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Multiple Fastener Extractor

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ABSTRACT

A fastener extractor 1 for extracting multiple fasteners 3 distributed over a length of material 2. The fastener extractor includes a clamp 5, actuators 8a, 8b and separators. The separators include material-engaging portions 11a, 11b, and separator drives 10a, 10b. The clamp 5 has a clamping members 6a, 6b with a pair of fastener-engaging surfaces 7a 7b. The clamping members 6a, 6b are relatively movable between an open position, and a clamping position for applying a clamping force F to the fasteners 3. The powered actuator 8a, 8b is operable to reciprocate the clamping members 6a, 6b between the open position and the clamping position to clamp the fasteners. The separators are operable to move the material 2 away from the clamp 5 to extract the fasteners 3 from the material 2.

Title: Multiple Fastener Extractor

Technical Field

0001 The present invention relates to tools for extracting fasteners and more particularly to a powered fastener extractor and method for extracting multiple fasteners from wood or other material.

Background Art

0002 Modern vineyards use a trellis system for supporting and training grapevines to grow in a desired direction and shape. The trellis includes a row of wooden posts spaced between two end 'strainer' posts. A series of wires are attached to the strainer posts and each wire spans the row.

0003 As the grapevines grow upwards, they entangle themselves about a wire which supports their growth.

0004 Each wire is supported on each intervening post by a plastic wire clip that is retained on the post by a nail or staple driven through the clip and into the corresponding post. Such wire clips are now more predominantly used than protruding nails.

0005 The wire clips have snap-fit recesses for retaining the wires, which thereby enable the wires to be attached and detached as required. A series of multiple clips are nailed to the post, typically between 6-15 clips per post, dependant on the application. The clips are typically arranged about 200mm apart over the length of the post. However, these are manually installed and so the separation can vary significantly, depending on the precision of the installer.

0006 A greater number of clips than wires are required per post to enable a vine 'lifting' process. As the vines grow, they need to be lifted to encourage open vine growth and maximise sun exposure. The wires are thus periodically unclipped from one clip and lifted to be retained in another clip positioned higher on the post.

0007 During vineyard operations of pruning, post-pruning, spraying, harvesting or other mechanized operations, it is possible for a harvester or tractor to strike a post and break it off at a point adjacent the ground. Posts may also snap under the tension from the wires depending on the environmental and soil conditions. These broken posts must be removed and replaced with a new post.

0008 The broken posts are predominantly considered a waste product to be disposed of and thus represent a cost to the vineyard operation. Posts are often chemically treated with a preservative and so cannot be burnt while meeting environmental regulations. The posts are therefore instead deposited to a rubbish landfill.

0009 Some vineyards sell or donate the broken posts to households, farmers or others who want to recycle the broken posts. The recycled posts are shorter (about 1.8m or less) than the new vineyard posts (about 2.4 metres) and thus unsuited for re-use in vineyards. However, the recycled posts are still useful for many other applications, though the nails, staples and plastic clips retained on the recycled posts are an impediment for many uses, prevent sawing into battens, and are often deemed aesthetically displeasing for household applications. Moreover, the plastic clips on the posts will deteriorate over time and pollute the environment.

0010 It is thus desirable to remove the plastic clips and nails from the posts to aid recycling. Naturally, these clips and nails can be removed manually with a pry-bar, pliers, hammer or other conventional tools. However, manual removal is labour intensive, unsuited for economies of scale, and tedious. A powered solution would therefore be advantageous.

0011 There exist myriad powered nail extractor devices in the prior art. A typical powered nail extractor is described in US 7,658,368 by *Laun* and shown in figure 15 of the present application. The *Laun* device has a claw assembly 30 that can be positioned around a protruding head 41 of a nail to be removed. The assembly 30 is mounted to a threaded spindle 25 that moves relative to a correspondingly threaded housing 12. The housing 12 is positioned in use to abut the wood the nail is embedded in. A cordless drill or other rotary tool can rotate the threaded spindle 25 to cause the relative movement to remove the nail.

0012 US 3,978,576 by *Stambaugh* describes an alternative tool that is pneumatically or hydraulically powered. The *Stambaugh* device has a pair of clamping jaws that are pneumatically driven into the wood the nail is imbedded in, to clamp about the nail's head. A piston then moves the jaws axially relative to the tool housing to extract the nail. The jaws are necessarily shaped to encircle the nail head, thereby providing a secure grip.

0013 Other powered prior art tools may use levering or prying actions to remove nails, akin to a conventional clawed prybar use.

0014 The prior art devices have a single pair of jaws sized to fit around an individual nail head, extracting a single nail at a time. The prior art is incapable of removing multiple nails simultaneously. Moreover, the prior art is designed for removing nails with protruding heads and are not capable of effective use in removing plastic clips or other fasteners surrounding the nail. The *Laun* and *Stambaugh* devices for example would likely be incapable of removing a nailed plastic clip from a post as the clip would interfere with the jaw closure.

0015 It may thus be advantageous to provide a fastener extractor capable of extracting plastic clips or similar fasteners, from a post.

0016 It may also be advantageous to provide a fastener extractor that is capable of simultaneous extraction of multiple fasteners from a post or other material.

0017 It is also an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

0018 All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although several prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general knowledge in the art, in New Zealand or in any other country.

0019 It is acknowledged that the term 'comprise' may, under varying jurisdictions, be attributed with either an exclusive or an inclusive meaning. For the purposes of this specification, and unless otherwise noted, the term 'comprise' shall have an inclusive meaning - i.e. that it will be taken to mean an inclusion of not only the listed components it directly references, but also other non-specified components or elements. This rationale will also be used when the term 'comprised' or 'comprising' is used in relation to one or more steps in a method or process. Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

0020 Reference throughout this specification to the singular should be interpreted to include the plural and vice versa unless specifically and explicitly stated otherwise.

Disclosure of Invention

0021 According to a first aspect of the present invention, there is provided a fastener extractor for use in extracting fasteners from a material to which the fasteners are affixed, the fastener extractor including:

- at least one clamp, the at least one clamp including at least one pair of elongate, and mutually opposing, clamping members, the clamping members being capable of relative movement between an open position and a closed position, wherein each clamping member has at least one fastener-engaging surface,
- at least one powered actuator, the actuator being operable to move the clamping members together to the closed position, thereby moving the fastener-engaging surfaces in use to engage with at least one fastener located therebetween, and apply a clamping force thereto;

- at least one powered separator, operable to provide relative movement of the material and clamping members.

0022 According to another aspect of the present invention, there is provided a fastener extractor for use in extracting multiple fasteners distributed over a length of material to which the fasteners are affixed, the fastener extractor including:

- at least one clamp, the at least one clamp including at least one pair of clamping members, each clamping member having at least one fastener-engaging surface, at least one fastener-engaging surface of one clamping member mutually opposing at least one fastener-engaging surface of the other clamping member, thereby forming at least one pair of mutually opposing fastener-engaging surfaces;
- at least one powered actuator;
- at least one powered separator, and

wherein the clamping members are relatively movable between:

- an open position, and
- a clamping position, for applying a clamping force to any set of multiple fasteners located between the at least one pair of mutually opposing fastener-engaging surfaces,

wherein a clamping region is defined by the extents of the at least one pair of mutually opposing fastener-engaging surfaces in the clamping position, and

wherein the clamping region is elongate, with a clamping length defined by the length of the clamping region orientated approximately perpendicular to the clamping force and approximately parallel with the distribution of the set of multiple fasteners affixed to the length of material,

wherein the at least one powered actuator is operable to reciprocate the clamping members between the open position and the clamping position, and

wherein the at least one powered separator is operable to provide relative movement of the material and the clamp.

0023 Preferably, when in the clamping position, said relative movement is in a direction perpendicular to the clamping force and clamping length, the fastener extractor thereby extracting the set of multiple fasteners from the material.

0024 In use, the extractor is preferably operable by powering the actuator to move the clamping members to the clamping position to grip the fasteners and then operating the separator to provide relative movement of the material and clamping members, and therefore the fasteners. The fasteners are thus separated from the material.

0025 Preferably, the at least one powered actuator is configured as a separate mechanism to the at least one powered separator, respectively operating to perform clamp closing and provide relative movement of the material and clamping members.

0026 Preferably, the fastener extractor is configured to simultaneously extract multiple said fasteners during said relative movement. The fastener extractor may be capable of said simultaneous extraction via the use of elongate clamping members, thereby providing an extended clamping area capable of gripping multiple fasteners at a time.

0027 The term “fastener”, as used herein, should be understood to mean any device configured for the securement of, and/or to, another device, and includes a nail, staple, clip, tie, screw, clasp, pin, bolt, and the like.

0028 The term “elongate”, as used herein, should be understood to refer to an object with a shape having an elongate dimension longer than the object’s dimensions perpendicular to the elongate dimension.

0029 The term “material-engaging portion" as used herein, refers to any portion of the separator configured to directly or indirectly contact or ‘engage’ with the material during operation.

0030 The term “fastener-engaging surface” refers to any continuous or discontinuous surface configured to directly contact or ‘engage’ with one or more of the fasteners when the clamp is in the clamping position.

0031 Reference herein to the fasteners being ‘extracted’, ‘removed’ or similar should be understood to mean that the fasteners are no longer affixed, embedded, or otherwise attached to the material.

0032 Reference herein to the relative movement of the material and clamp should be understood to include any movement of either the material or clamp relative to the other and includes where both the material and clamp are moving. The provided relative movement may be referred to herein as “clamp-material relative movement”, “material-clamp relative movement” or other appropriate variations.

0033 Throughout the specification the ‘length’ of the clamping members, fastener-engaging surfaces, clamping area, or material refers to a dimension in a direction parallel or coincident with the length of the corresponding elongate clamping member.

0034 The fastener extractor is particularly useful in extracting plastic wire clips secured to a wooden post via nails, staples, or screws. To aid clarity and for brevity, reference will be made herein to the fasteners being such plastic wire clips and the ‘material’ being a wooden post. It should be appreciated however that the fasteners and material may be other types, e.g. the fasteners may

be insulators, protruding nails, staples or other fasteners. The material may be wood, plastic, metal, or other material.

0035 According to another aspect of the present invention, there is provided a method of separating fasteners distributed over a length of material to which the fasteners are affixed, the method performed using a fastener extractor as described herein, the method including the steps of:

- positioning multiple attached fasteners between the fastener-engaging surfaces, and with the clamp in the open position;
- operating the actuator to move the clamping members together to the clamping position, thereby moving the fastener-engaging surfaces to engage and clamp any fasteners located therebetween;
- operating the separator to provide relative movement of the material and clamping members, the relative movement being sufficient to separate the fasteners from the material.

0036 The method preferably further includes operating the actuator to move the clamp to the open position, thereby releasing the extracted fasteners from between the fastener-engaging surfaces.

0037 The method may be repeated for additional material and fasteners, thereby providing an efficient means for simultaneously extracting multiple fasteners from material.

0038 Preferably, the method includes simultaneously clamping multiple fasteners protruding from the material, wherein the clamping members do not penetrate or deform said material in the clamping position. Thus, the material may not be damaged by the extractor in use.

0039 Preferably, the method includes simultaneously clamping multiple fasteners protruding from the material, wherein the clamping members at least partially deform the fasteners. Thus, the plastic clips may be deformed under sufficient clamping force, which aids in the gripping of the clips during extraction.

0040 Preferably, each clamping member includes a fastener engaging surface, wherein in the clamping position, each fastener is gripped or clamped between the mutually opposing fastener engaging surfaces.

0041 Each clamping member is preferably of sufficient length to simultaneously grip at least two fasteners when closed and more preferably at least five fasteners. For vineyard posts, each clamping member is therefore preferably at least 400mm in length and more preferably at least 800mm in length.

0042 Preferably, each clamping member is elongate in a direction transverse to the direction of movement of the clamp between the open and clamping positions. Similarly, preferably, each

clamping member fastener-engaging surface is elongate in a direction transverse to the direction of movement of the clamp between the open and clamping positions.

0043 Preferably, each clamping member is elongate in a direction transverse to the clamping force. Similarly, preferably, each clamping member fastener-engaging surface is elongate in a direction transverse to the clamping force.

0044 The term “transverse”, as used herein preferably includes both perpendicular and slanted, i.e. non-parallel. The clamping members and/or fastener engaging surfaces are preferably perpendicular (or close thereto) to the direction of clamping force.

0045 There is considerable wear imparted on the fastener engaging surfaces as they repeatedly grip the fasteners with sufficient force to hold the fasteners during the material-clamp relative movement. The fastener engaging surfaces may therefore wear and no longer grip with equal force along their length. The clamping members thus preferably include at least one wear strip, the wear strip including the fastener engaging surface(s). The wear strip can be removed and replaced when worn, obviating the need for entire clamping member replacement.

0046 Preferably, at least two said wear strips are provided, e.g. at least one wear strip for each clamping member.

0047 In vineyard clip applications, irrespective of the irregularity of other clip locations spread out over the length of the post, there is typically at least one clip located at the ‘upper’ distal end of each post. The consistent presence of a clip at the distal end results in significant wear at the corresponding end of each clamping member wear strip. The hardened steel of the wear strips is worn at the same position as a result. This wear results in increased separation between clamping members at the wear point and therefore less clamping force at this position. To resolve this issue, the wear strips are preferably reprofiled over their length when the wear becomes too severe at a particular point. However, ‘dressing’ the wear strips in this way results in increased separation between clamping members. Therefore, preferably the position of at least one said clamping member is adjustable to change the separation between clamping members when in the clamping position.

0048 The opposing fastener-engaging surfaces can be of different shape and dimensions but need to have at least some mutually opposing portions that can grip the fasteners therebetween. Therefore, the mutually opposing portions of the fastener engaging surfaces preferably at least have the same length.

0049 Preferably, a said fastener-engaging surface includes an elongate edge extending over at least part of the length of the corresponding clamping member.

0050 Preferably, a said fastener-engaging surface is provided as a continuous or semi-continuous elongate edge, preferably coterminous with the length of the corresponding clamping member.

0051 In an alternative embodiment, the fastener engaging surfaces are formed on wear strips as a series of 'teeth'. The teeth are preferably removable. Thus, as individual teeth wear, the worn teeth can be replaced, rather than requiring replacement of a complete wear strip.

0052 The separator is preferably powered, such as by a hydraulic, pneumatic, mechanical or electrical drive. It will be appreciated that the separator may take many forms, subject to being able to provide relative movement between the material and clamp.

0053 In preferred embodiments the separator includes a pushing or pulling mechanism for engaging with the material and moving the material away from the clamping members. It will be appreciated that the converse configuration is also usable, i.e., holding the material while moving the clamping members away.

0054 The choice of whether to move the material or clamping members, or both, will depend on the application, e.g., if the material is heavier than the clamp it will be less energy intensive to move the clamp than the material, and vice versa.

0055 Preferably, the separator includes at least one reciprocating material-engaging portion for engaging with and moving the material, the material-engaging portion being reciprocated between a 'start' position and an 'end' position. In use the fasteners are preferably completely removed when the material-engaging portion has moved a sufficient distance toward the end position.

0056 Preferably, the material-engaging portion is reciprocated between the 'start' position and the 'end' position by actuation of at least one separator drive.

0057 The separator drive preferably includes at least one hydraulic ram. Alternatively, the separator drive may include at least one of:

- pneumatic ram;
- chain drive,
- screw drive;
- rack and pinion;
- electrical actuator;
- linear drive.

0058 Preferably, the separator includes at least two reciprocating material-engaging portions.

0059 Preferably, the material-engaging portions are longitudinally separated with respect to the length of the clamping members.

0060 Preferably, each material-engaging portion is located adjacent a respective longitudinal end of the clamp.

0061 In use the material-engaging portions engage longitudinally separated portions of the material and thereby move the entire material away from the clamping members. In contrast, if only one material-engaging portion is provided and pushes on one end, the material will pivot.

0062 Preferably, the separator is configured to provide approximately simultaneous movement of the at least two material-engaging portions relative to the clamping members. The simultaneous movement of the at least two material-engaging portions ensures the material-clamp relative movement along the length of the clamping members is consistent, and therefore all fasteners are displaced to the same extent. If the material-engaging portions were to move asynchronously then the material would pivot, resulting in some fasteners being displaced more than others, potentially leaving some fasteners still attached.

0063 It will be appreciated that the purpose of the fastener extractor is to extract the fasteners from the material, and any sufficient relative movement may be satisfactory for some applications. However, for plastic clips attached to vineyard posts, and similar applications, the more closely aligned the relative movement is to the longitudinal direction of the nails (or staples) that affix the fasteners to the post, the more efficient the extraction. The operation is therefore more efficient the more aligned the material movement is to being coaxial or parallel to the longitudinal direction of the nails or staples. Excessive pivoting or rotational movement is less optimal and may cause the nails/staples to bend excessively, which will reduce the efficiency of extraction and make it more difficult for subsequent separation of the nails from the clips.

0064 Thus, providing multiple said material-engaging portions, moving simultaneously, can ensure that minimal rotational/pivoting movement is applied to the fasteners.

0065 However, it should be appreciated that where a fastener is located at a position interposed between the material-engaging portion and material, that fastener will not be extracted during operation. In such cases, it may be necessary to position the material with that fastener in the clamp and restrain the material in such a way that only one material-engaging portion engages with the material and the fastener is extracted. Once the interposed fastener is removed the material can be positioned optimally and remaining fasteners removed.

0066 In an alternative embodiment, a single reciprocating material-engaging portion may be provided and positioned approximately centrally along the clamping members' length. It will be noted that the maximum length of such a single material-engaging portion is constrained by the spacing

between fasteners. However, preferably, such a single material-engaging portion is of sufficient length that the material-clamp relative movement is approximately consistent over the entire length of the clamp. Such a single reciprocating material-engaging portion may be useful in applications where the fasteners are distributed closer to the ends of the material than at the centre.

0067 In one embodiment, the separator material-engaging portions are coupled to a common support platform, the separator moving the clamping members relative to the common support platform.

0068 In use there may be more fasteners attached to the material than can be accommodated in the length of the clamping members. Any fasteners located beyond the extents of the clamping region may therefore interfere with the material-engaging portions and cause the material to pivot, rotate, or otherwise misalign relative to the clamp. Therefore, preferably, the material engaging portions have a start position that is separated from a material-facing surface of the clamping members by at least the distance a fastener protrudes from the material. In applications using wooden posts and vineyard clips, such a ‘set-back’ distance is preferably at least 20mm.

0069 The material-clamp relative movement may be achieved by having the clamp stationary when closed and moving the material-engaging portion, or vice versa. The relative movement may also be achieved by moving both the clamp and material-engaging portion such that there is still relative movement therebetween. Thus, the material-clamp relative movement is preferably provided by the relative movement between the material-engaging portions and clamp.

