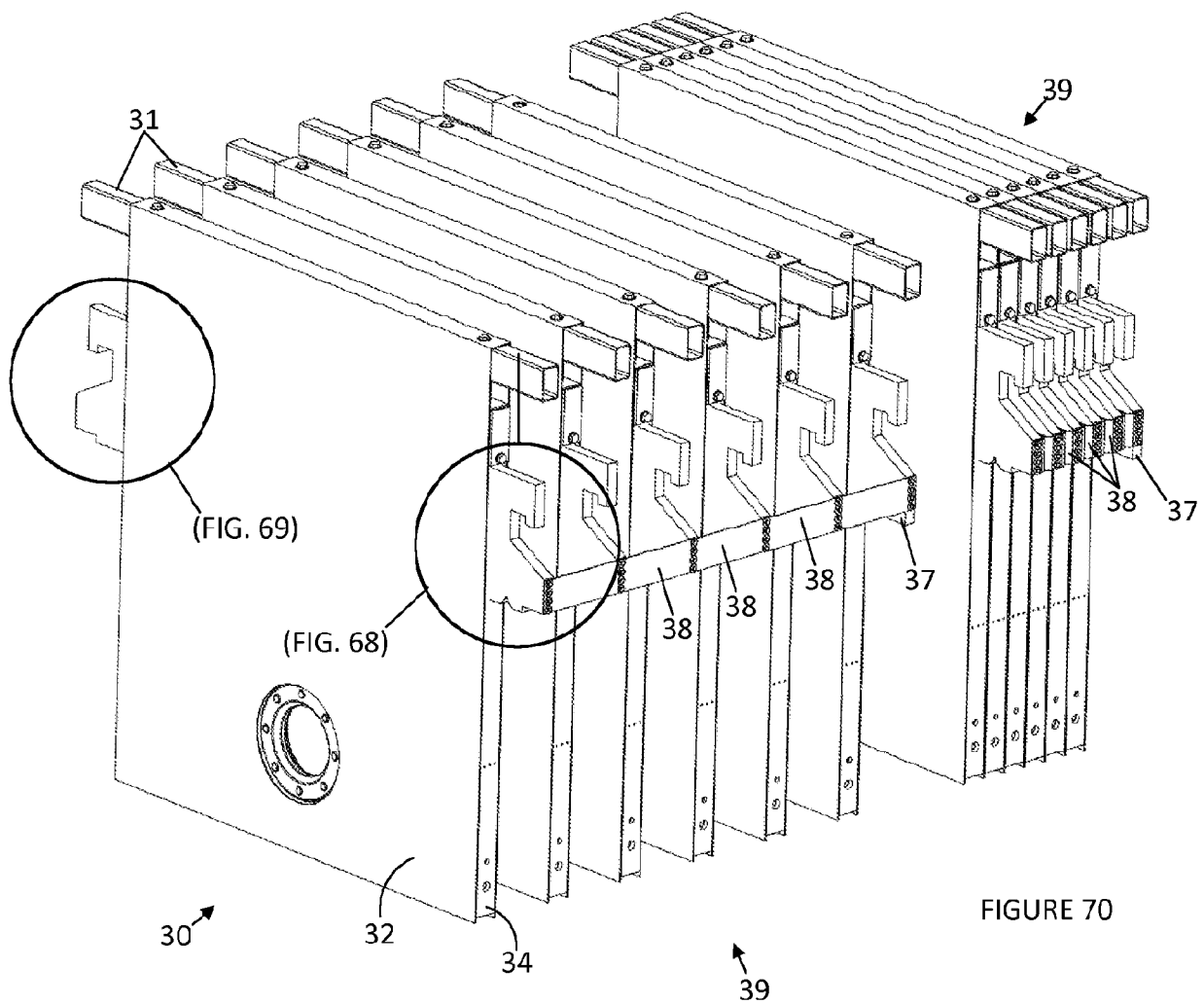


FIGURE 70