0070 However, the clamp and associated components are typically much heavier than the material-engaging portion. Moreover, wooden posts can be of different size, shape and weight, making positioning the posts in a consistent repeatable position difficult. The separator therefore preferably moves the material while the clamp remains stationary.

0071 The material-engaging portion and/or clamp are preferably guided during the material-clamp relative movement such that the material-engaging portion to clamp relative movement is approximately linear.

0072 The material-engaging portion is preferably guided during the material-clamp relative movement such that the relative movement of the material-engaging portion and clamp is constrained in a plane approximately perpendicular to a long axis of the elongate clamping member.

0073 At least one guide is preferably provided for guiding a said material-engaging portion and/or clamp linearly. Preferably, the guide includes a slot, track, rail or similar, to which the material-engaging portion and/or clamp is coupled to move during the material-clamp relative movement.

0074 The guide preferably directs, channels and/or guides movement of a said material-engaging portion.

0075 The material-engaging portion preferably needs to be able to engage with and move the post relative to the clamp. However, the material to which the fasteners are attached is seldom regular or uniform. Material such as wooden posts, for example, may be formed as full-round, half-round or quarter round posts and are irregular over their length, with protruding knots, twists and irregular diameter.

0076 It may be relatively simple to guide a flat-faced material-engaging portion into engagement with a corresponding flat face of a quarter-round or half-round post. However, round posts present a curved surface to the material-engaging portion(s) and thus a flat face of a material-engaging portion will only engage tangentially at a point on the circumference of the full-round post. This relatively small point of contact may place undue strain on the material-engaging portion if the material-engaging portion(s) are not aligned to move in a direction along a radial line of the post.

0077 It will be appreciated that different material-engaging portion(s) could be provided to engage with each type of post. However, this adds complexity and cost.

0078 Moreover, reactive forces applied to the material-engaging portion(s) may also occur during the material-clamp relative movement. These reactive forces may impart torque, rotation or bending of the material-engaging portion relative to the guide. Such movements may cause undue wear on the material-engaging portion and/or guide.

0079 Therefore, to ameliorate these problems the material-engaging portion is preferably pivotable relative to the guide, thereby reducing potential strain and wear on the material-engaging portion.

0080 Preferably, the at least one clamp actuator can reciprocate the clamping members between the open and clamping positions. The term “reciprocating” should be understood in this context to include linear and/or non-linear movement.

0081 The clamp actuator preferably includes one or more clamp drives for causing such reciprocating movement.

0082 The clamp drive preferably includes at least one of:

- hydraulic or pneumatic rams;
- chain drive,
- screw drive;
- rack and pinion;
- electrical actuator;
- linear drive.

0083 Preferably, a said clamp drive is configured to provide at least 12kN of force, and more preferably at least 17kN of force.

0084 At least one said clamping member is preferably pivotable relative to the other said clamping member. It will be appreciated that it is not necessary for both clamping members to move, e.g. one clamping member may pivot relative to the other, between the open and clamping positions. The clamping members in such a pivoting clamp can be referred to as a pair of jaws, at least one jaw capable of pivoting relative to the other jaw.

0085 Preferably, the clamping force provided by the clamping members is at least 5kN, and more preferably at least 12kN. A sufficient clamping force is required to grip the fasteners during extraction but should not be so high as to sever the fasteners. It will be appreciated that the force required is therefore application-dependant and may be varied as required.

0086 Preferably, the clamping force can be varied, by varying the force applied by the clamp drive.

0087 The dimensions of the fastener engaging surfaces also influence whether the fasteners are cut or gripped when clamped. Too narrow a surface and the fasteners could be cut or severed, thereby potentially preventing extraction. Thus, the fastener engaging surface is preferably blunt and of sufficient thickness to prevent the fasteners from being cut or severed when clamped. Preferably, the at least one fastener engaging surface is at least 5mm in width.

0088 It will be appreciated that the fasteners may not be precisely aligned on the material, particularly in the case of clips on wooden posts where a person has manually affixed the clips. This misalignment can be accommodated by the fastener extractor by providing a clamp that opens to a sufficient separation of clamping members such that slightly misaligned fasteners fit between the clamping members. As the clamping members close, any slightly misaligned fasteners are pushed into alignment by the clamping members. Any fasteners that are misaligned to such an extent that they do not fit within the clamping members may need to be extracted on a subsequent separation cycle after repositioning the material.

0089 The fastener extractor has an operating cycle preferably including a preparation or ‘setup’ phase and subsequent extraction and reset phases.

0090 In a preparation phase the material is placed in an initial ‘setup’ position, with the fasteners located between the clamping members and the clamp in the open position.

0091 Preferably, once the material is in the setup position, the fastener extractor is operated to perform a separation cycle including the steps of:

a) moving the clamp to the clamping position, thereby gripping the fasteners;

b) operating the separator to provide relative separating movement of the material-engaging portion(s) and clamping members, the at least one material-engaging portion reaching an ‘end’ position relative to the clamping members;

c) operating the separator to reverse the relative separating movement of the material-engaging portion(s) and clamping members, the at least one material-engaging portion reaching a ‘start’ position, ready for a next cycle, and

d) moving the clamp to the open position, thereby releasing the fasteners.

0092 Steps c) and d) need not be performed sequentially. However, steps a) and b) need to be performed sequentially, the fasteners being gripped first before being extracted.

0093 It will be appreciated that the time for a complete cycle is preferably minimised to maximise the operational efficiency.

0094 At least one control system is preferably provided to control the clamp and separator. The control system preferably includes at least one of: electrical, pneumatic and/or hydraulic circuits.

0095 The control system is preferably connected to and controls the clamp and separator drives.

0096 Preferably, the control system is configured to control the at least one clamp drive and the at least one separator drive, to:

- control the provision of power to the at least one clamp drive to close the clamp;
- control the provision of power to the at least one separator drive to move the at least one material-engaging portion to the end position;
- process a signal that the material-engaging portion has reached the end position;
- reverse the drive direction of the at least one separator drive, thereby returning the at least one material-engaging portion to the start position;
- reverse the drive direction of the at least one clamp drive thereby returning the clamp to the open position.

0097 Preferably, the control system includes a hydraulic circuit, the at least one clamp drive including at least one bi-directional hydraulic actuator and the at least one separator drive including at least one bi-directional hydraulic actuator.

0098 The hydraulic circuit preferably includes at least one pump or hydraulic motor, at least one sequencing valve, at least one directional valve, and appropriate interconnecting fluid lines, conduits or channels.

0099 Sequencing valves are known devices and generally include an input port and at least one output port. A sequencing valve includes internal threshold valves operable to permit fluid flow to each

outlet port upon threshold pressures being exceeded. Sequencing valves are thus useful in sequentially providing fluid flow to parts of a hydraulic circuit depending on the pressure in the valve.

0100 A directional valve is a component cable of controlling direction of fluid flow in a hydraulic circuit and includes inlet and outlet ports and valves that can be controlled to permit or prevent fluid flow between ports.

0101 Preferably, the purpose of the aforementioned hydraulic circuit is to provide hydraulic pressure to the:

a) at least one clamp drive - to close the clamp;

b) at least one separator drive - to move the material-engaging portions relative to the clamp;

c) at least one clamp drive - to open the clamp;

d) at least one separator drive - to move the material-engaging portions to the start position.

0102 The hydraulic circuit is thus preferably capable of sequential activation of the drives and providing fluid pressure to opposing sides of the drives.

0103 Preferably, the present hydraulic circuit includes a directional valve including:

- at least one inlet port (P),
- at least two outlet ports (A, B);
- at least one return port (T).

0104 Such a directional valve preferably includes two solenoid valves operable to set the directional valve in the following states:

- P -> A, B and T closed
- P -> B, A and T closed
- P -> T, A and B closed

0105 Preferably, the hydraulic circuit is configured to provide fluid flow such that:

a) fluid flows to the at least one clamp drive to close the clamp,

b) a threshold pressure is reached at the at least one clamp drive, and fluid subsequently flows to the at least one separator drive to move the material engaging portions until the material engaging portions reach the end position,

wherein, the steps a) and b) are hereinafter collectively referred to as an ‘extraction’ phase.

0106 Preferably, the hydraulic circuit is configured to provide fluid flow such that:

c) fluid flows to the at least one clamp drive to open the clamp, and

d) fluid flows to the at least one separator drive to return the material engaging portions to the start position,

wherein, the steps c) and d) are hereinafter collectively referred to as a 'reset' phase.

0107 As previously discussed, steps c and d need not be sequential and may occur:

- simultaneously or
- d) before c) or
- simultaneously for at least part of the movement.

0108 Preferably, the hydraulic circuit has an operational state, hereinafter referred to as 'idle state', wherein there is no fluid flow to the clamp drive and separator drive.

0109 The control system is preferably operable to switch from the idle state to the extraction phase, via activation of a manually activated switch. Thus, in use, an operator may position the material and fasteners into position in the setup phase and then activate the extraction phase.

0110 In one embodiment, the control system may be configured to switch the hydraulic circuit to the reset phase upon manual activation by an operator, e.g. by releasing the manually activated switch or activating another switch. However, requiring an operator to manually switch between phases introduces the potential for error or incomplete fastener extraction and adds an additional step for the operator. Therefore, preferably, the control system is configured to automatically switch the hydraulic circuit to the reset phase upon the material-engaging portion reaching the end position.

0111 Preferably, the fastener extractor includes a separator position sensor configured to indicate the position of a said material-engaging portion.

0112 Preferably, the control system is configured to switch the hydraulic circuit to the reset phase when the separator position sensor indicates the material-engaging portion reaches the end position.

0113 The separator position sensor is preferably a limit switch or other mechanical switch. In other embodiments for example, the separator position sensor is selected from: optical, radio, capacitive, rotary, or resistive position sensors.

0114 Preferably, the control system is configured to automatically switch the hydraulic circuit to the idle state when the clamp reaches the open position and the extraction phase is not activated. The fastener extractor therefore preferably includes a clamp position sensor configured to indicate a position of the clamp, i.e. open, closed or somewhere in between.

0115 As with the material separator position sensor, the clamp position sensor is preferably a limit switch or other mechanical switch, but may take any other suitable form, e.g. optical, radio, capacitive, rotary, or resistive position sensors.

0116 Preferably, the control system is configured to switch the hydraulic circuit to the idle state when the clamp position sensor indicates the clamp is in the open position and an extraction phase is not activated.

0117 Preferably, the hydraulic circuit includes an emergency cut-off valve, operable to stop hydraulic fluid flow in the hydraulic circuit. An emergency activation switch, button or equivalent control is preferably accessible by an operator for activating the cut-off valve.

0118 A hydraulic circuit with hydraulic drives is used in applications requiring high enough loads on the drives to remove embedded nails from a wooden post. Thus, reference herein is made to the use of hydraulics for the components. However, it will be appreciated that equivalent pneumatic, mechanical and/or electronic components may be used if the resultant extractor can provide sufficient force for extraction of for use in other applications where such high loads are not required.

0119 Preferably, the fastener extractor includes a support platform for supporting fastener extractor components, including the clamp, separator and/or other components. Preferably, the support includes a table, plate, or other surface upon which the components may be mounted.

0120 Preferably, the support includes one or more material supports, the material supports being adjustable to adjust the position of the material relative to the clamp. The material supports can be adjusted to suit different sized and shaped material, e.g. a ‘full-round’ wooden post (with circular cross-section) will have a diameter that is typically twice the radius of a ‘quarter-round’ post, being one quarter of a ‘full-round’. The height adjustment thus allows the fastener extractor to be used for full-round, half-round and quarter-round posts.

0121 Alternatively, material supports may be omitted and the operator may simply hold the post in position with the fasteners located in the clamp.

0122 Preferably, where the clamping members are aligned horizontally, the material supports are height adjustable.

0123 Preferably, material supports are included for positioning the material at a predetermined separation from the clamp. Such material supports can be used to push the material up against the clamp to ensure alignment.

0124 Extraction operations are generally performed on one type of post at a time, i.e. processing 1000 full-round posts and then 1000 quarter-round posts. Thus, the material supports are preferably

detachable so that they are only attached when needed, preventing them interfering with the operation when not required.

0125 It will be appreciated that the extractor contains multiple relatively moving parts, capable of rapid movement and high force loadings. These movements present a danger to an operator who may place body parts in the clamp, between separator and material or in other parts of the extractor. A safety shroud, housing or the like is therefore preferably provided to cover the operating components, where feasible.

0126 As the fasteners are extracted, they may drop and interfere with subsequent extraction operations. Therefore, preferably the fastener extractor includes an extracted fastener guide for guiding the extracted fasteners away from the clamping members.

0127 In one embodiment, the extracted fastener guide includes a chute, ramp, aperture or other guide located beneath or adjacent the clamping members, such that extracted fasteners fall onto the extracted fastener guide and are guided away from the clamping members, e.g. to a container for storage.

0128 Reference herein is made to various aspects and embodiments of the present invention. For clarity, and to avoid prolixity, every possible combination, iteration or permutation of features, aspects and embodiments are not described explicitly. Thus, it should be appreciated that the disclosure herein includes any combination, iteration, multiple or permutation unless explicitly and specifically excluded.

0129 The order in which aspects, embodiments, features or descriptions occur in this description should not be interpreted to necessarily require the preceding aspects, embodiments, features or descriptions.

Brief Description of Drawings

0130 Further aspects and advantages of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

Figure 1 shows a wooden post with fasteners attached and a fastener extractor according to one preferred embodiment of the present invention, the fastener extractor clamp being in an open position;

Figure 2 shows the fastener extractor of Figure 1 with the clamp in a clamping position;

Figure 3 shows the fastener extractor of Figures 1 and 2, with material-engaging portions extended to an ‘end’ position;

Figure 4 shows a rear view of the fastener extractor of Figures 1-3;

Figure 5 shows a cross-section of the fastener extractor through section A-A as shown in Figure 3;

Figure 6 shows the fastener extractor of Figures 1-5 with the post positioned ready for fastener extraction;

Figure 7 shows the fastener extractor of Figures 1-6 with the clamp closed, gripping the fasteners;

Figure 8 shows the fastener extractor of Figures 1-7 with the clamp closed and the fasteners extracted from the post;

Figure 9 shows the fastener extractor of Figures 1-7 enclosed in its safety housing in the idle state;

Figure 10 shows the fastener extractor of Figure 9, with the clamp closed and material engaging portions fully extended.

Figure 11 shows an exemplary fastener in the form of a wire clip nailed to a wooden post;

Figure 12 shows a hydraulic circuit and control system for use with the fastener extractor for Figures 1-10;

Figure 13a shows a simplified schematic diagram of the clamp arrangement of the extractor of figures 1-10;

Figure 13b shows a simplified schematic diagram of the separator arrangement of the extractor of figures 1-10;

Figure 14 shows a simplified schematic diagram of an alternative embodiment of an extractor with a different clamp arrangement to the embodiment of figures 1-10;

Figure 15 shows a simplified schematic diagram of an alternative embodiment of an extractor with a different separator arrangement to the embodiment of figures 1-10;

Figure 16a shows a simplified schematic diagram of the clamp arrangement of the extractor of figures 1-10 for use with a different post shape;

Figure 16b shows a simplified schematic diagram of the separator arrangement of the extractor of figures 1-10 for use with a different post shape;

Figure 17 shows a prior art fastener extractor described in US 7,658,368 by *Laun*;

Best Modes for Carrying out the Invention

0131 Although specific advantages have been enumerated above, various embodiments may include some, none, or all, of the enumerated advantages.

0132 Other technical advantages may become readily apparent to one of ordinary skill in the art after review of the following figures and description.

0133 It should be understood at the outset that, although exemplary embodiments are illustrated in the figures and described below, the principles of the present disclosure may be implemented using any number of techniques, whether currently known or not. The present disclosure should in no way be limited to the exemplary implementations and techniques illustrated in the drawings and described below.

0134 Unless otherwise specifically noted, articles depicted in the drawings are not necessarily drawn to scale.

0135 Modifications, additions, or omissions may be made to the systems, apparatuses, and methods described herein without departing from the scope of the disclosure. For example, the components of the systems and apparatuses may be integrated or separated. Moreover, the operations of the systems and apparatuses disclosed herein may be performed by more, fewer, or other components and the methods described may include more, fewer, or other steps. Additionally, steps may be performed in any suitable order. As used in this document, “each” refers to each member of a set or each member of a subset of a set.

Drawing Reference Table

1	Fastener Extractor	31a, 31b	Sequencing valves
2	Wooden Post	32	Flow divider
3	Fastener	33	Activation switch
4	Nail	34	Separator limit switches
5	Clamp	35	Clamp limit switch
6a, 6b	Clamping members	36	Pump motor
7a, 7b	Fastener engaging surfaces	37	Return line
8	Clamp drives	38	Fastener guide slot
9a, 9b	Separator mechanisms	39	Material engaging portion start position
10a, 10b	Separator drives	40	Material engaging portion end position
11a, 11b	Separator material-engaging portions	41	Material engaging portion offset
12	Hydraulic circuit	42	Clamp drive upper clamp pivot point
13	Control system	43	Clamp drive lower clamp pivot point
14a	Wear strips	44	Material supports

14b			
15a 15b	Clamping member plates	45	Valve Cartridge
16a, 16b	Guides	46	Drain Line
17a, 17b	Guide Slots	47	Cut-off valve
18a, 18b	Guide brackets	48	Cut-off switch
19	Housing	49	Filter
20	Clamp axis	50	Material engaging portion bolts/pivot axes
21	Support brackets	100	Clamp second embodiment
22	Clamp pivot bolts	200	Separator second embodiment
23	Support brackets	51	Clamping region
24	Clamp drive piston rod	52	Clamping length
25	Support platform		
26	Separator drive piston rods		
27	Electronic Circuit		
28	Reservoir		
29	Pump		
30	Directional valve		

0136 Figures 1-10 show a fastener extractor 1 according to one preferred embodiment.

0137 Figures 9 and 10 show the fastener extractor enclosed in housing 19 while Figures 1-8 have had the housing 19 omitted so that the internal componentry is visible.

0138 The fastener extractor is shown in an ‘open’ position in Figs ,1, 6, 9 and 13a. The fastener extractor is shown in a ‘clamping’ position in Figs 2-5, 7-8, 10 and 13b.

0139 The clamping’ position shown in the drawings shows the clamping member fastener-engaging surfaces 7a, 7b touching as if fasteners are not present therebetween. However, it should be noted that in use the fasteners 3 are present between the fastener-engaging surfaces 7a, 7b and the surfaces 7a, 7b will not be touching - unless the fasteners 3 have been completely severed. The ‘clamping’ position will thus also change with the thickness of the fasteners 3.

0140 Thus, reference herein to the ‘clamping’ position should not be construed as a fixed position or relative orientation, but rather a relative state determined by the clamping force applied, i.e. being closed sufficiently to clamp the fasteners 3 with sufficient force.

0141 The fastener extractor 1 is used to simultaneously extract multiple fasteners distributed over a length of a material to which the fasteners are affixed. In figures 1-7 the material is in the form of a wooden vineyard post 2 and the fasteners are plastic clips 3, secured to the post 2 via nails (not shown in figs 1-7).

0142 Figure 11 shows an enlarged view of a plastic clip 3 with securing nail 4. Other clips may also be attached via staples or screws. The fastener extractor 1 can extract the clips regardless of whether nails, screws or staples are used. The fastener extractor may also be used for extracting protruding nails or staples without corresponding clips.

0143 Figures 1-10 show a preferred embodiment of the present invention, in the form of a fastener extractor 1.

0144 The fastener extractor 1 has a clamp 5 formed from a pair of elongate clamping members 6a, 6b.

0145 The clamping members 6a, 6b are capable of relative movement between an open position (shown in Figures 1 and 6) and a clamping position (shown in Figures 2-5 and 7).

0146 Each clamping member 6a, 6b has a corresponding fastener-engaging surface formed as an elongate edge 7a, 7b. The fastener-engaging surfaces 7a, 7b collectively form a pair of mutually opposing fastener-engaging surfaces.

0147 A pair of powered actuators are provided in the form of clamp drives 8a, 8b (see Figure 4). The clamp drives (8a, 8b) are occluded by the clamp in figures 1-3. Both drives 8a, 8b are shown in figure 4. The clamp drives 8a, 8b are double-acting hydraulic actuators or other drives capable of reciprocating movement.

0148 The clamp drives 8a, 8b are capable of retracting to move the clamping members (6a, 6b) together to the clamping position and extending to move the clamping members 6a, 6b apart to the open position.

0149 The pair of fastener-engaging surfaces 7a, 7b are configured to engage with any post fasteners 3 located therebetween, thereby gripping /clamping the fasteners 3. This closed clamp state is shown in figure 7 which also shows the occluded side of the post 2 and fasteners 3 in phantom.

0150 The extractor 1 also includes a separator formed from two separator mechanisms 9a, 9b. Each separator mechanism includes a corresponding reciprocating material-engaging portion 11a, 11b. The material-engaging portions 11a, 11b are each coupled to a corresponding separator drive 10a, 10b. The separator drives 10a, 10b are double-acting hydraulic actuators, similar to the clamp drives 8a, 8b.

0151 The separator drives 10a, 10b reciprocate the material-engaging portions 11a, 11b between start and end positions to move the post 2 relative to the clamping members 6a, 6b.

0152 An elongate ‘clamping region’ 51 is defined by the volume bound by the extents of the mutually opposing fastener-engaging surfaces 7a, 7b, when in the clamping position. A ‘clamping’ length 52 of the clamping region 51 is defined by the extent of the clamping region 51 orientated

approximately perpendicular to the clamping force F and approximately parallel with the distribution of the set of multiple fasteners 3 affixed to the length of material 2.

0153 The extractor 1 is mounted to a support table 25, upon which the post 2 can be positioned adjacent the clamp 5.

0154 The housing 19 provides an enclosure to reduce detritus ingression into the mechanisms while also providing a safety guard to prevent operators from injuring themselves by placing their hands into the internal working parts of the extractor 1. The material-engaging portions 11a, 11b, are also enclosed for safety and to minimise the number of pinch points accessible to the operator.

0155 A hydraulic circuit 12 is shown in Figure 12 and includes each drive 8a, 8b, 10a, 10b. The hydraulic fluid lines are not shown in Figures 1-10 for clarity but correspond to the circuit shown in Figure 12.

0156 The extractor 1 is particularly useful for removing the multiple plastic clip fasteners 3 that are used on wooden vineyard posts 2. As mentioned in the background art, some vineyard trellising systems use wooden posts that have a series of plastic clips nailed, screwed or stapled to the post. The clips 3 support trellis wires that in turn support the grape vines.

0157 During vineyard operations of pruning, post-pruning, spraying, harvesting or other mechanized operations, it is possible for a harvester or tractor to strike a post 2 and break the post 2 off at a point adjacent the ground. These broken posts 2 must be removed and replaced with a new post.

0158 The broken posts 2 are a waste product and must be disposed of, which represents a cost to the vineyard operation. The broken posts 2 are shorter than when unbroken but can still be recycled for different uses. However, the plastic clips and nails retained on the recycled posts are an impediment for use in many applications.

0159 Prior art extractors are typically used in removing nails from wood for the purpose of then disposing or recycling of the wood without the metal nails contaminating the wood. Nails in most prior art use cases are embedded in the wood, without any portion protruding significantly. The prior art therefore typically includes sharp claws or other members capable of digging into the wood to slide under the nail head. The claw is then pulled away from the wood to extract the nail by the claw pulling the nail head.

0160 Alternatively, the nails must be manually hammered from the acuminated end until the opposing nail head protrudes enough for an encircling portion to encircle the nail beneath the nail head, thereby enabling the portion to be pulled away from the material, pushing on the nail head and removing the nail.

0161 Vineyard posts have clips with nails that inherently protrude. However, the heads of the nails are located distal to the post and are recessed in the clip. It's therefore not practical to use prior art extractors to encircle the nail below the nail head. Prior art extractors may also not be large enough to position the claw between the clip and post. Prior art extractors are also inherently only capable of removing one nail at a time.

0162 The present fastener extractor 1 has therefore been devised to overcome these problems by

a) applying a clamping force to the fastener 3, rather than relying on pulling on a nail head or hooking a staple, and

b) simultaneously removing multiple fasteners.

0163 The method of operation is best exemplified by the transition between figures 6 to 8.

0164 Figure 6 shows a setup phase wherein an operator has positioned a post on the support platform 25 adjacent the clamp 5 such that the fasteners 3 are positioned between the clamping member edges 7a, 7b. The clamp 5 is in an open position and the separator material engaging portions 11a, 11b are in their 'start' positions as indicated by dashed line 39.

0165 The operator then activates an extraction phase to close the clamp 5 and extract the fasteners 2.

0166 In the extraction phase the clamp drives 8a, 8b retract, thereby moving the clamping members 6a, 6b to the clamping position, as shown in figure 7.

0167 The fasteners 3 are thereby gripped by the clamping member edges 7a, 7b. The force applied to the clamping members 6a, 6b is sufficient for the edges 7a, 7b, to grip the fasteners 3, but not such that the fasteners and nails are severed.

0168 The separator drives 10a, 10b are then activated by the hydraulic circuit 12 to move the material engaging portions 11a, 11b, toward the post 2, which engage with the post 2 to push the post 2 away from the clamping members 6a, 6b. The material engaging portions 11a, 11b move a distance to their 'end' position indicated by dashed line 40, as shown in Figures 3 and 8. Figure 8 shows the fasteners 3 extracted.

0169 The hydraulic circuit 12 maintains pressure at the clamp drives 8a, 8b throughout this relative movement, to ensure that a clamping force is applied to the fasteners 3 as the material engaging portions 11a, 11b push the post 2 away from the clamping members 6a, 6b. The relative movement of the post 2 and clamping members 6a, 6b thus results in the fasteners 3 being extracted from the post 2 along with their securing nails 4.

0170 The material engaging portion end positions 40 need to be a sufficient distance from their start position 39 such that the relative movement between clamping members 6a, 6b and post 2 is

sufficient to extract the fasteners and nails. This relative movement distance for typical vineyard clips is about at least 75mm, i.e., being the typical embedded length of the nails used.

0171 Separator position sensors are provided in the form of separator limit switches 34 that are coupled to each material-engaging portion 11a, 11b. The separator limit switches 34 are plunger type switches with a plunger portion extending forward toward the post 2. Other sensor types may also be used. However, the operating environment is typically very dirty, with dust, wood chips, smoke and other detritus potentially interfering with other sensors. Mechanical limit switches are also relatively inexpensive and simple to maintain.

0172 The clamp 5, separator mechanisms 9a, 9b and associated components are located within the housing 19 (shown in Figures 9 and 10) that includes internal side walls with protrusions (not visible) located in the path of travel of the corresponding separator limit switch 34, such that when the material-engaging portions 11a, 11b move to their end positions, the plungers of the separator limit switches 34 contact the protrusions and are activated.

0173 If either separator limit switch 34 is activated, it sends a signal to trigger a redirection of hydraulic fluid pressure in the relevant parts of hydraulic circuit 12. The end position 40 can thus be controlled by the separator limit switch 34 position. The 'stroke length' of the material-engaging portions 11a, 11b can be changed by adjusting the separator limit switch 34 position on the material-engaging portion 11a, 11b.

0174 Other limit switch types or position sensors may be used for determining the end position and triggering a reset phase of the hydraulic circuit 12.

0175 The separator limit switches 34 may be attached to the housing for contacting a protruding part of the separator mechanisms 9a, 9b that move with the material-engaging portions 11a, 11b, rather than vice versa - as is shown in the figures.

0176 In a 'reset' phase, the hydraulic circuit 12 is configured to automatically return the material-engaging portions 11a, 11b to their start position 39 and the clamping members 6a, 6b to the open position.

0177 A clamp limit switch 35 is mounted to a portion of the frame about which the upper clamping member 6a pivots. The clamp limit switch 35 is of the same type as the separator limit switches 34 and is positioned to define an open position of the clamp 5. The control system 13 is configured to place the circuit 12 to an idle state when the clamp limit switch 35 is activated.

0178 The limit switches 34, 35 may be in a normally open or normally closed state depending on how the electronic circuit is configured.

0179 There is considerable wear imparted on the fastener engaging edges 7a, 7b as they repeatedly grip the fasteners 3 with sufficient force to hold the fasteners 3 during the post-clamp relative movement. The fastener engaging surfaces are therefore provided as elongate edges 7a, 7b formed on hardened steel wear strips 14a, 14b that are welded to steel plates 15a, 15b. As wear occurs, the wear strips 14a, 14b can be dressed to return them to a continuous flat surface. However, after being dressed too many times, the separation between edges 7a, 7b may increase in the clamping position to such an extent that the clamp no longer clamps the fasteners effectively. Therefore, the lower clamping member 7b is adjustable to change the separation distance of the edges 7a, 7b in the clamping position, thereby compensating for such wear.

0180 It will be appreciated that the clamping member edges 7a, 7b could be provided as discontinuous surfaces, such as a series of teeth or other opposing surfaces. However, such an arrangement presents the disadvantage that fasteners 3 could become caught in any discontinuity between teeth or there may be significantly unequal force applied to different fasteners 3 over the length of the post 2, and some fasteners 3 may not be gripped sufficiently. A continuous edge is thus preferable and preferably approximately straight.

0181 The clamping member edges are flat and about 7mm in width, being the thickness of readily available hardened steel plate and sufficient to prevent the fasteners 3 being severed by the edges 7a, 7b, i.e., if the edges are too thin. Moreover, edges that are too thin may overlap and behave like scissors, potentially severing the fasteners 3 and nails 4 or imparting additional wear on the pivot bolts 22 and associated bushings.

0182 It can be advantageous to use wider edges 7a, 7b that could provide a higher friction contact with the fasteners, and therefore provide better gripping during extraction, and thus a thicker hardened steel plate could be used to achieve such wider edges 7a, 7b. However, cost and convenience are likely to dictate what steel plate is used for the wear strips 14a, 14b and therefore edge 7a, 7b thickness.

0183 It will be appreciated that it's desirable for the post-clamp relative movement to be coincident or parallel to the longitudinal direction of the nails (or staples) that affix the fasteners 3 to the post 2 so that the nails are pulled straight out along their axis, and not bent. Excessive pivoting movement is thus undesirable.

0184 The separator material-engaging portions 11a, 11b are thus located adjacent distal ends of the clamping length 52. The material-engaging portions 11a, 11b engage longitudinally separated portions of the post 2 and the separator drives 10a, 10b are synchronised to move together simultaneously. Thus, the entire post 2 is moved away from the clamping members 6a, 6b with minimal pivoting movement.

0185 In use there may be more fasteners 3 attached to the post 2 than can be accommodated in the clamping region 51. Any fasteners 3 located beyond the extents of the clamping length 52 may interfere with the material-engaging portions 11a, 11b and cause the post 2 to pivot, rotate or otherwise misalign relative to the clamp 5. The material engaging portions 11a, 11b are therefore offset from the fastener-engaging edges 7a, 7b when in the 'start' position 39. This offset is indicated in figure 2 as reference number 41 and is about 20mm from the material-facing surface, at least for typical vineyard post clips.

0186 Any clip 3 that protrudes toward a material engaging portion 11a, 11b does not contact that portion 11a or 11b as the post 2 is positioned and clamp 5 is closed. The offset 41 can be adjusted to suit different sized fasteners 3.

0187 Each material engaging portion 11a, 11b is mounted to a corresponding guide 16a, 16b formed as a pair of slots 17 in a pair of guide brackets 18.

0188 The material-engaging portions 11a, 11b need to be able to engage with and move the posts 2 relative to the clamp 5. However, the posts 2 to which the fasteners 3 are attached are usually not perfectly regular or uniform and may be formed as full-round, half-round or quarter round posts. It may be relatively simple to guide material-engaging portions 11a, 11b with a flat face to engage with a corresponding flat face of a quarter-round or half-round post. However, full-round posts 2 present a curved surface to the material-engaging portions 11a, 11b and thus a flat face of a material-engaging portion 11a, 11b will only engage with a point on the circumference of the full-round post. This relatively small point of contact may place undue strain on the material-engaging portions 11a, 11b if the material-engaging portions 11a, 11b are not aligned to move in a direction along a radial line of a round post 2.

0189 Moreover, reactive forces may be imparted to the material-engaging portions 11a, 11b during the material-clamp relative movement as a result of pushing on the post 2. The reactive forces may apply torque, rotation or bending of the material-engaging portion 11a, 11b relative to the guide slots 17 and brackets 18. Such movements may cause wear or damage on the material-engaging portions 11a, 11b and/or guides 16.

0190 To ameliorate this problem the material-engaging portions 11a, 11b are pivotably attached to the guide 16 via pivot bolts 50 that travel within the corresponding slots 17. The separator material engaging portions 11a, 11b are therefore able to pivot about the bolt 50 axis relative to the corresponding guide 16 and drive 10a, or 10b. Similarly, the opposing end of each separator drive 10a, 10b is pivotally attached to the support platform 25 to enable the entire drive 10a, 10b to pivot, if necessary, thereby preventing bending damage to the drive 10a, 10b.

0191 Alternatively, differently shaped interchangeable material-engaging portions 11a, 11b may be provided to specifically engage with each type of post shape. However, this would add complexity and cost.

0192 The clamping members 6a, 6b are pivotable about a clamp axis 20. The lower clamping member 6b is mounted to the support and remains stationary relative to the support platform 25. The upper clamping member 6a is pivotally mounted to the support platform 25 via bolts 22 coupled to corresponding support brackets 21.

0193 Structural framing plates and ribs 23 are provided connecting the upper clamping member 6a to the pivot axis 20 at bolts 22. Significant torque is applied because of the clamping action and the connection between the upper clamping member 6a needs to be correspondingly robust.

0194 The upper clamping member 6a is pivotable about at least two coaxial pivot points 22 along the pivot axis 20 to prevent significant pivoting of the upper clamping member about an axis perpendicular to the pivot axis 20. A single pivot attachment could be used but would need to be long enough to prevent pivoting of the upper clamping member about an axis perpendicular to the pivot axis 20.

0195 Pivoting of the either clamping member 6a, 6b about an axis perpendicular to the pivot axis 20 will potentially result in an uneven clamping of fasteners 3 and could lead to damage of the extractor 1.

0196 The two hydraulic clamp drives 8a, 8b are provided to generate the pivoting movement of the upper clamping member 6a. As shown most clearly in figure 4, the clamp drives 8a, 8b each have a piston rod 24a 24b that extends from a corresponding cylinder. The clamp drives 8a, 8b are pivotally attached to the upper clamping member 6a at pivots 42. The opposing ends of the clamp drives 8a, 8b are pivotally attached to the support platform 25 at pivots 43 (only right-hand pivot 43 visible).

0197 The location of the piston rod attachments 42 to the clamping member 6a is important as it determines the:

a) Rod travel distance (stroke length) required to move the clamping member 6a between open and clamping positions, i.e. the closer the attachment point is to the clamp pivot axis 20, the smaller the rod travel distance between open and clamping positions. A shorter stroke length results in a shorter open-close time for a given piston speed.

b) Force required to close and open the clamping members 6a, 6b, i.e. the force required from the clamp drive 8a, 8b decreases with increasing distance from the clamp pivot axis 20.

0198 The clamp drive 8 piston rods are attached to the upper clamping member 6a at a point approximately half-way between the clamp axis 20 and the clamping member edge 7b. This 'halfway' position provides an optimum balance between stroke length and force requirement for the hydraulic clamp drives 8a, 8b used.

0199 As the fasteners 3 are extracted, they may drop from the clamp 5 and interfere with subsequent extraction operations. Therefore, the fastener extractor 1 includes an extracted fastener guide provided in the form of open guide slot 38 located beneath the clamp 5. The extracted fasteners 3 are released from the clamp 5 when the upper clamping member 6a opens sufficiently. The fasteners 3 therefore drop down and into the slot 38. A container, conveyor or chute can be positioned under the slot 38 for receiving the fasteners 3. The fasteners 3 can have their nails/screws/staples removed and then be re-used if they have not been damaged excessively or recycled.

0200 A schematic diagram of the hydraulic circuit 12 and control system 27 is shown in Figure 12. Connections of intersecting lines are indicated by a dot at the connection. Intersecting lines without such a dot are not connected.

0201 The hydraulic circuit 12 includes:

- fluid reservoir 28,
- pump 29,
- directional solenoid valve 30,
- sequencing valves 31a, 31b,
- flow divider 32
- clamp drives 8a, 8b, and
- separator drives 10a, 10b.

0202 The control system 13 includes an electronic circuit connected to:

- activation switch 33,
- separator limit switches 34
- clamp limit switch 35
- directional valve 30

0203 In operation, the pump 29 is powered by a motor 36. Hydraulic fluid flows from the reservoir 28, to the pump 29 and to the inlet port P of the directional valve 30.

0204 The directional valve includes:

- inlet port (P),
- two outlet ports (A, B);
- return port (T).