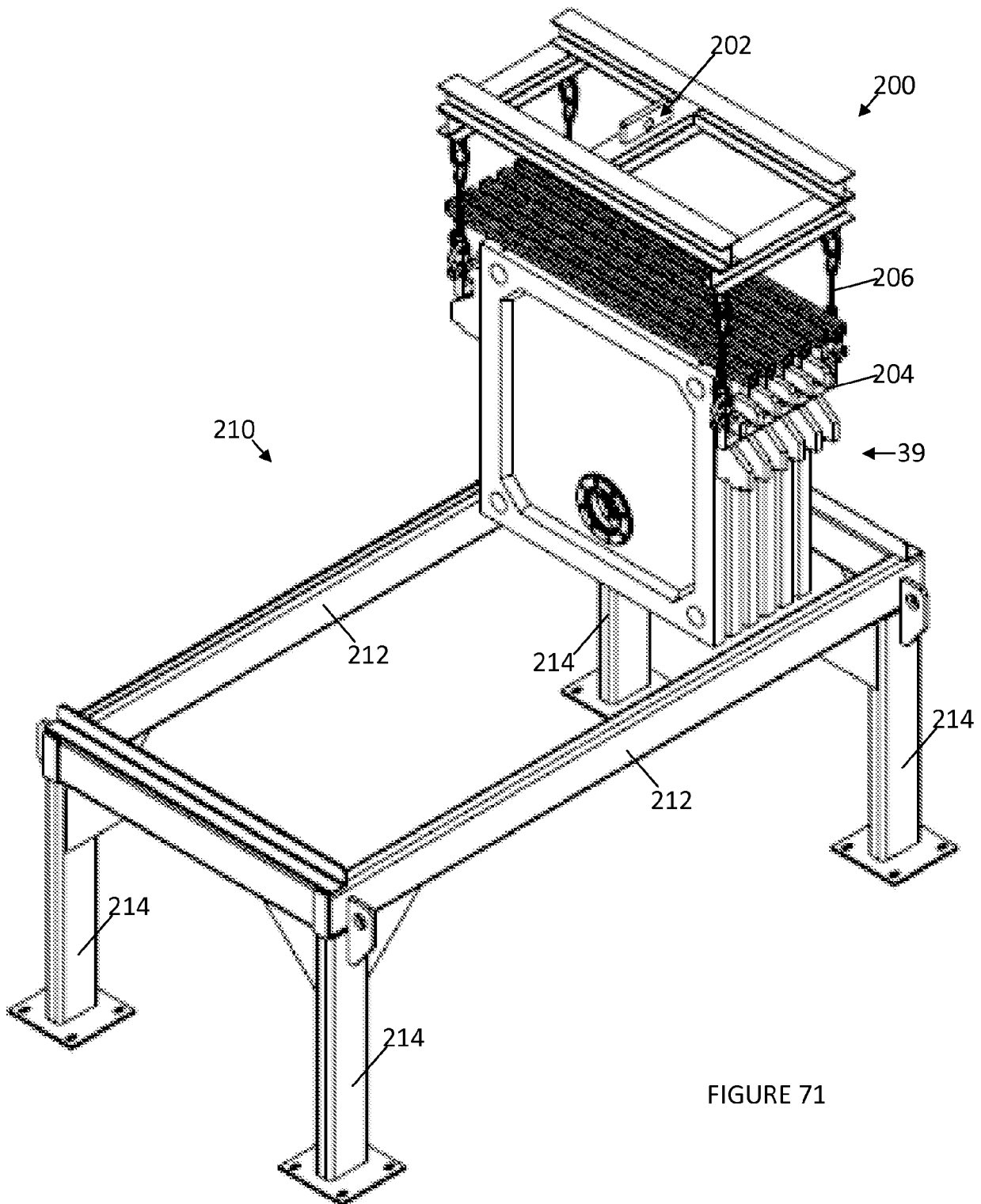


FIGURE 71

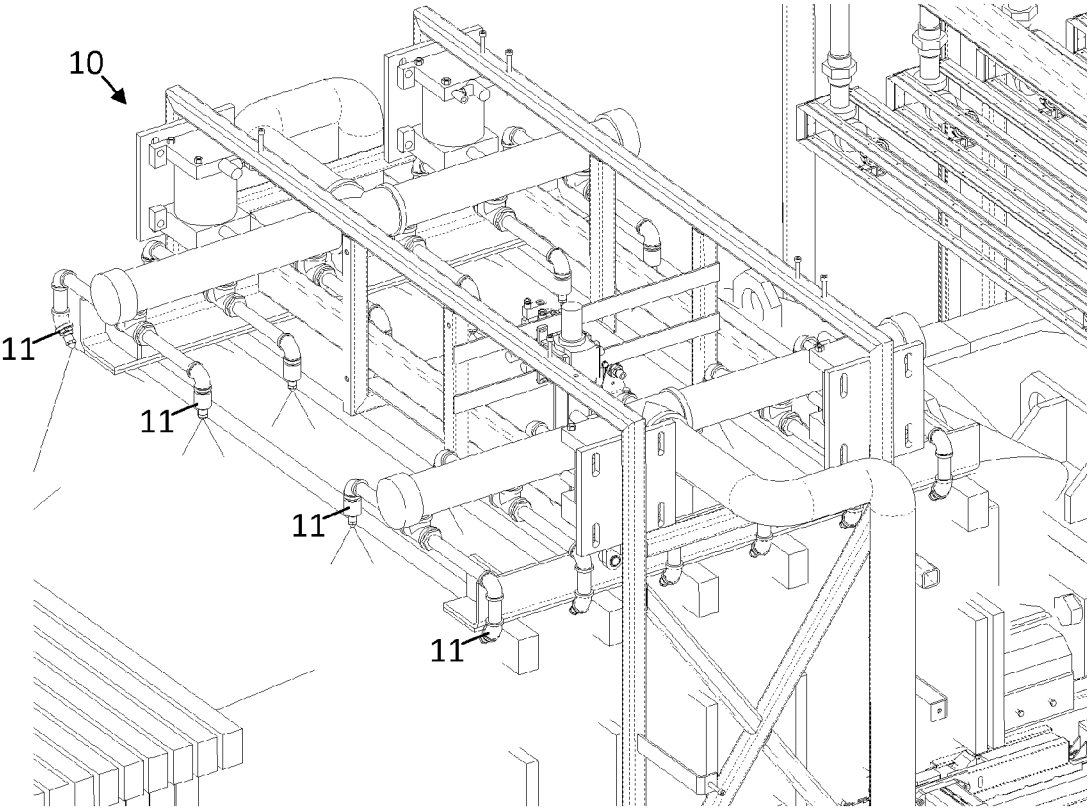


FIGURE 72

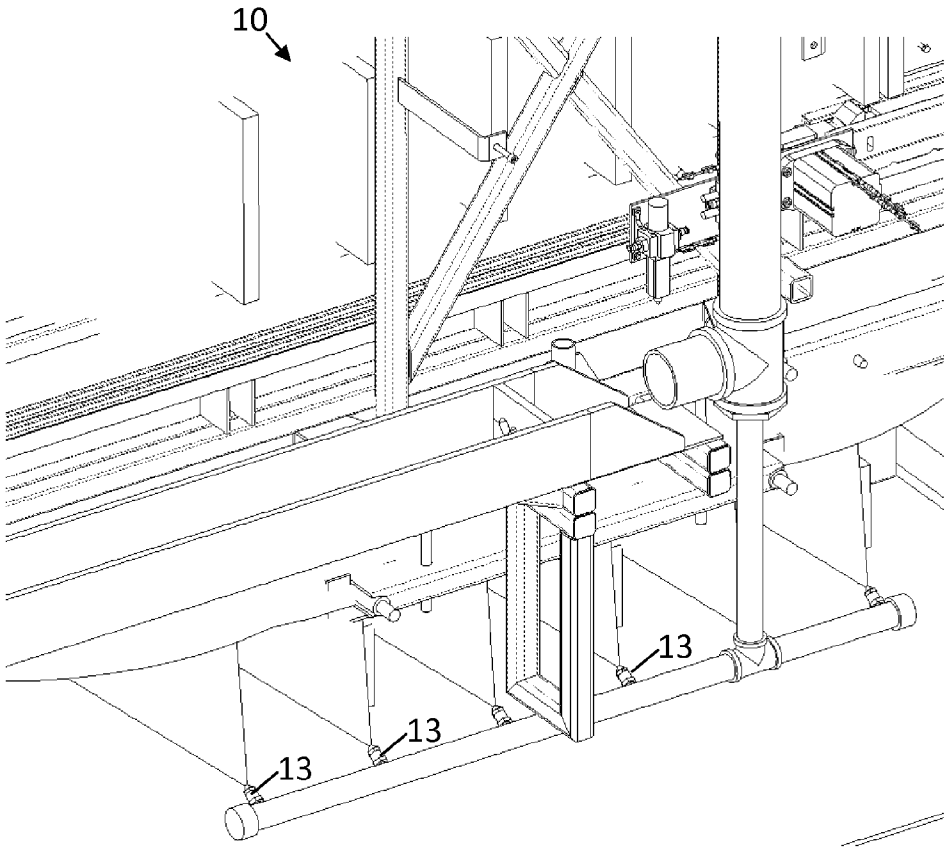