0205 Such a directional valve includes two solenoid valves operable to set the directional valve in the following states:

Forward: P -> A, B and T closed

Reverse: P -> B, A and T closed

Idle: P -> T, A and B closed

0206 Sequencing valves 31a, 31b each include an input port 31a-1 / 31b-1 and two output ports 31a-2 /31b-2 and 31a-3 / 31b-3. Two corresponding threshold valves in each sequence valve 31a, 31b open to permit fluid flow to each outlet port 31a-2 /31b-2 and 31a-3 / 31b-3 upon threshold pressures being exceeded.

0207 The first sequencing valve 31a has a first valve controlling fluid flow to port 31a-2 when a set threshold pressure is exceeded, e.g., 1200psi. The second valve of the sequencing valve 31a is set at a higher threshold e.g., 1500psi, and permits fluid flow to the second outlet port 31a-3 when that pressure (1500psi) is exceeded.

0208 With respect to Figure 13, the clamping members 6a, 6b are dimensioned to be about 300mm from the pivot axis 20 to the clamping member edges 7a, 7b.

0209 The clamp drives 8a, 8b, have cylinders with a bore of 50.8mm and a rod diameter of 25.4mm, i.e., 2” and 1” respectively. On the rod side (retracting), the effective piston area is about 5.067^{-4} m^2. At 1500psi (about 10.34MPa) the clamp drives 8a, 8b thus provide about 15.7kN of retraction force each.

0210 The distance from the clamp drive upper clamp pivot point 42 to the clamping member pivot axis 20 is about 120mm and so the clamp drives apply about 1.88kNm of torque to the clamping members 6a, 6b.

0211 The distance between clamping member axis 20 and the fastener engaging surface 7a is about 0.3m. Thus, the clamping force applied to the fasteners at a hydraulic pressure of 1500psi is about 6.28kN per drive.

0212 The separator drives 10a, 10b are of a similar type to the clamp drives 8a, 8b but have a longer stroke length. The separator drives 10a, 10b are extending when in the extraction phase and thus fluid applied to the cylinder side at 1500psi. This results in the separator drives 10a, 10b applying about 20.9kN of pushing force to the post 2.

0213 The fastener extractor 1 has a full operational cycle including ‘extraction’ and ‘reset’ phases and an ‘idle’ state.

0214 Referring now to Figure 12.

0215 In an initial start-up phase, the motor 36 is started and pump 29 therefore starts pumping hydraulic fluid from the reservoir/tank 28 to the pressure port P of the directional valve 30.

0216 The circuit 12 is initially in the idle state with both solenoids of the directional valve 30 being unpowered and the directional valve 30 thereby only permitting fluid flow to the return port T. The directional valve 30 in this embodiment is a double solenoid CETOP 3 hydraulic directional control valve. It will be appreciated that other directional valves can be used with equivalent functionality.

0217 Idle State

0218 In the idle state, the motor 36 and pump 36 circulates fluid through the directional valve 30 and back to the reservoir 28. There is no significant load on the pump and so energy use is minimised in this state.

0219 The control system 27 is connected to the activation switch 33. In use, with the circuit in the idle state, the operator positions the post 2 in place and then closes the activation switch 33 to switch the circuit to start the extraction phase. The activation switch 33 is ideally a foot-operated pedal as the operator will have both hands holding the post 2 in position. The activation switch 33 is also a ‘dead-man’s’ switch that automatically opens if the user is not applying pressure to the switch 33. If the operator releases the switch 33, the circuit 12 immediately returns to the idle state.

0220 Extraction phase

0221 In the extraction phase the electronic circuit 27 is configured to provide power to a first solenoid of the directional valve 30 to permit fluid flow between inlet port P and outlet port A.

0222 Fluid is thus able to flow from port A of the directional valve to the input port 31a-1 of the first sequencing valve 31a.

0223 Upon activation, the first solenoid is activated and fluid flows from pump 29 through to the sequencing valve 31a via directional valve 30. Pressure rises until it exceeds the first threshold pressure (1200psi) at which time the sequencing valve 31a opens to permit fluid flow from inlet port 31a-1 to outlet port 31a-2. Fluid flows to the clamp drives 8a, 8b causing them to retract, and thereby close the clamp 5.

0224 In this extraction phase the hydraulic fluid flows into retraction ports 8a-2, 8b-2 of the clamp drives 8a, 8b, thereby causing the piston rods 24 to retract into the cylinder. As the clamp drives

8a, 8b retract, the clamp 5 is moved to the clamping position by pivoting the upper clamping member 6a. The fasteners 3 are thereby clamped by the fastener-engaging edges 7a, 7b of the clamping members 6a, 6b.

0225 As the clamp 5 applies clamping force to the fasteners 3, the pressure between the pump 29 and clamp drives 8a, 8b increases until the second threshold pressure (1500psi) is exceeded, at which time the sequencing valve 31a second valve opens and permits fluid flow through the second outlet port 31a-3.

0226 The second outlet port 31a-3 is connected to the flow divider 32, in turn connected to extension ports 10a-1, 10a-1 of separator drives 10a, 10b respectively. The fluid flow to the separator drives 10a, 10b, results in the corresponding piston rods 26 extending. The material-engaging portions 11a, 11b, being mounted to the piston rods 26, thus extend to engage with and push the post 2 away from the clamp 5.

0227 The flow divider 32 is provided to equalize the pressure between the two separator drives 10a, 10b, thereby ensuring they extend at the same rate and with the same force. Without such a flow divider 32, there is potential for asynchronous extension, resulting in one end of the post 2 being pushed before the other end.

0228 The separator drives 10a, 10b continue to extend until one of the separator limit switches 34 is triggered, indicating the material-engaging portions have reached their ‘end’ position.

0229 The control system 13 is configured to switch the circuit 12 to the reset phase when a separator limit switch 34 is closed. Thus, when the material-engaging portions reach the end position, the reset phase is automatically triggered, without requiring user intervention.

0230 Reset phase

0231 In the reset phase, the electronic circuit 27 is configured to provide power to the second solenoid of the directional valve 30 and thereby permit fluid flow from inlet port P to outlet port B and block fluid flow to return port T and outlet port A. Fluid then flows to the inlet port 31b-1 of the second sequencing valve 31b.

0232 The second sequencing valve 31b is set with a first threshold pressure (1200psi) controlling fluid flow to outlet port 31b-2. Fluid flows to first outlet port 31b-2 when this first threshold pressure is exceeded. The 1200psi is a minimum pressure required to rapidly retract the separator drives 10a, 10b.

0233 The first outlet port 31b-2 of the second sequencing valve 31b is connected to the retraction ports 10a-2/10b-2 of the separator drives 10a, 10b. The separator drives 10a, 10b thus retract to return the material-engaging portions 11a, 11b, to their start position. A retraction flow divider may

optionally be provided to ensure simultaneous retraction, though this is not as important as ensuring simultaneous extension.

0234 At the start position, the separator drives 10a, 10b can retract no further and the pressure in the second sequencing valve 31b rises. The second outlet port 31b-3 of the second sequencing valve then opens when the pressure exceeds the second threshold pressure (1500psi) and fluid flows to extension ports 8a-1, 8b-1 of the clamp drives 8a, 8b causing them to extend to open the clamp 5.

0235 The clamp drives 8a, 8b continue to extend until the clamp limit switch 35 is closed.

0236 The control system 13 is configured to cut power to both solenoids when the clamp limit switch 35 is closed, thereby switching the circuit into the idle state. The clamp limit switch 35 is thus positioned to determine the maximum allowed extension of clamp drives 8a, 8b, and therefore the 'open' position of the clamp 5.

0237 In the idle state the clamp 5 is open and separator material-engaging portions 11a, 11b are at their start positions, ready for the next extraction phase.

0238 The sequencing valves 31a and 31b are mounted to a common cartridge block indicated by dashed box 45. The cartridge block 45 provides a robust mount for the valves 31a, 31b and includes:

- inlet ports connected to the outlet ports A, B of the directional valve 30 and fluid passages connected to corresponding sequence valve inlet ports 31a-1, 31b-1, and
- outlet ports connected to the clamp drives 8a, 8b and flow divider 32, with corresponding passages to the sequence valve outlet ports 31a-2, 31a-3, 31b-2, 31b-3, and
- drain port, connected to a drain line 46 that is connected to the reservoir 28.

0239 An in-line filter 49 is provided to remove contamination from the hydraulic fluid as it circulates.

0240 An emergency cut-off valve 47 is connected in-line between the pump 29 and directional valve 30. The emergency cut-off valve 47 is a normally open solenoid valve that when activated cuts fluid flow between pump 29 and directional valve inlet port P. The cut-off valve 47 thus ensures that an operator, or other person, can quickly cut fluid flow to the directional valve 30 and drives 8a, 8b and 10a, 10b. The valve 47 is activated by a cut-off switch 48 which also switches off power to the motor 36 when activated. Alternative or supplementary emergency deactivation systems may also be incorporated.

0241 It is possible for the reservoir 28, pump 29 and/or motor 36 to be provided as part of an external hydraulic power system, such as Power Take Off (PTO) systems such as provided on tractors or other vehicles. The directional valve inlet port P may, for example, be connected directly to a quick-connect hydraulic coupling on such a system. However, such couplings are often dirty and

the hydraulic fluid in those systems may contain detritus or other material that block or interferes with the sequencing valves 31a, 31b, or other parts of the circuit 12. An in-line filter may be installed to ameliorate this problem, but the lifetime of such a filter is likely to be very short given the operating environment using such external power systems.

0242 Thus, in the preferred embodiments, the circuit 12 is formed as a 'closed' circuit, without requiring a fluid connection to an external pump. It is therefore far less likely that detritus can enter the circuit 12 and interfere with the operation.

0243 The forces required by the clamp drives 8a, 8b and separator drives 10a, 10b may be significant and while a large pump and/or high-power output motor can be used, the energy requirements can be high. It is therefore desirable to minimise the pump and motor sizes.

0244 It is also undesirable for the clamp 5 to close too rapidly, as this will cause impact forces on the components and fasteners 3, potentially damaging components and severing the fasteners 3.

0245 Similarly, a separator 9 that operates with an excessive rapid movement may eject the post 2 with such force that it is a hazard to the operator or equipment.

0246 However, the speed of the operational cycle needs to be maximised within safety and reliability constraints to ensure rapid extraction of fasteners 3. An optimal balance is thus desirable between minimum cycle time for the operation while preventing excessively rapid drive movements and minimising energy usage.

0247 The hydraulic circuit 12 arrangement is such that it:

a) provides sufficient pressure to clamp drives 8a, 8b to close the clamp 5 with sufficient force to hold the fasteners 3 securely;
b) minimises the time between the clamp 5 closing with said sufficient force and the separator drives 10a, 10b extending to push the post 2 away from the clamp 5.
c) opens the clamp 5 and return the separator drives 10a, 10b to their start position with minimal time ready for the extraction phase to repeat.

0248 As mentioned previously, the locations of the clamp drive connections to the clamping members 6a, 6b minimises the open-close time while still providing sufficient clamping force.

0249 The automatic switching between forward-reverse-idle states ensures minimal operator input is required and minimal potential for delays in the cycle. The operator may simply start the operation cycle by pressing the activating switch 33 and release when they wish to stop the process at any stage.

0250 Adjustments can be easily achieved by changing the thresholds of the sequencing valves to suit different applications or motor-pump combinations.

0251 The motor 36 and pump 29 used also affect the operational cycle time and power provided.

0252 Larger motors are more powerful and can provide greater flowrates but are also typically more expensive to purchase and operate than smaller motors. Larger pumps can provide larger flow volumes but are also typically more expensive and require a larger motor.

0253 An optimal balance of motor and pump is desirable that maximises speed and minimises energy use while still providing sufficient pressure for the drives 8, 10 to operate effectively.

0254 Thus, in preferred embodiments the motor is configured to operate at a constant low RPM (less than 2000rpm). The motor 36 is a thirteen-horsepower motor and the pump 29 has a capacity of 8cc. This combination provides for sufficient power and speed while having relatively small energy and cost requirements.

0255 It will be appreciated that alternative hydraulic circuits may be used with varying valve types and control systems, subject to being capable of performing the same functions as the hydraulic circuit 12.

0256 Equivalent electronic, pneumatic and/or mechanical systems could also be used, though hydraulic circuits are typically more efficient for high-load applications such as removing fasteners.

0257 It will be appreciated that the functionality of the hydraulic circuit 12 may also be achieved by replacing or supplementing the sequencing valves 31a, 31b with solenoid valves connected to the electronic control system and further including pressure sensors that provide signals indicative of the pressure at the clamp drives 8a, 8b and separator drives 10a, 10b. The control system may then selectively open the solenoid valves to control fluid flow in response to the signals received from the pressure sensors.

0258 It will be appreciated that hydraulic circuits are generally better suited to damp and dirty environments with high loading requirements, such as the removal of wire clips from posts. However, for other applications, the hydraulic circuit above could be replaced with an electrical or pneumatic circuit with equivalent functionality and still operate effectively.

0259 The fastener extractor 1, shown in figures 1-10 is orientated with a horizontal clamp-post relative movement. However, it will be appreciated that in alternative embodiments (not shown) the extractor may be aligned such that the relative movement occurs at any angle, from horizontal to vertical. However, a relative movement that is vertical, (or with significant vertical component) has several disadvantages, including:

- a relative movement requiring movement of the clamping members and/or material against gravity, thus requiring a separator that can provide relatively greater force than a corresponding horizontal relative movement;

- a more difficult manual positioning and alignment process for an operator, if the clamping members are below the material, as the operator cannot see the fasteners without additional effort, mirrors or other viewing systems;
- increased potential for detritus to reach working components if the extractor is positioned beneath the material;
- increased safety hazard as the working components would be located closer to the operator comparative to an extractor with drives, pivots etc on the opposing side of the clamping members to the operator.

0260 Figures 13a and 13b show simplified schematic diagrams of the mechanical operation of the extractor 1.

0261 Figure 13a shows the clamp 5 pivoting between opened and clamping positions. In the clamping position, the upper clamping member 6a is shown in dashed lines and solid lines in the open position. Similarly, the clamp drive 8 is shown in an extended state with the clamp 5 being open and in the retracted state (dashed line) when the clamp 5 is closed. The pivoting movement of the clamp drive 8 with respect to the support platform 25 is shown in the relative position between open and clamping positions.

0262 The fasteners 3 protrude from the post 2 and so can be gripped/clamped between the clamping members in the clamping position. The fastener extractor 1 can simultaneously clamp multiple fasteners 3 (along the length of post 2) protruding from the material while not penetrating or deforming the post. This clamping force is provided by the clamp drives 8a, 8b via the clamping members 6a, 6b.

0263 The clamping force is sufficient to deform the fasteners 3 when clamped and so provides a better grip than relying on catching a portion of the fastener, e.g. a nail head.

0264 Figure 13b similarly shows a separator mechanism 9 at a start position as indicated in solid lines and an end position as indicated in dashed lines. Figure 13b also shows the resulting post movement (start in solid lines, end in dashed lines) as the post 2 is pushed away from the clamping member 6a, 6b to position 2'. The separator drive 10 is pivotally connected at one end to the material-engaging portion 11 and at the other end to a frame portion on the support platform 25.

0265 Figure 14 shows an alternative embodiment of an extractor 100 with a linear clamp 106 rather than a pivoting clamp 5 as per the preceding embodiment. The linear clamp 106 as an upper clamping member 106a attached to a shuttle 101, in turn slidably mounted to a rail support 102. The shuttle 101 can thus reciprocate linearly between open and clamping positions. A clamp drive 108 is included and can be actuated to reciprocate the shuttle 101. It will be appreciated

numerous other clamping arrangements may be utilised to achieve such a linear clamp. Similarly, numerous separator arrangements may be utilised.

0266 An extractor 200 with an exemplary alternative separator arrangement is shown in Figure 15 and shows a separator mechanism 209 effectively reversed from the embodiment of figures 1-10. The separator drives 210 are mounted to the underside of the support platform 25 and the material engaging portions 211 extend up through slots in the support platform 25 to engage with the post 2. At the start position, the separator drives 210 are extended and then retracted to pull the post 2 away from the clamping members 6a, 6b as indicated by dashed lines which indicate an end position of the material engaging portions 211.

0267 As previously mentioned, the posts 2 may take the form of 'full-round' 'half-round' or 'quarter-round' posts with the clips 3 positioned on various sides of the post 2. Figure 16a and 16b therefore show the use of interchangeable material supports 44 in providing height and shape adjustment for various shaped posts 2. Figure 16a and 16b show a quarter round post 2q being positioned on a corresponding material support 44. The material support 44 consists of square-section steel tubing in four joined sections arranged over the support platform 25 to support the post 25. Each section has a lug that fits into a corresponding coupling in the support platform 25 to secure the support 44 to the platform 25. Different sized square-section tubing can be used to provide different height material supports 44 to accommodate differently sized posts 2.

0268 Reference herein is made to various aspects and embodiments of the present invention. For clarity and to aid prolixity every possible combination, iteration or permutation of features, aspects and embodiments are not described explicitly. Thus, it should be appreciated that the disclosure herein includes any combination, iteration, multiple or permutation unless explicitly and specifically excluded.

0269 The order in which aspects, embodiments, features or descriptions occur in this description should not be interpreted to necessarily require the preceding aspects, embodiments, features or descriptions.

0270 It should be understood that there exist implementations of other variations and modifications of the invention and its various aspects, as may be readily apparent to those of ordinary skill in the art, and that the invention is not limited by the specific embodiments described herein. Features and embodiments described above may be combined with and without each other. It is therefore contemplated to cover any and all modifications, variations, combinations or equivalents that fall within the scope of the basic underlying principals disclosed and claimed herein.

Claims:

1. A fastener extractor for use in extracting multiple fasteners distributed over a length of material to which the fasteners are affixed, the fastener extractor including:

   - at least one clamp, the at least one clamp including at least one pair of clamping members, each clamping member having at least one fastener-engaging surface, at least one fastener-engaging surface of one clamping member mutually opposing at least one fastener-engaging surface of the other clamping member, thereby forming at least one pair of mutually opposing fastener-engaging surfaces;
   - at least one powered actuator;
   - at least one powered separator, and

   wherein the clamping members are relatively movable between:

   - an open position, and
   - a clamping position, for applying a clamping force to any set of multiple fasteners located between the at least one pair of mutually opposing fastener-engaging surfaces,

   wherein a clamping region is defined by the extents of the at least one pair of mutually opposing fastener-engaging surfaces in the clamping position, and

   wherein the clamping region is elongate, with a clamping length defined by the length of the clamping region orientated approximately perpendicular to the clamping force and approximately parallel with the distribution of the set of multiple fasteners affixed to the length of material,

   wherein the at least one powered actuator is operable to reciprocate the clamping members between the open position and the clamping position, and

   wherein the at least one powered separator is operable to provide relative movement of the material and the clamp.