FIGURE 73

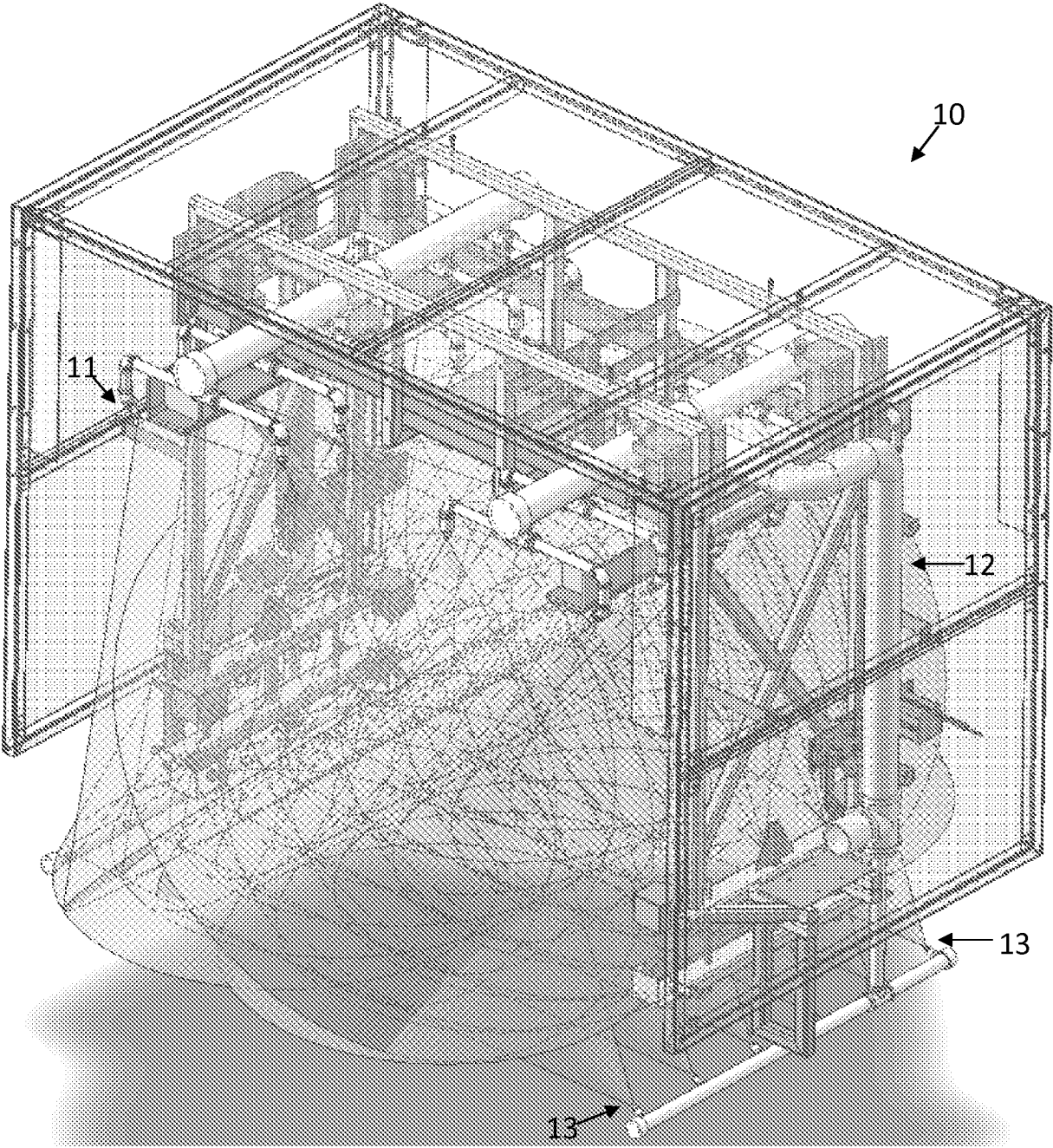


FIGURE 74

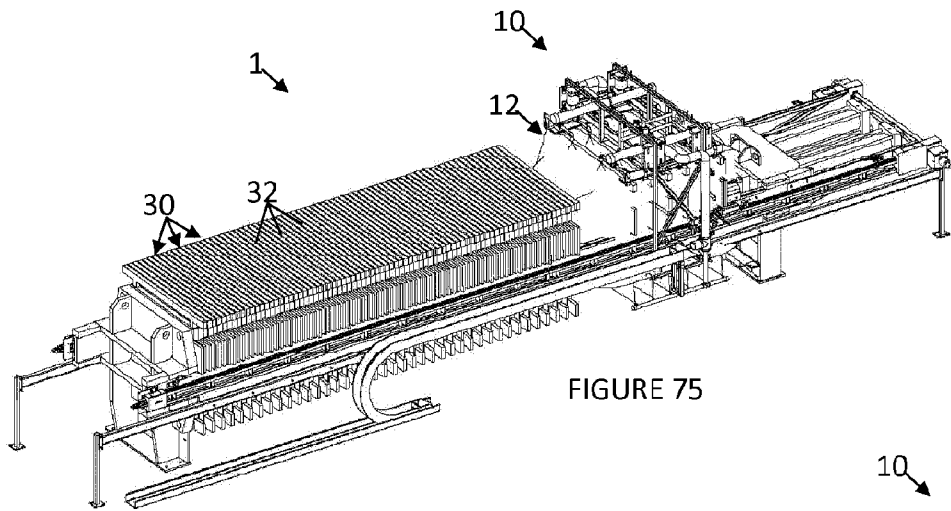


FIGURE 75

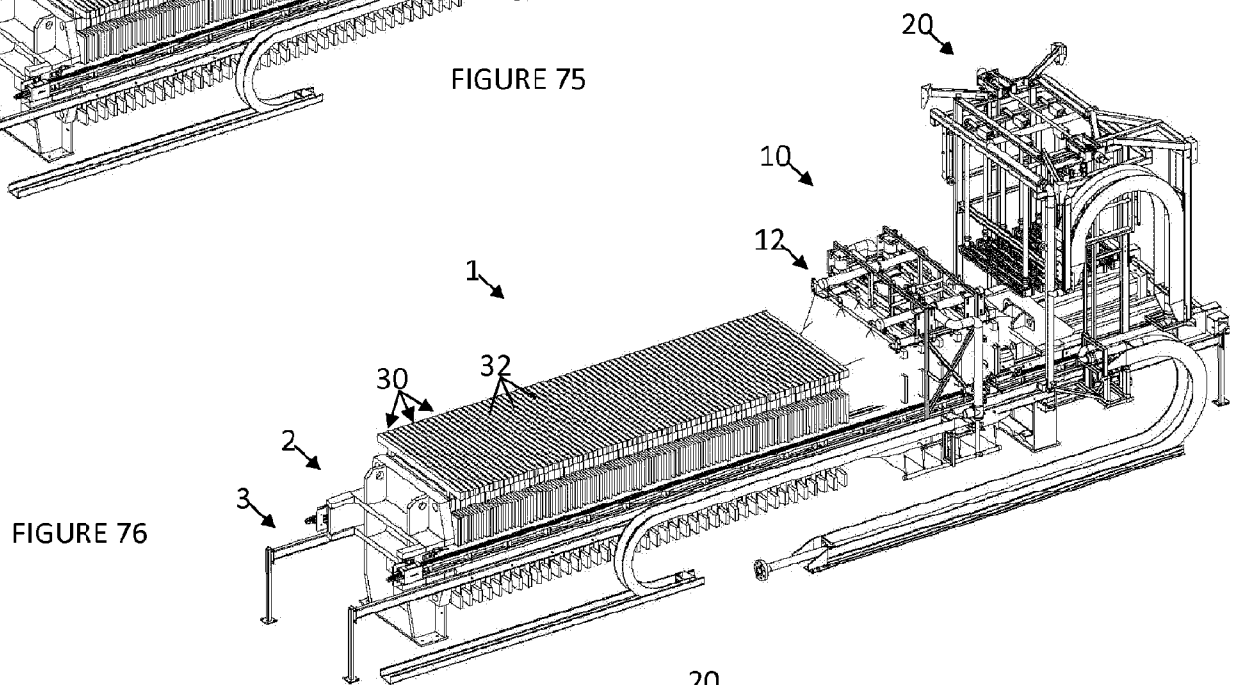