2. The fastener extractor of claim 1, wherein, where the clamp is in the closed position, each fastener is clamped between mutually opposing fastener engaging surfaces.

3. The fastener extractor of claim 1 or claim 2, wherein each clamping member is at least 300mm in length.

4. The fastener extractor of any one of the preceding claims, wherein the clamping members each include at least one removable wear strip, the wear strip including the fastener engaging surfaces.

5. The fastener extractor of any one of the preceding claims, wherein a said fastener-engaging surface is provided as a continuous or semi-continuous elongate edge extending over at least part of the length of the corresponding clamping member.

6. The fastener extractor of any one of the preceding claims, wherein the position of at least one said clamping member is adjustable to change the separation between clamping members when in the closed position.

7. The fastener extractor of any one of the preceding claims, wherein the separator includes at least one reciprocating material-engaging portion and at least one separator drive, the reciprocating material-engaging portion configured to engage with the material and move the material relative to the clamp, the material-engaging portion being reciprocated between a ‘start’ position and an ‘end’ position.

8. The fastener extractor of claim 7, wherein the material-engaging portion is reciprocated between the ‘start’ position and the ‘end’ position by actuation of at least one separator drive.

9. The fastener extractor of claim 8, wherein the separator drive includes at least one hydraulic ram.

10. The fastener extractor of any one of claims 8-9, wherein the separator includes at least two reciprocating material-engaging portions, longitudinally separated relative to the clamping length.

11. The fastener extractor of claim 10, wherein each material-engaging portion is located adjacent a respective longitudinal end of the clamp.

12. The fastener extractor of claim 10 or claim 11, wherein the separator is configured to provide approximately simultaneous movement of the at least two material-engaging portions relative to the clamping members.

13. The fastener extractor of any one of claims 7-12, wherein the separator material-engaging portions are coupled to a common support platform, the separator moving the clamping members relative to the common support platform.

14. The fastener extractor of any one of claims 7-13, wherein the material engaging portions have a start position that is separated from a material-facing surface of the clamping members by at least 20mm.

15. The fastener extractor of any one of claims 7-14, wherein the material-engaging portions are guided during the material-clamp relative movement such that the material-engaging portion to clamp relative movement is approximately linear.

16. The fastener extractor of any one of claims 7-15, including at least one guide for guiding the material-engaging portions during the material to clamp relative movement such that the material to clamp relative movement is constrained in a plane approximately perpendicular to the clamping length.

17. The fastener extractor of any one of claims 7-14, wherein at least one guide is provided for guiding a said material-engaging portion.

18. The fastener extractor of claim 17, wherein the guide includes a slot, track, rail or similar, to which the material-engaging portion and/or clamp is coupled to move during the material-clamp relative movement.

19. The fastener extractor of any one of claims 17-18, wherein a said material-engaging portion is pivotable relative to the at least one guide.

20. The fastener extractor of any one of the preceding claims, wherein the at least one clamp actuator is configured to reciprocate the clamping members between the open and closed positions.

21. The fastener extractor of any one of the preceding claims, wherein the clamp actuator includes one or more clamp drives.

22. The fastener extractor of claim 21, wherein a said clamp drive is configured to provide at least 12kN of retraction force.

23. The fastener extractor of any one of the preceding claims, wherein at least one said clamping member is pivotable relative to the other said clamping member.

24. The fastener extractor of any one of the preceding claims, wherein the clamping force provided by the clamping members is at least 5kN.

25. The fastener extractor of any one of the preceding claims, wherein a said elongate fastener engaging surface is at least 5mm in width.

26. The fastener extractor of any one of the preceding claims, further including at least one control system connected to the actuator and separator to control same, .

27. The fastener extractor of claim 25 or claim 26, wherein the control system is configured to control at least one clamp drive and at least one separator drive, to:

- provide power to the at least one clamp drive to close the clamp;
- provide power to the at least one separator drive to move the at least one material-engaging portion from a start position to an end position;
- process a signal indicating that the material-engaging portion has reached the end position;
- reverse the drive direction of the at least one separator drive, thereby returning the at least one material-engaging portion to the start position;
- reverse the drive direction of the at least one clamp drive thereby returning the clamp to the open position.

28. The fastener extractor of claim 26 or claim 27, wherein the control system includes at least one hydraulic circuit.

29. The fastener extractor of any one of claims 26-28, wherein the control system includes a hydraulic circuit, the at least one clamp drive including at least one bi-directional hydraulic actuator and the at least one separator drive including at least one bi-directional hydraulic actuator.

30. The fastener extractor of claim 29, wherein the hydraulic circuit includes at least one pump or hydraulic motor, at least one sequencing valve, at least one directional valve, and interconnecting fluid lines, conduits or channels.

31. The fastener extractor of claim 30, wherein the hydraulic circuit is configured to control and provide hydraulic pressure to the:
    - at least one clamp drive - to close the clamp;
    - at least one separator drive - to move the material-engaging portions relative to the clamp;
    - at least one clamp drive - to open the clamp;
    - at least one separator drive - to move the material-engaging portions to the start position.

32. The fastener extractor of claim 30 or claim 31, wherein the hydraulic circuit is capable of sequential activation of the drives and providing fluid pressure to opposing sides of the drives.

33. The fastener extractor of any one of claims 30-32, wherein the directional valve includes:
    - at least one inlet port (P),

- at least two outlet ports (A, B);
- at least one return port (T).

wherein the directional valve includes two internal valves operable to set the directional valve in the following states:

- P -> A, B and T closed
- P -> B, A and T closed
- P -> T, A and B closed

34. The fastener extractor of any one of claims 30-33, wherein the hydraulic circuit is configured to provide fluid flow to perform an extraction phase, including:
    - fluid flow to the at least one clamp drive to close the clamp,
    - a threshold pressure being reached at the at least one clamp drive, and fluid subsequently flowing to the at least one separator drive to move the material engaging portions until the material engaging portions reach the end position.
35. The fastener extractor of claim 34, wherein the hydraulic circuit is configured to provide fluid flow to perform a reset phase, including:
    - fluid flow to the at least one clamp drive to open the clamp, and
    - fluid flow to the at least one separator drive to return the material engaging portions to the start position, and

    wherein the control system is configured to automatically switch the hydraulic circuit to the reset phase upon the material-engaging portion reaching the end position
36. The fastener extractor of claim 34 or claim 35, wherein the hydraulic circuit is configured to provide an idle state, wherein there is no fluid flow to the clamp drive and separator drive.
37. The fastener extractor of claim 36, wherein the control system is configured to automatically switch the hydraulic circuit to the reset cycle upon the material-engaging portion reaching the end position.
38. The fastener extractor of claim 37, wherein the fastener extractor includes a separator position sensor configured to indicate the position of a said material-engaging portion.
39. The fastener extractor of claim 38, wherein the control system is configured to switch the hydraulic circuit to the reset phase when the separator position sensor indicates the material-engaging portion reaches the end position.

40. The fastener extractor of any one of claims 36-39, wherein the control system is configured to automatically switch the hydraulic circuit to the idle state when:
    - an extraction phase is not activated, and
    - the clamp reaches the open position.
41. The fastener extractor as claimed in claim 40, further including a clamp position sensor configured to indicate the position of the clamp to the control system.
42. The fastener extractor of claim 41, wherein the control system is configured to switch the hydraulic circuit to the idle state when the clamp position sensor indicates the clamp is in the open position and the extraction cycle is not activated.
43. The fastener extractor of any one of claims 29-42, wherein the hydraulic circuit includes an emergency cut-off valve, operable to stop hydraulic fluid flow in the hydraulic circuit.
44. The fastener extractor of any one of the preceding claims, including a support platform for supporting fastener extractor components, including the clamp and separator.
45. The fastener extractor of claim 44, wherein the support includes one or more material supports, the material supports being adjustable to adjust the position of the material relative to the clamp.
46. The fastener extractor of any one of the preceding claims, including a housing for enclosing at least a portion of each of the separator and actuator.
47. The fastener extractor of any one of the preceding claims, including an extracted fastener guide for guiding the extracted fasteners away from the clamping members.
48. The fastener extractor of any one of the preceding claims, wherein the clamp actuator includes one or more clamp drives.
49. The fastener extractor of any one of the preceding claims, wherein at least one said clamping member is pivotable relative to the other said clamping member, the pivotable clamping member pivotable about at least two pivot points aligned on a pivot axis parallel with the clamping length.
50. The fastener extractor of any one of the preceding claims, wherein the clamping members each include at least one removable wear strip, the wear strip including the corresponding at least one fastener engaging surface.

51. The fastener extractor of any one of the preceding claims, wherein a said fastener-engaging surface is provided as a continuous or semi-continuous elongate edge, extending over the clamping length.

52. The fastener extractor of any one of the preceding claims, wherein the position of at least one said clamping member is adjustable to adjust the resulting separation between clamping members when in the clamping position.

53. A method of separating multiple fasteners from a material to which the fasteners are affixed, the method performed using a fastener extractor, the fastener extractor including:

    - at least one clamp, the at least one clamp including at least one pair of elongate, and mutually opposing, clamping members, the clamping members being capable of relative movement between an open position and a closed position, wherein each clamping member has at least one fastener-engaging surface,
    - at least one powered actuator, the actuator being operable to move the clamping members together to the closed position, thereby moving the fastener-engaging surfaces to engage with any fasteners located therebetween, and apply a clamping force thereto;
    - at least one powered separator, operable to provide relative movement of the material and clamping members,

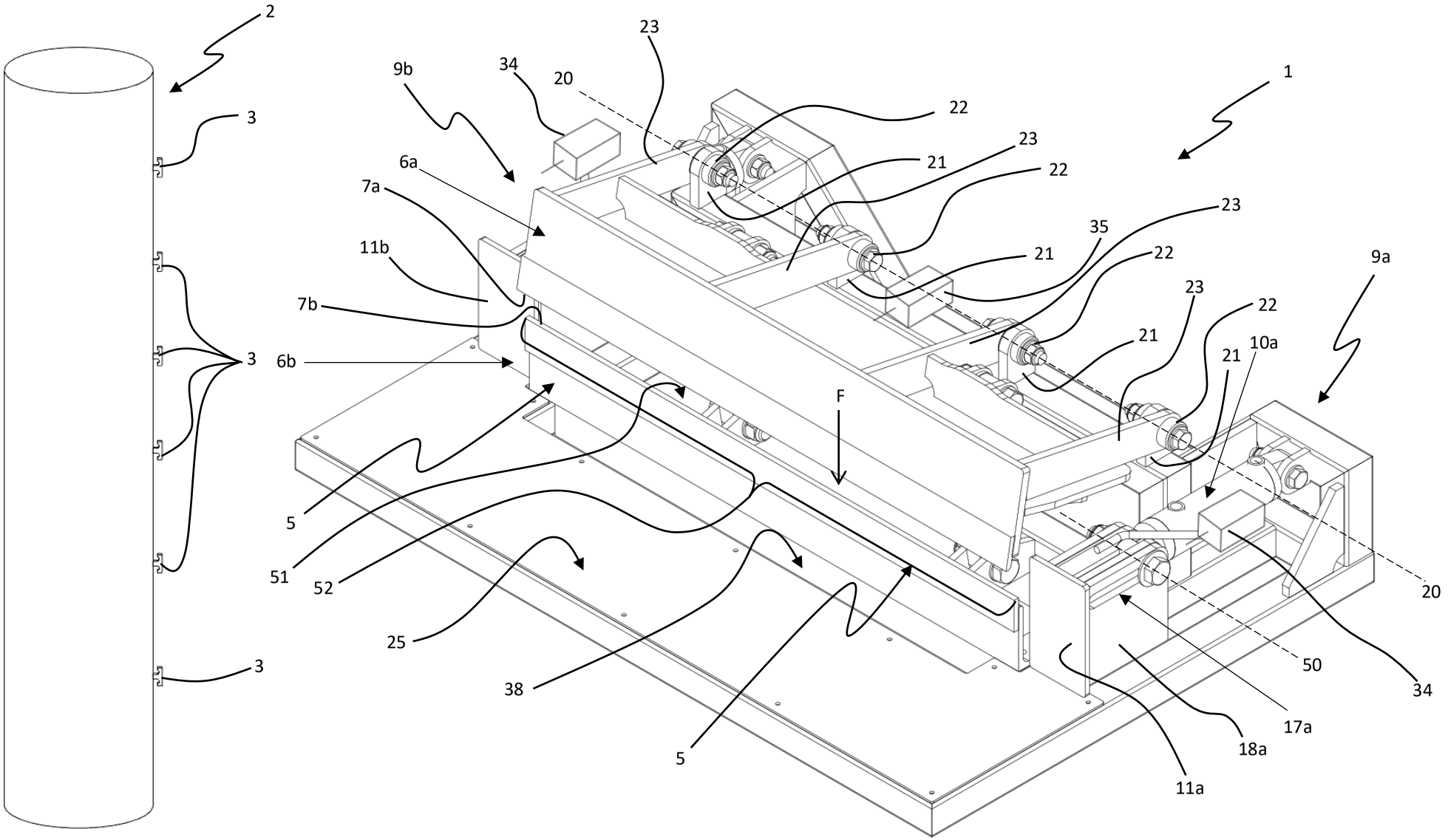
    the method including the steps of:

        - positioning the material, with at least a plurality of attached fasteners located between the fastener-engaging surfaces, and with the clamp in the open position;
        - operating the actuator to move the clamping members together to the closed position, thereby moving the fastener-engaging surfaces to engage and clamp any fasteners located therebetween.
        - operating the separator to provide relative movement of the material and clamping members, the relative movement being sufficient to separate the fasteners from the material.

54. The method of claim 53, further including operating the actuator to move the clamp to the open position, thereby releasing the extracted fasteners from between the fastener-engaging surfaces.

55. The method of claim 53 or claim 54, including simultaneously clamping multiple fasteners protruding from the material, wherein the clamping members do not penetrate or deform said material in the closed position.

56. The method of any one of claims 53-55, including simultaneously clamping multiple fasteners protruding from the material, wherein the clamping members at least partially deform the fasteners.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9a
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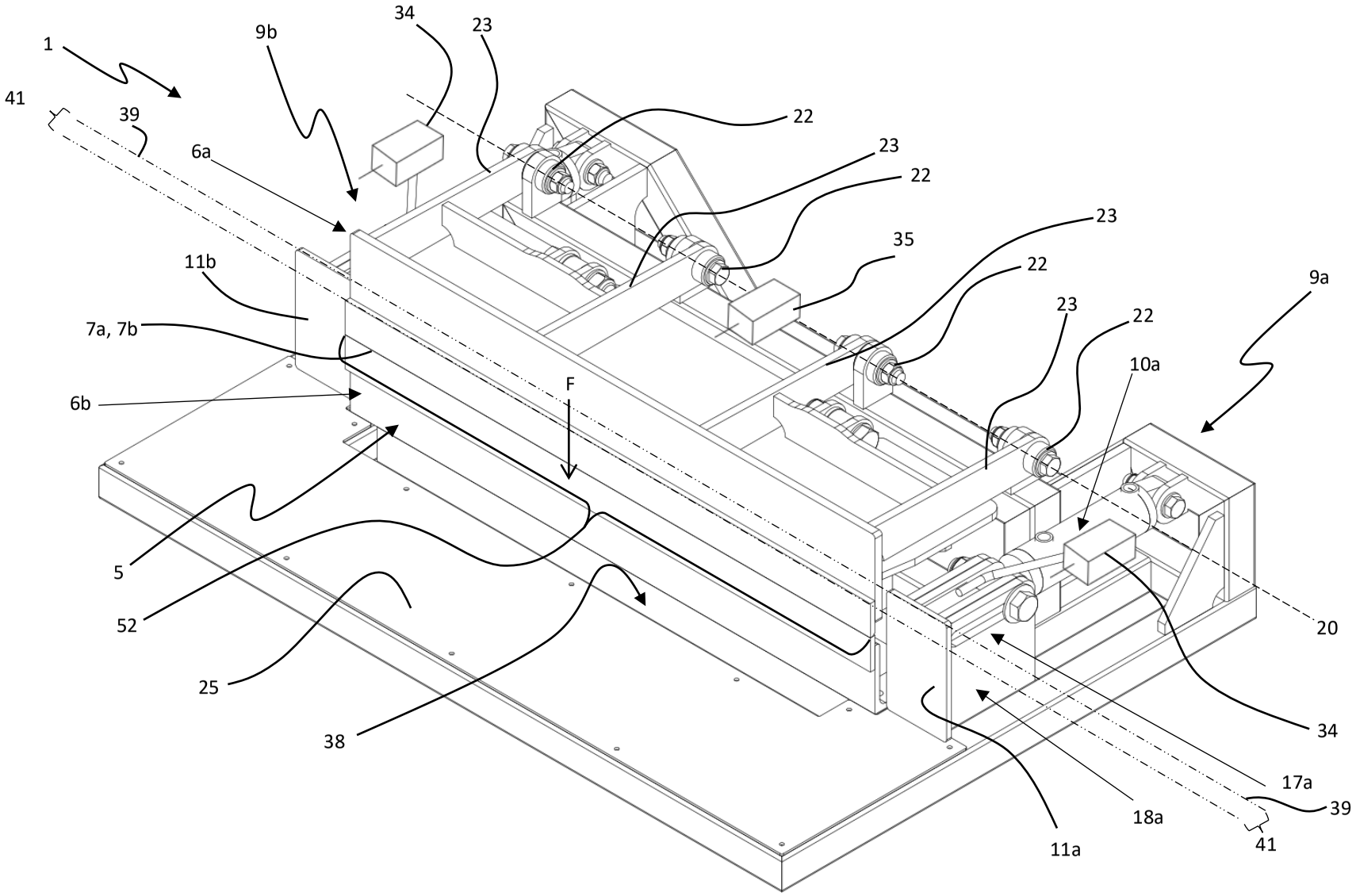
11a
20