FIGURE 76

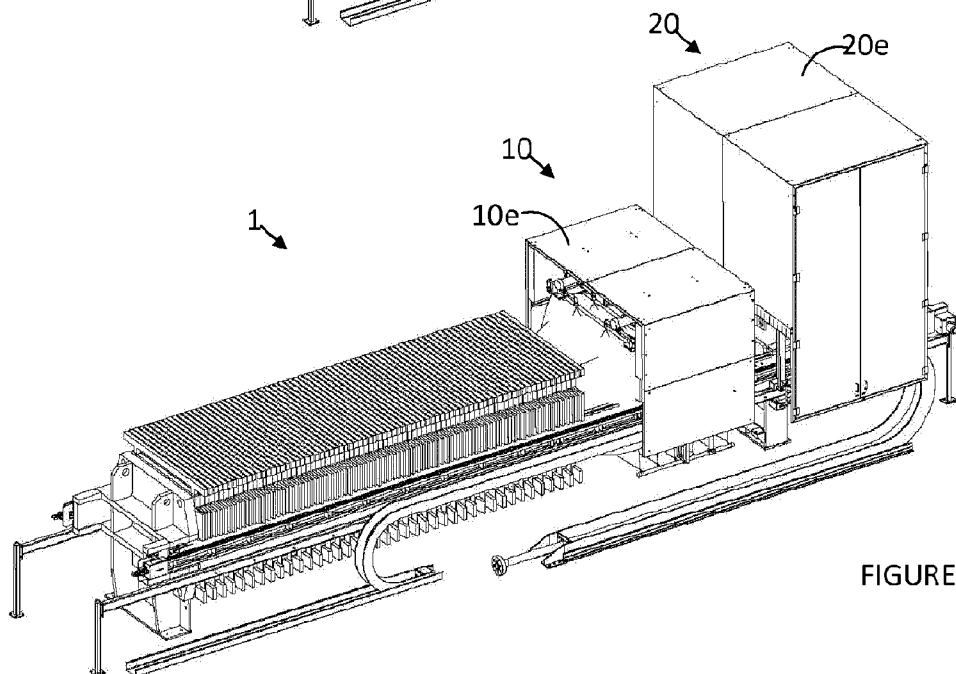


FIGURE 77

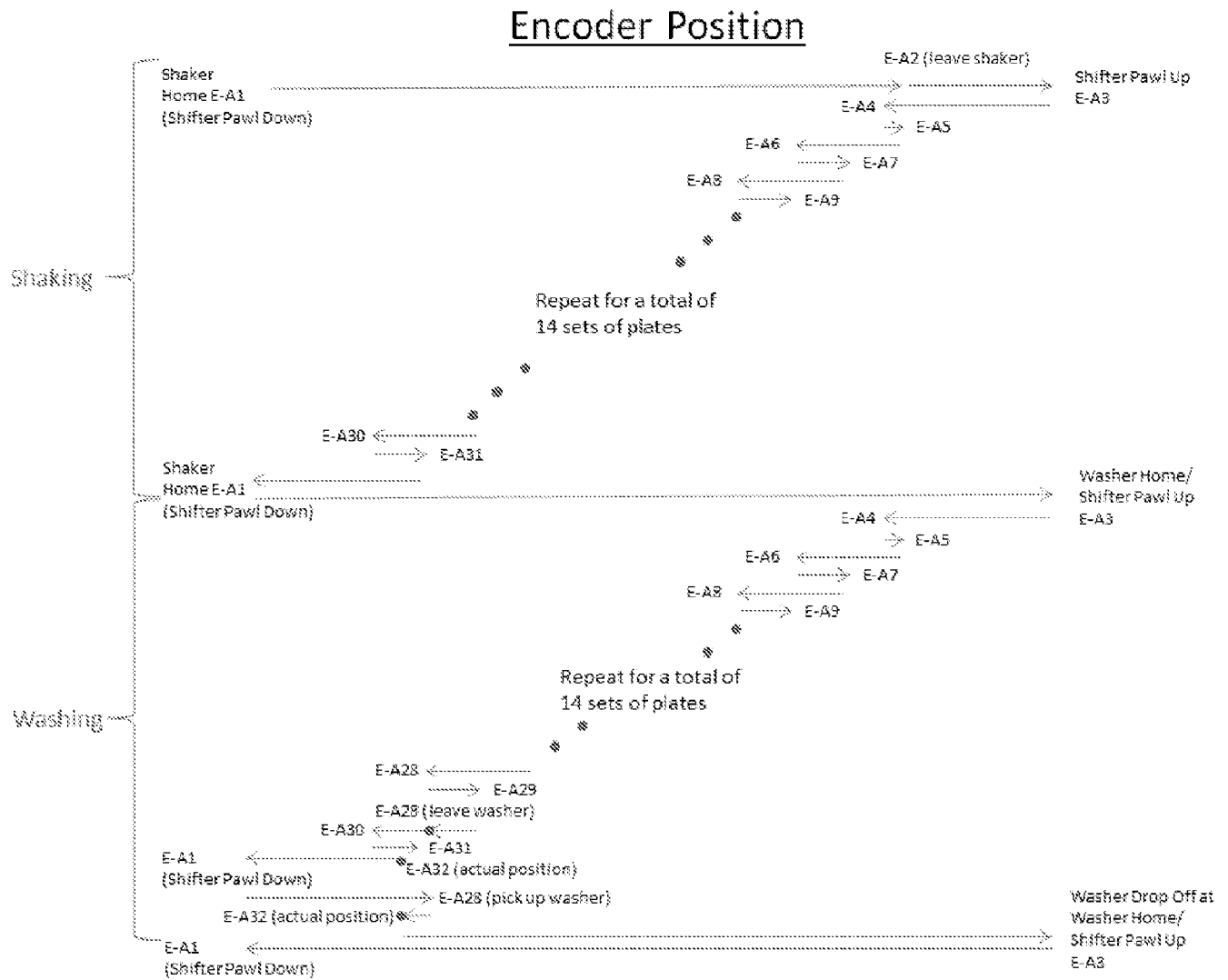


FIGURE 78