Figure 2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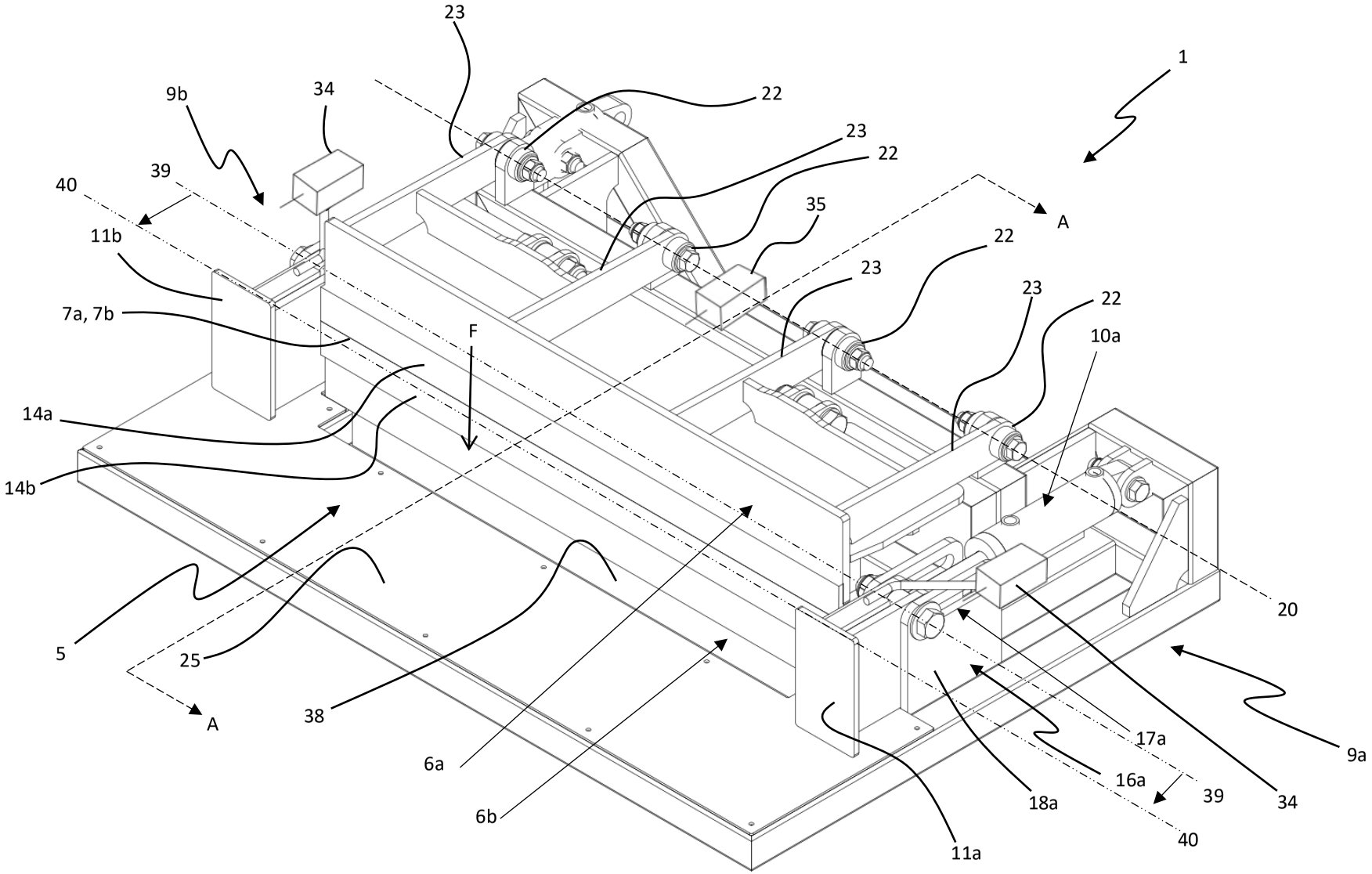
11a

Figure 3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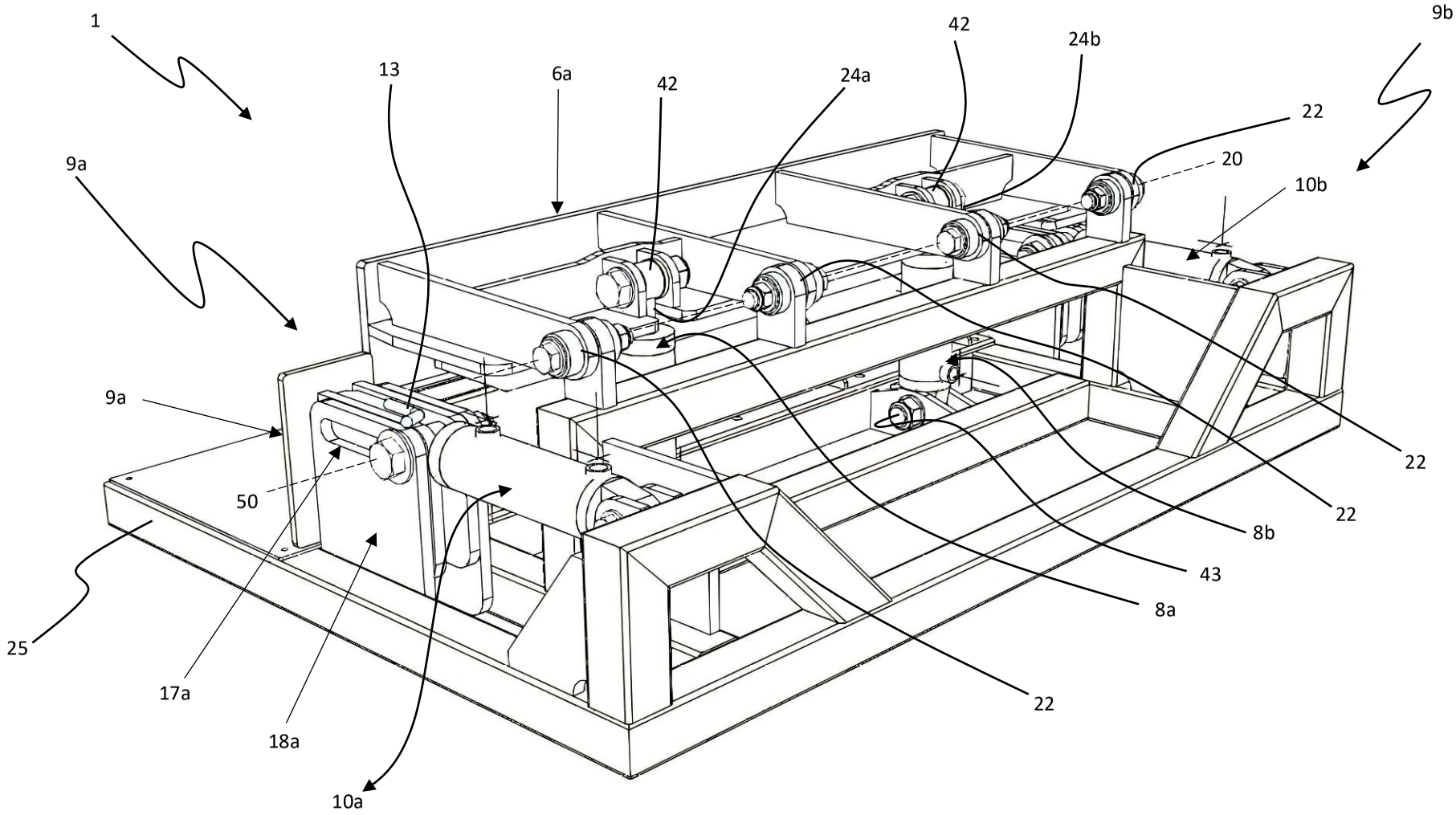
39
34
40
11a
A

Figure 4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8b
43
8a
25
17a
18a
22
10a

Figure 3

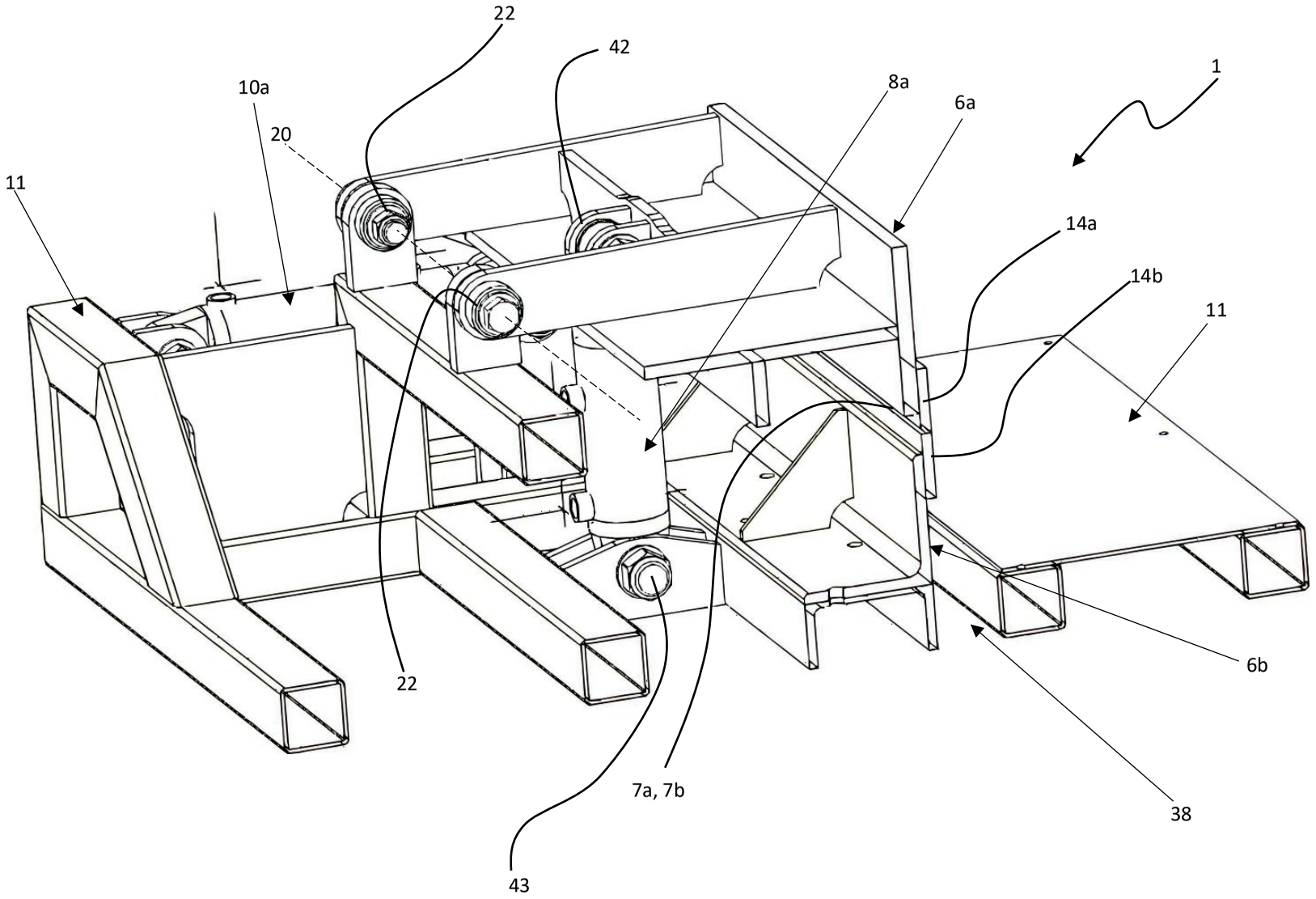

Figure 6

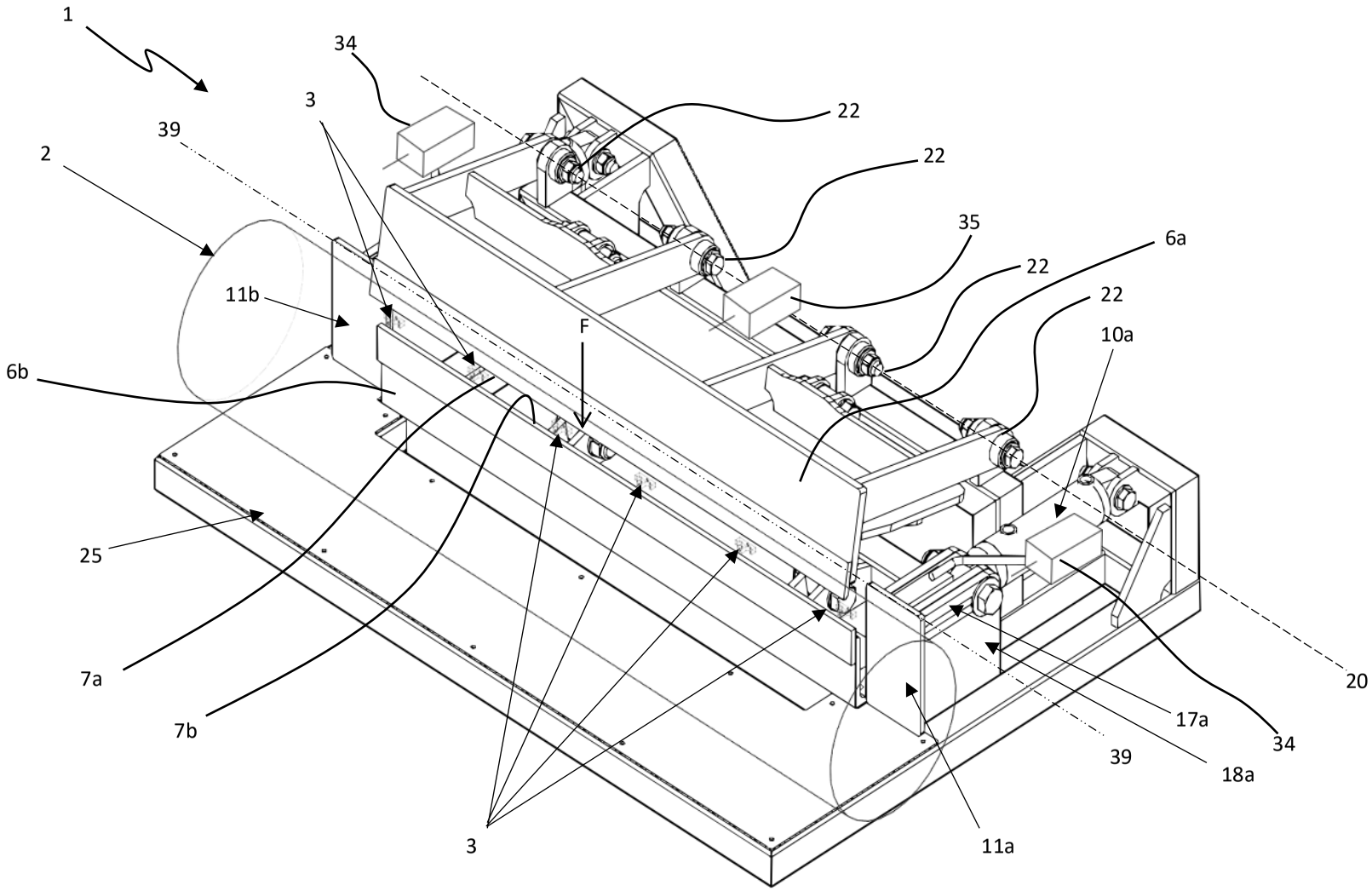
1
34
3
39
2
22
22
35
6a
22
22
11b
F
10a
6b
25
7a
7b
3
11a
17a
18a
39
34
20

Figure 7

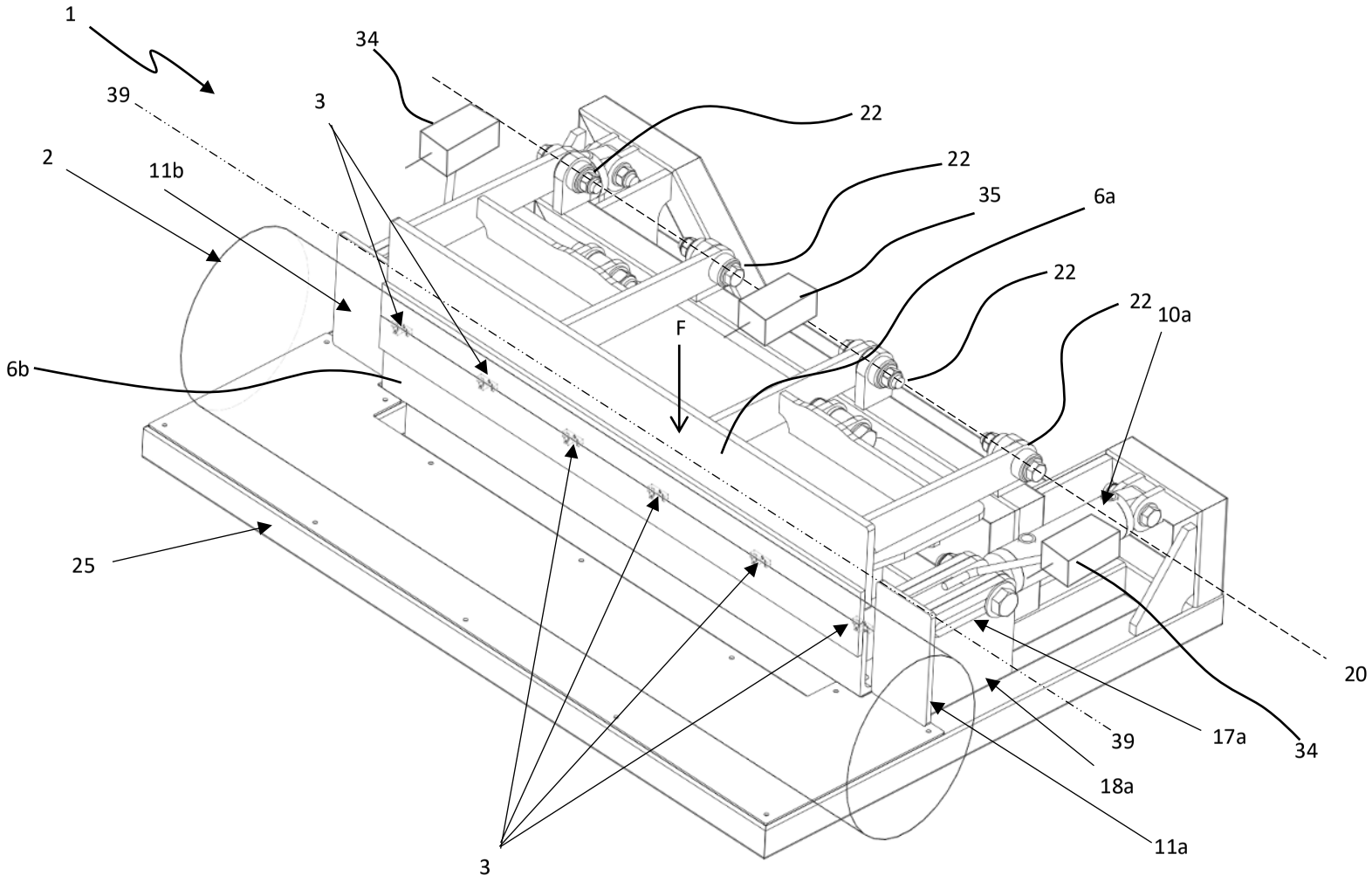

Figure 8

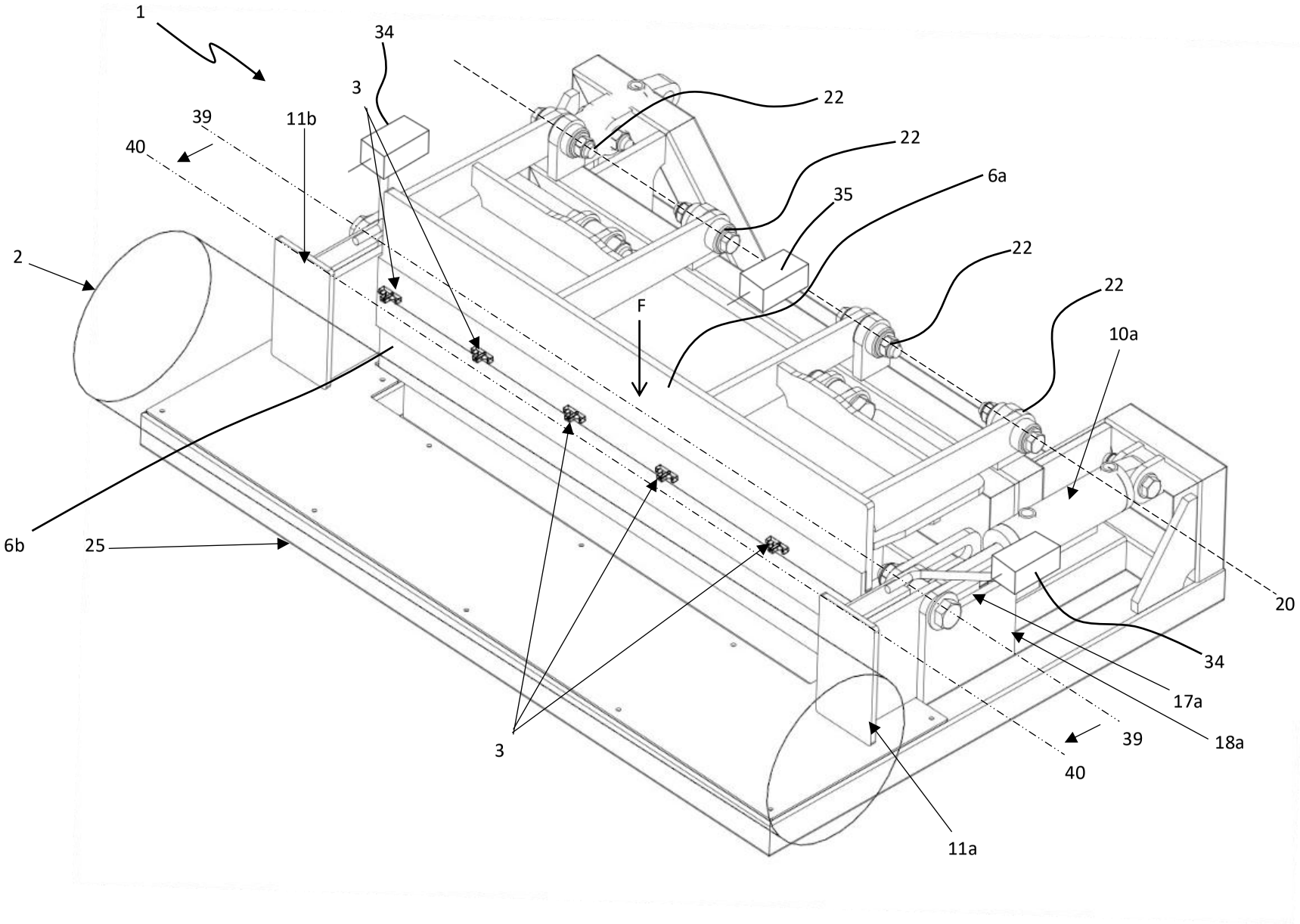
1
34
3
39
11b
40
22
22
6a
35
22
22
2
F
10a
6b
25
20
34
17a
18a
39
3
40
11a

Figure 9

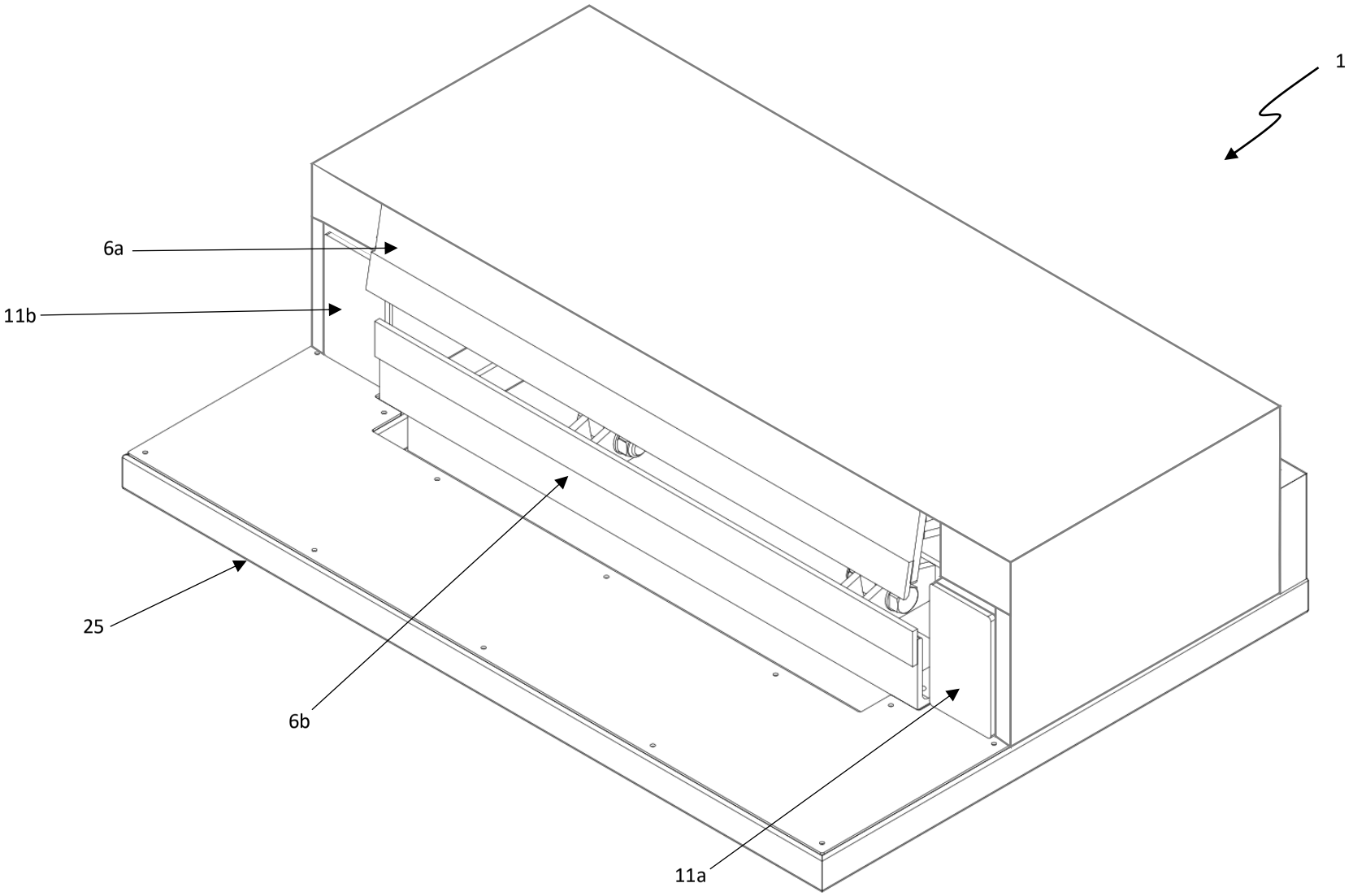

Figure 10

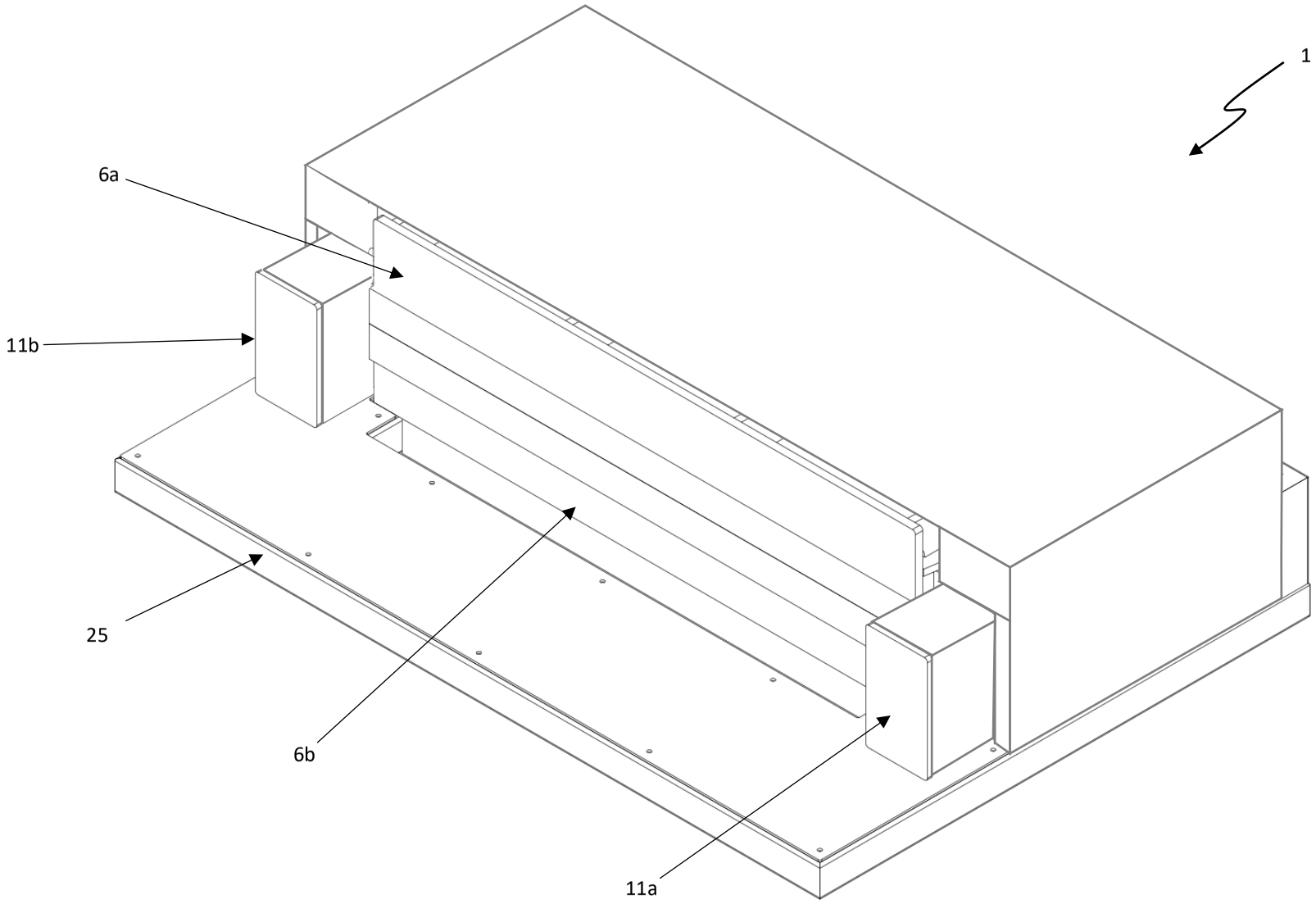

Figure 11

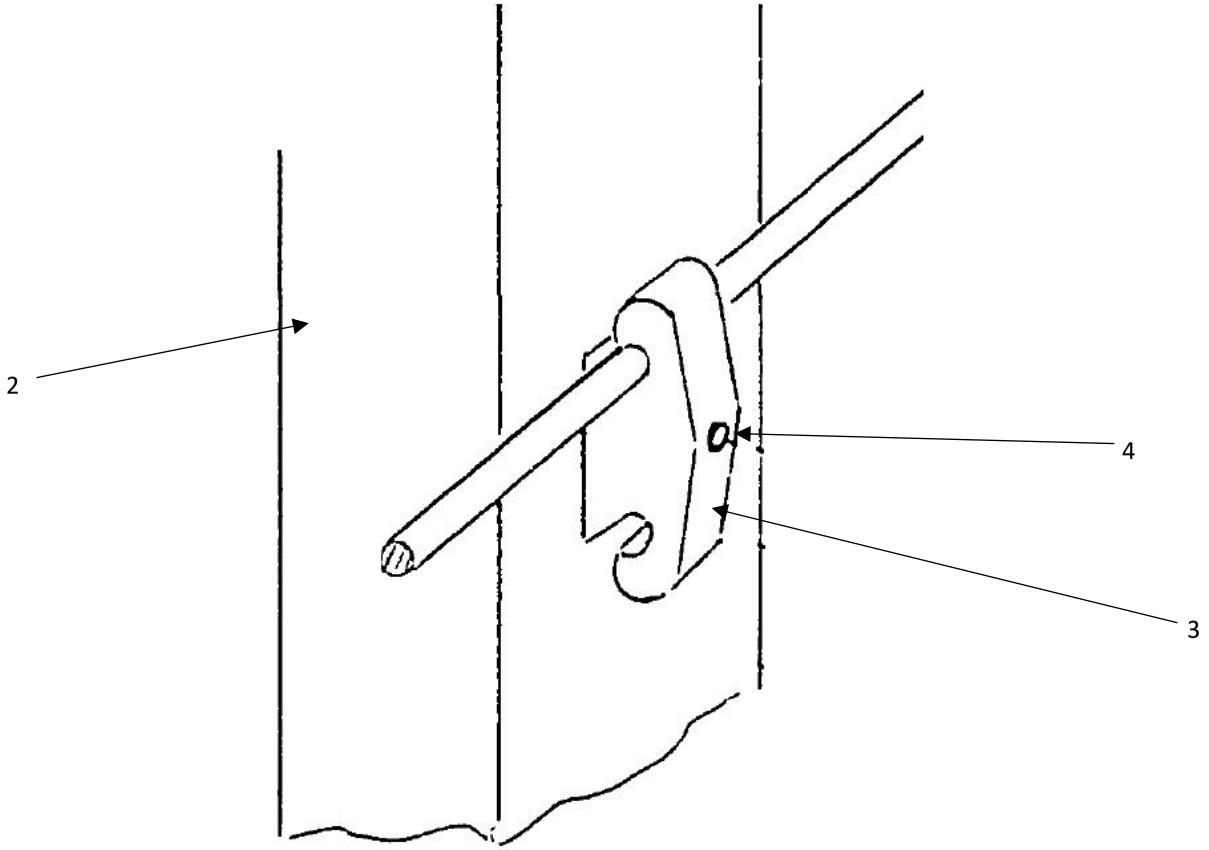

Figure 12

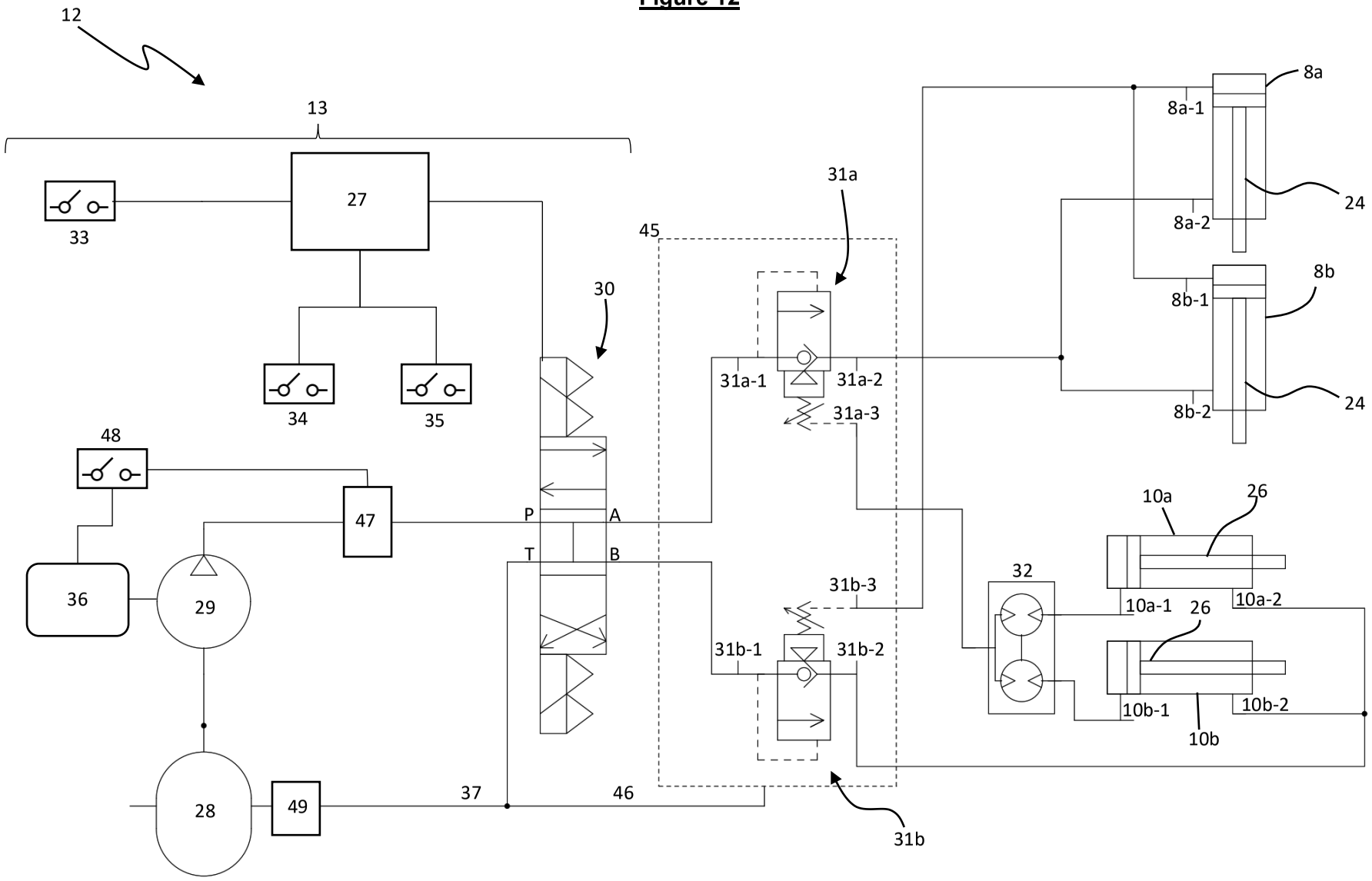
12
13
27
33
34
35
48
47
36
29
28
49
37
46
30
45
31a
31a-1
31a-2
31a-3
31b
31b-1
31b-2
31b-3
P
A
T
B
32
8a
8a-1
8a-2
24
8b
8b-1
8b-2
24
10a
26
10a-1
10a-2
26
10b-1
10b-2
10b

Figure 13a

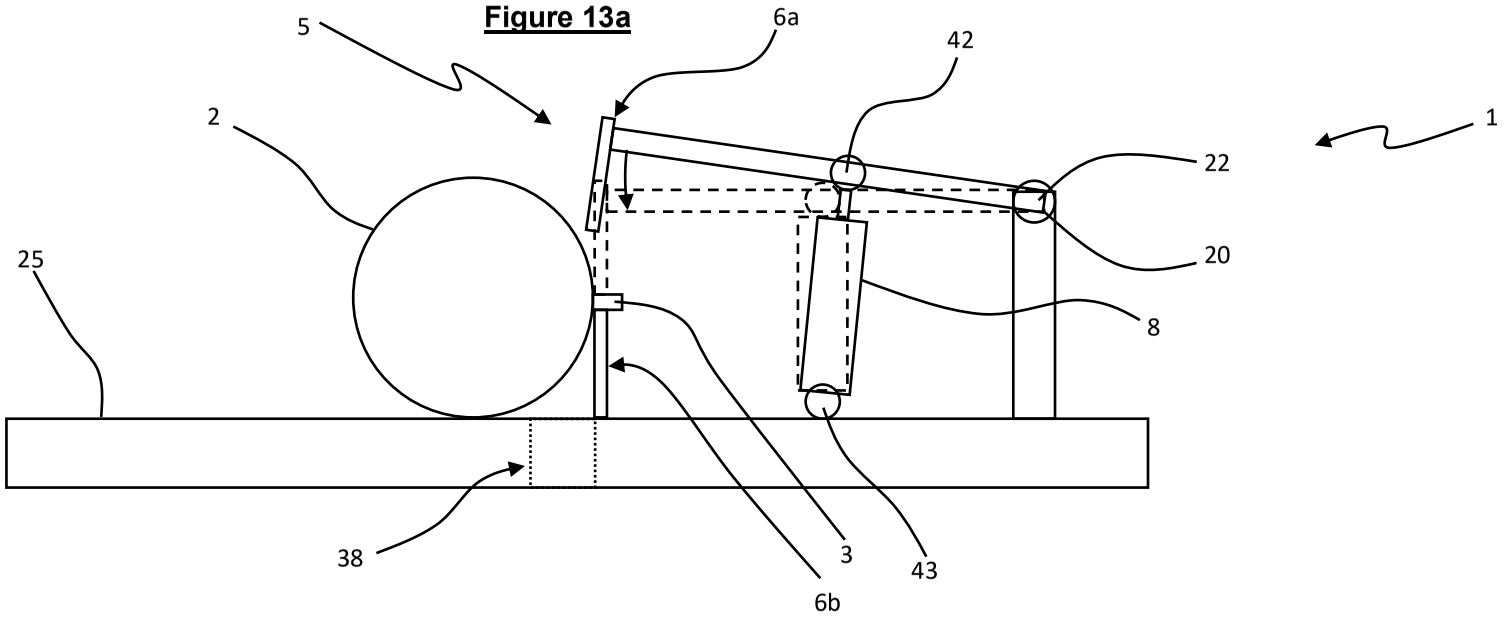

Figure 13b

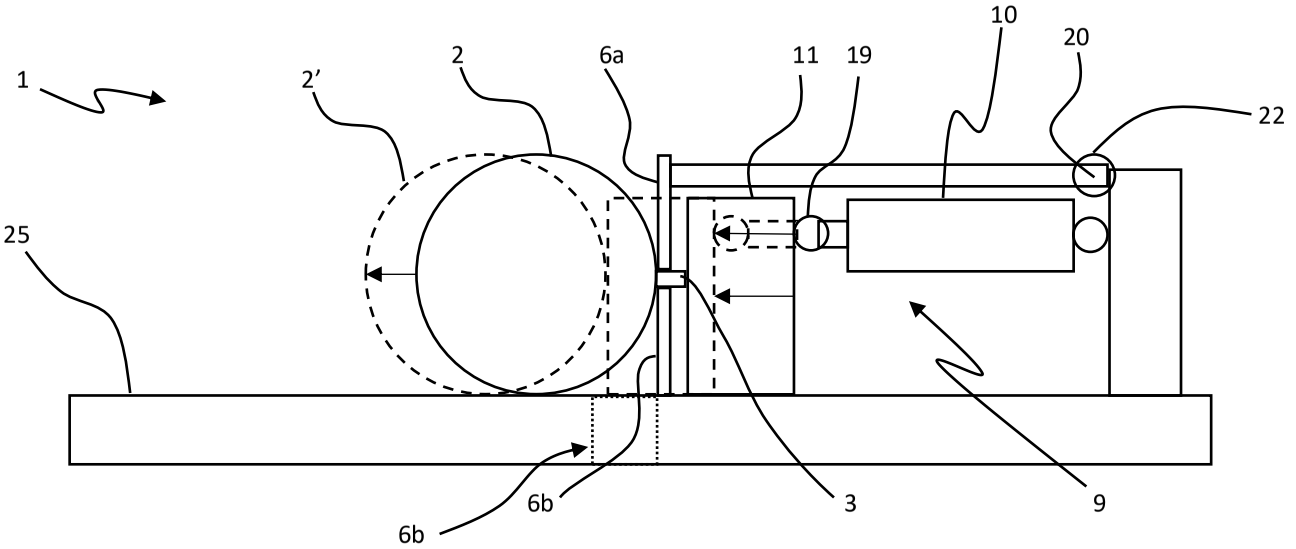

Figure 14

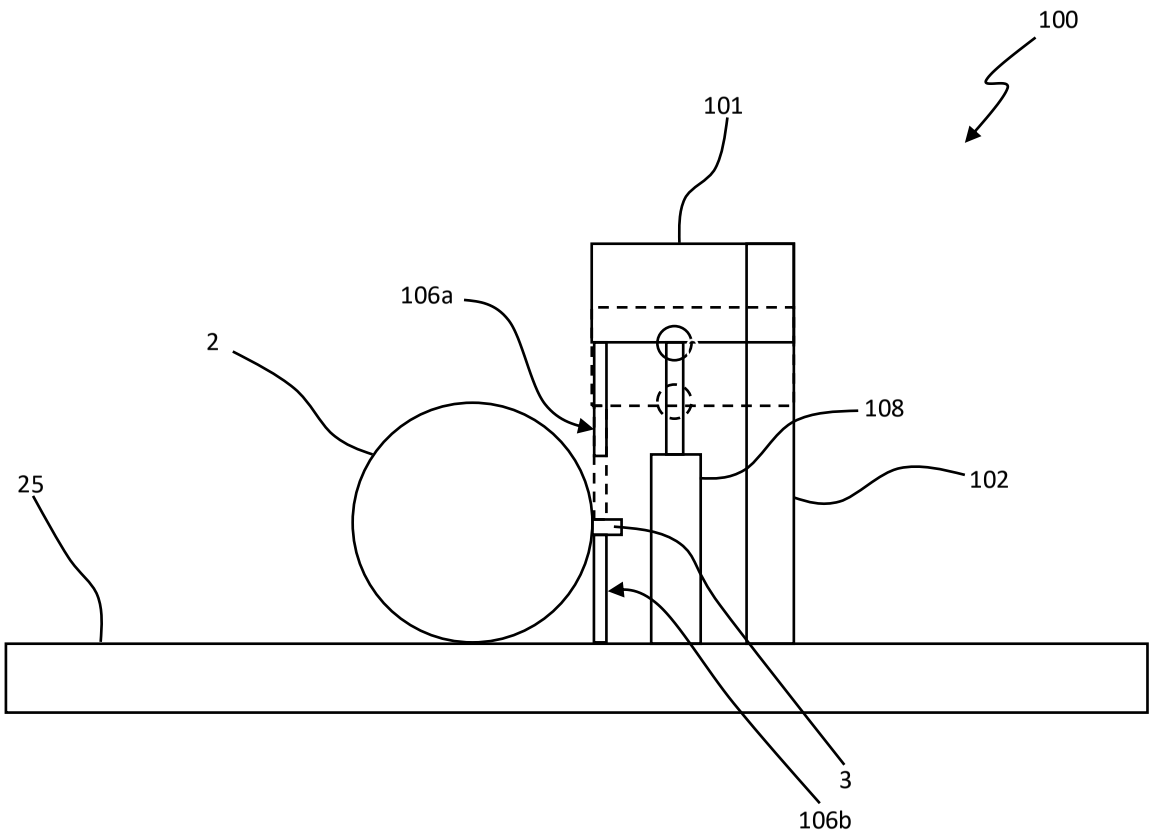

Figure 15

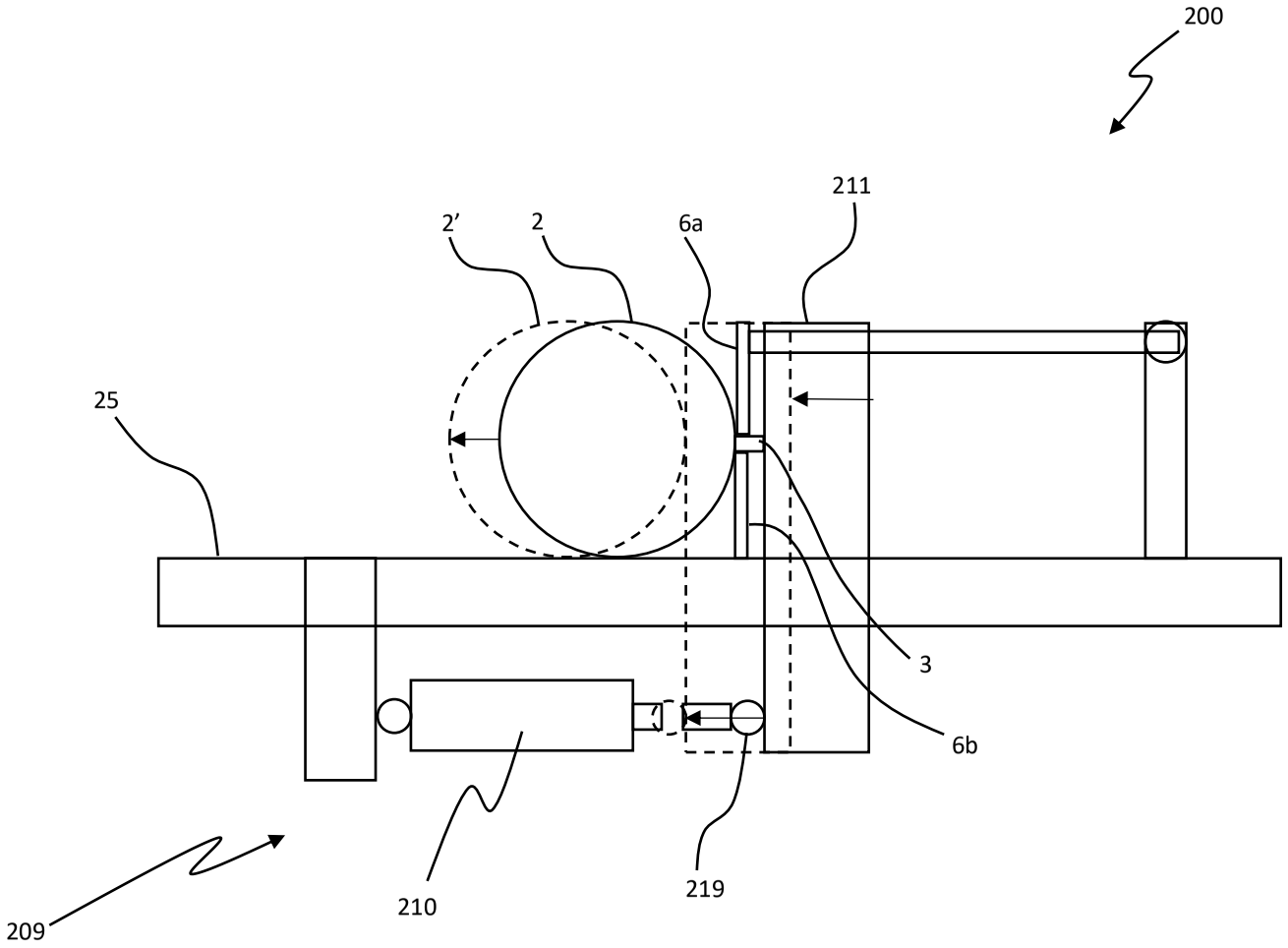

Figure 16a

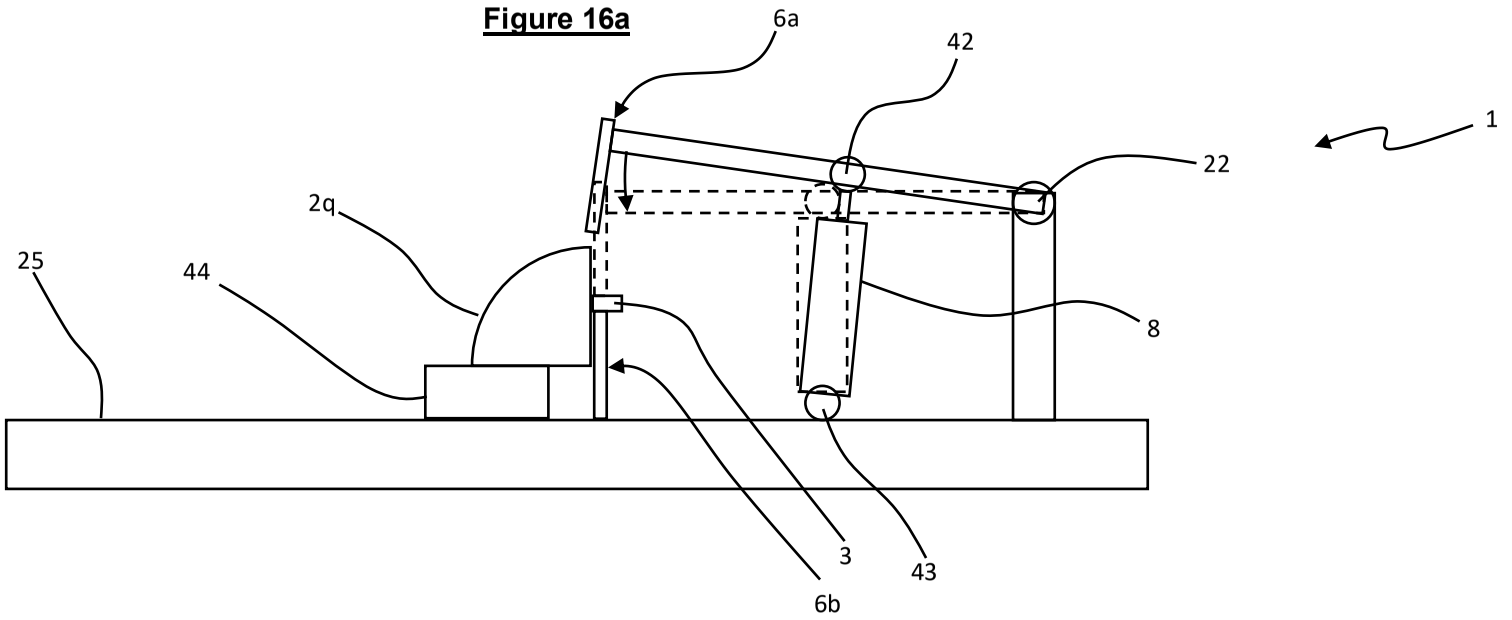

Figure 16b

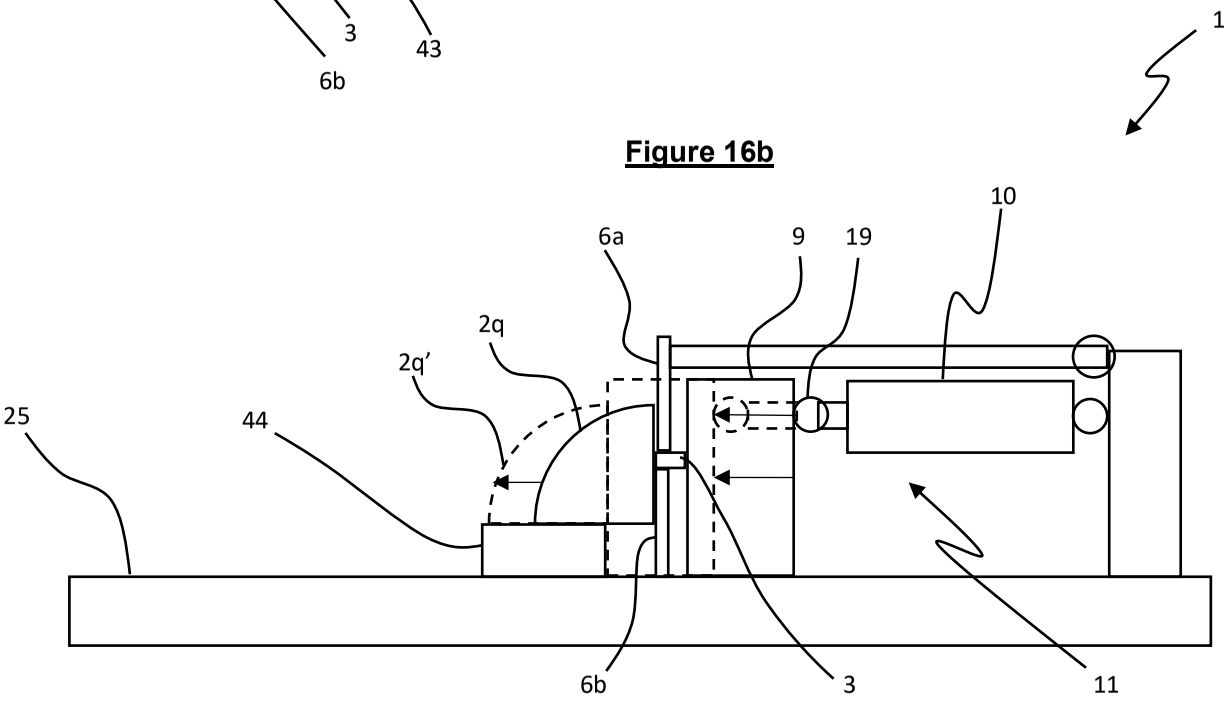

Figure 17

(Prior Art)